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Acceptable Knowledge Document for INEEL Stored Transuranic Waste— Rocky Flats Plant Waste

February 28, 2003

Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC

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Rev. 3

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Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC (BBWI)
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
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EXECUTIVE SUMMARY

A consistent, defensible, and auditable record of acceptable knowledge for waste generated at the Rocky Flats Plant (RFP) which was sent to the Idaho National Engineering and Environmental Laboratory (INEEL) for storage is provided in this document and its supporting documentation. The wastes addressed by this document include containers currently in the INEEL accessible storage inventory, and those containers characterized and sent for disposal at the Waste Isolation Pilot Plant (WIPP) facility during the 3,100 m^3 Project. The inventory consists of transuranic (TRU) waste generated at the Rocky Flats Plant (RFP) from 1971 through 1988. The wastes consist of a wide variety of matrices generated during plutonium parts production and support operations including recovery, treatment, maintenance, laboratory, and research and development. The inventory also contains TRU wastes generated by nonroutine events including renovations, spills, fires, and decommissioning.

The Resource Conservation and Recovery Act (RCRA) and New Mexico Hazardous Waste Management Regulations authorize waste generators and treatment, storage, and disposal facilities to use acceptable knowledge (AK) in appropriate circumstances to make hazardous waste determinations. Knowledge of the materials and processes that generated a waste was used for characterization of TRU wastes when adequate documentation relating to the generating processes and composition of the wastes were available. For example, wastes contaminated with one or more spent solvents were characterized as listed hazardous waste if the compound(s) had been used for their solvent properties in the processes that generated the waste.

Acceptable Knowledge (AK) 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.

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 revision also includes confirmatory AK data generated during the 3,100 m^3 Project; the results of data collection and confirmatory sampling and analyses conducted at the INEEL in compliance with the WIPP Contact Handled Waste Acceptance Criteria (CH-WAC) and Waste Analysis Plan (WAP) as documented in Waste Stream Profiles (WSPs). Over 600 sources of information were obtained, reviewed, and incorporated into a data management system. 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.

In an effort to facilitate the review of the available acceptable knowledge documentation, the inventory was subdivided into “waste groups” consisting of materials with similar physical and chemical properties. Once AK information was identified and obtained, the documentation was incorporated into source files. As this document is reviewed the reader can access the source files to review the references as needed.

This document was organized to provide the reader a comprehensive presentation of the TRU waste inventory ranging from descriptions of the historical plant operations that generated and managed the waste to specific information about the composition of each waste group. The requirements that dictated and directed TRU waste characterization and authorized the use of the acceptable knowledge approach are listed in Section 2. The historical operations, waste management, characterization, certification activities associated with the inventory as well as the TRU waste inventory are summarized in Section 3. Sections 5.0 through 26.0 contain descriptions of the individual waste groups in the

inventory including waste generation, waste packaging, and waste characterization. The source references and acceptable knowledge documents reviewed during this program are listed in Appendix A.

An expanded discussion for each waste group of potential radionuclide contaminants, in addition to other physical properties and interferences that could potentially impact radioassay systems, was included in Revision 1 of this document. Revisions l and 2 also included a table in Appendix B, which was compiled to allow the user to determine the building or area of generation for containers in inventory using the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific contaminants. The accessible storage drum inventory was segregated in the table by waste group (numbered the same as the sections in this document), Item Description Code (IDC), Container Prefix, and building of generation. The generation dates, process descriptions, and potential radionucide contaminants were identified for each population. The Appendix B table is no longer included in this document. Information from the Appendix B table has been incorporated into each section for easier reference. Revision 3 was developed to augment the AK information as well as incorporate the results from confirmatory solid, and headspace gas sampling and analysis conducted for the 3,100 m^3 Project.

Information in previous revisions of this document was used by the 3,100 m^3 Project to delineate waste streams as required by the WIPP Hazardous Waste Facility Permit, Attachment B .Waste Analysis Plan. Waste stream delineation is documented in Radioactive Waste Management Complex (RWMC) EDF-922, “Identification of Transuranic Waste Streams.” The information was then used to compile waste stream profiles (WSPs) and acceptable knowledge waste stream summary sheets for each waste stream. Each waste stream summary sheet was attached to its corresponding WIPP WSP and submitted to the DOE Carlsbad Field Office for review and approval. This revision can be used to continue the characterization of the RFP wastes for disposal at the WIPP facility.

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TABLES

ACRONYMS

AK	Acceptable Knowledge
ANL-W	Argonne National Laboratory-West
ATMX	atomic materials rail transfer
BWR	Backlog Waste Reassessment
CBFO	Carlsbad Field Office (formerly known as the Carlsbad Area Office [CAO])
CFR	*Code of Federal Regulations*
CH	contact -handled
CH-WAC	Contact-Handled Waste Acceptance Criteria
CH-WAP	Contact-Handled Waste Analysis Plan
CWS	Chemical Warfare Service
DCP	direct cementation process
DHDECMP	dihexyl-n,n-diethylcarbamoyl methylphosphonate
DOD	United States Department of Defense
DOE	United States Department of Energy
DOR	direct oxide reduction
DOT	United States Department of Transportation
DU	depleted uranium
ECL	Environmental Chemistry Laboratory
EDF	Engineering Design File
EDL	economic discard limit
EDTA	ethylenediaminetetraacetic acid
EPA	United States Environmental Protection Agency
EU	enriched uranium
FBI	Fluidized Bed Incinerator
FY	fiscal year

GGT	Gas Generation Testing
HEPA	high efficiency particulate air
HSA	high specific activity
HSG	headspace gas
HVAC	heating, ventilation, and air conditioning
HWN	hazardous waste number
IDC	item description code
INEEL	Idaho National Engineering and Environmental Laboratory
LASL	Los Alamos Scientific Laboratory
LDR	land disposal restriction
LLNL	Lawrence Livermore National Laboratory
LLW	low level waste
LRL	Lawrence Radiation Laboratory
LSA	low specific activity
MBA	Material Balance Area
MCP	Management Control Procedure
MDC	minimum detectable concentration
MDL	method detection limit
MSE	molten salt extraction
ND	not detected
NDA	nondestructive radioassay
NGS	nuclear generating station
NMAC	New Mexico Administrative Code
OASIS	Organic and Sludge Immobilization System
ORNL	Oak Ridge National Laboratory
PADC	passive/active drum counter

PAN	passive/active neutron
PCBs	polychlorinated biphenyls
PRQL	program required quantitation limit
PVC	polyvinyl chloride
QAPD	Quality Assurance Program Description
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RFP	Rocky Flats Plant
RH	remote-handled
RPC	residue process container
RTL	regulatory threshold limit
RTR	real-time radioscopy
RWMC	Radioactive Waste Management Complex
SGRS	SWEPP Gamma-Ray System
SGS	segmented gamma scan
SRV	size reduction vault
SS	special source
SWB	standard waste box
SWEPP	Stored Waste Examination Pilot Plant
TCLP	toxicity characteristic leaching procedure
TISAB	total ionic strength adjustment buffer
TRIPS	Transuranic Reporting, Inventory, and Processing System
TRU	transuranic
TRUPACT	transuranic package container

TSA	Transuranic Storage Area
TSCA	Toxic Substance Control Act
TWCP	TRU Waste Characterization Program
UCL	upper confidence limit
VE	visual examination
WAC	Waste Acceptance Criteria
WAGS	Waste Assay Gamma System
WAP	Waste Analysis Plan
WG Pu	weapons grade plutonium
WIPP	Waste Isolation Pilot Plant
WIPPOK	WIPP okay (meets applicable WIPP criteria)
WSIC	Waste Stream Identification and Characterization
WSP	Waste Stream Profile
WSPF	Waste Stream Profile Form
WSRIC	Waste Stream and Residue Identification and Characterization
WSS	Waste Stream Summaries
WSSS	Waste Stream Summary Sheet
WWCP	WIPP Waste Characterization Program

Acceptable Knowledge Document for INEEL Stored Transuranic Waste — Rocky Flats Plant Waste

1. INTRODUCTION

The purpose of this document and supporting documentation is to present the Acceptable Knowledge (AK) available for Rocky Flats Plant (RFP) waste stored in accessible storage at the Idaho National Engineering and Environmental Laboratory (INEEL). The accessible storage inventory contains drums and boxes of transuranic (TRU) waste shipped to the INEEL from 1971 through 1988. This document focuses on the generation, packaging, and characterization of the drummed waste, since the waste boxes will be reprocessed prior to disposal. The primary objective of this document is to provide a consistent, defensible, and auditable record of AK for the inventory.

The Resource Conservation and Recovery Act (RCRA) and New Mexico Hazardous Waste Management Regulations authorize waste generators and treatment, storage, and disposal facilities to use AK in appropriate circumstances to make hazardous waste determinations. AK 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. AK, as an alternative to sampling and analysis, can be used to meet all or part of the waste characterization requirements under RCRA [P131, P132, P134, P136, P137].

Since TRU waste presents serious health and safety risks to waste characterization personnel, excessive handling and manipulation of the waste is to be minimized. In addition, TRU waste generated by Department of Energy (DOE) facilities consists of debris and other complex matrix materials that are extremely difficult to sample. The collection of representative samples of TRU waste is extremely costly and increases the potential of human exposure to radiation and, under most circumstances, is not feasible. TRU waste can be and has been characterized using AK in conjunction with radioscopy, headspace gas analysis, and solidified waste analysis, while limiting exposure to personnel and the environment [P131].

Data collected from a variety of sources relating to historical RFP operations, waste generating processes, and waste management practices are presented in this document. In addition, the available information used to determine the physical, chemical, and radiological composition of the TRU waste inventory and confirmatory data generated during characterization activities for the 3,100 m^3 Project at the INEEL have been incorporated. The information on waste is divided into waste groups that consist of populations of drums with similar sources and waste matrices. The AK record consists of Rocky Flats and INEEL information from the following sources:

Published Documentation. In general, published documents represent the most reliable, reviewed, and controlled sources of information. This documentation consists primarily of controlled documents, previously controlled documents, and procedures, in addition to formal reports, studies, and databases. Published sources are identified by the "P" at the beginning of the reference number, which appear in brackets throughout the document.

Unpublished data. Unpublished data consist of information from a variety of sources that has typically not received peer review and may not have been formally controlled. In many cases, this information will consist of the raw data used during the development of published documentation. Unpublished data include, but are not limited to, draft documents, analytical data packages, log books, and inventory lists, in addition to internal reports, studies, and databases. Unpublished sources are identified by the "U" at the beginning of the reference number, which appear in brackets throughout the document.

Correspondence. Correspondence consists of communication records relating to specific TRU waste streams or TRU waste management. Typically, this information consists of uncontrolled records of internal and external communications. Correspondence includes, but is not limited to, internal and external letters, memos, directives, telecommunication records, meeting minutes, personnel interview summaries, and discrepancy reports. Correspondence sources are identified by the "C" at the beginning of the reference number, which appear in brackets throughout the document.

Over 680 sources were collected and reviewed during the development of this document. The sources were incorporated into an inventory that is controlled as an AK record, (Appendix A) [U094]. When possible, discrepancies between sources were resolved by contacting cognizant personnel or collecting additional information. If the inconsistency was irresolvable, the most conservative information was incorporated into the document. Discrepancy reports were generated and referenced either directly in this document or in waste-stream specific waste stream summary sheets (WSSSs).

Appendix A contains the Acceptable Knowledge Record Inventory of the data sources. An Appendix B was included in revisions 1 and 2 of this document. This appendix had been compiled to allow the user to determine the building or area of generation for containers in inventory using the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific contaminants. The accessible storage drum inventory is segregated in the table by waste group (numbered the same as the sections in this document), item description code (IDC), container prefix, and building of generation. The generation dates, process descriptions, and potential radionuclide contaminants also were identified for each population. The Appendix B table is no longer included in this document. Information from the Appendix B table has been incorporated into each section for easier accessibility.

2. REQUIREMENTS

This section lists the requirement and guidance documents that dictate or direct waste characterization and certification activities associated with this program.

- **Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant (WIPP CH-WAC), DOE/WIPP-02-3122.** The Waste Isolation Pilot Plant (WIPP) Contact-Handled (CH) Waste Acceptance Criteria (WAC) defines the quality requirements associated with the certification of compliance with WIPP operational and safety criteria. The CH-WAC requires the preparation of certification plans and associated quality assurance plans describing site-specific transuranic (TRU) waste certification programs. Acceptable Knowledge requirements defined in the CH-WAC include radionuclide and defense waste determinations.

- **40 Code of Federal Regulations (CFR) Parts 260 through 265, 268, and 270.** Title 40 of the CFR describes the federal hazardous waste regulations implementing the RCRA. The regulations define the requirements for making a hazardous waste determination and obtaining hazardous waste permits, as well as control the land disposal of hazardous wastes. Also included are standards for waste generators; transporters; and treatment, storage, and disposal facilities.

- **WIPP Hazardous Waste Facility Permit, Attachment B – Contact-Handled TRU Waste Analysis Plan (CH-WAP), U.S. Environmental Protection Agency (EPA) No. NM4890139088.** The WIPP CH Waste Analysis Plan (CH-WAP) defines the requirements that each generating site must implement before disposal of CH TRU waste. The CH-WAP contains the requirements set forth in 20 NMAC 4.1.500 (incorporating 40 CFR 264.13), including waste characterization sampling methods, statistical methods used in sampling and analysis, quality assurance objectives and data validation techniques, and waste characterization using AK.

- **Quality Assurance Program Document (QAPD), CAO-94-1012.** The QAPD establishes, implements, and maintains an effective quality assurance program that supports compliance with applicable federal, state, and local regulations and U.S. Department of Energy Orders and requirements and is applicable to the Carlsbad Field Office (CBFO) quality assurance program. The QAPD also establishes the minimum requirements for CBFO personnel, and guidance for the development and implementation of quality assurance programs by all participants managed by the CBFO.

- **Quality Assurance Project Plan for the Transuranic Waste Characterization Program, PLN-190.** This Quality Assurance Project Plan (QAPjP) specifies the quality of data necessary and the characterization techniques employed at INEEL to meet the requirements of the WIPP CH-WAP. The QAPjP describes the roles and responsibilities of all participants in the Transuranic Waste Characterization Program.

- **Collection, Review, and Management of Acceptable Knowledge Documentation, Management Control Procedure (MCP)-2989.** This INEEL procedure outlines the method for compiling, reviewing, and managing AK documentation. This procedure was implemented to assure that a consistent, defensible, and auditable record is created.

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3. TRU WASTE GENERATION

The RFP operations associated with the generation of the TRU waste inventory stored at the INEEL, a brief history of the plant, and a summary of the mission of the RFP site are described in this section. In addition, plutonium operations, uranium operations, TRU waste management, TRU waste certification, and the inventory are described.

3.1 Rocky Flats Plant Description and Mission

The DOE's Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver. The 6,550-acre government-owned and contractor-operated facility was part of the nationwide nuclear weapons production complex. Groundbreaking for the first permanent buildings for the plant began in 1951. By 1954, approximately 700,000 square feet of building space had been completed. As the plant operations expanded, as much as 1.6 million square feet were 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). A map of the plant highlighting the buildings that generated TRU waste is provided in Figure 3-1 [P053].

The plant had two primary missions during the period of operations from 1952 through 1990: the production of triggers for nuclear weapons, and the processing of retired weapons for plutonium recovery. The triggers, also known as pits, were the first-stage fission bombs used to initiate the second-stage fusion reaction in hydrogen bombs [P053]. Plutonium metal was recovered from retired warheads and manufacturing residues, and was also imported from the Hanford Reservation in Washington State and the Savannah River Plant in South Carolina. Weapons parts were manufactured from plutonium, uranium, beryllium, stainless steel, and various other metals [P053].

In general, the plant's primary mission changed little from 1952 until 1990 when plutonium operations were suspended. In the early 1960s, the DOE implemented the single mission concept to reduce redundant operations between DOE facilities. At that time, Rocky Flats became the primary manufacturer for nuclear weapon triggers. 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 [P053].

The general design of the trigger did not change dramatically since 1958, although the relative amounts of metals, dimensions, and other features of the parts were modified over the years. The primary materials of construction included plutonium, uranium, beryllium, aluminum, and stainless steel. Other metals such as cadmium, vanadium, silver, and gold were also used in some of the parts. 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 [P053].

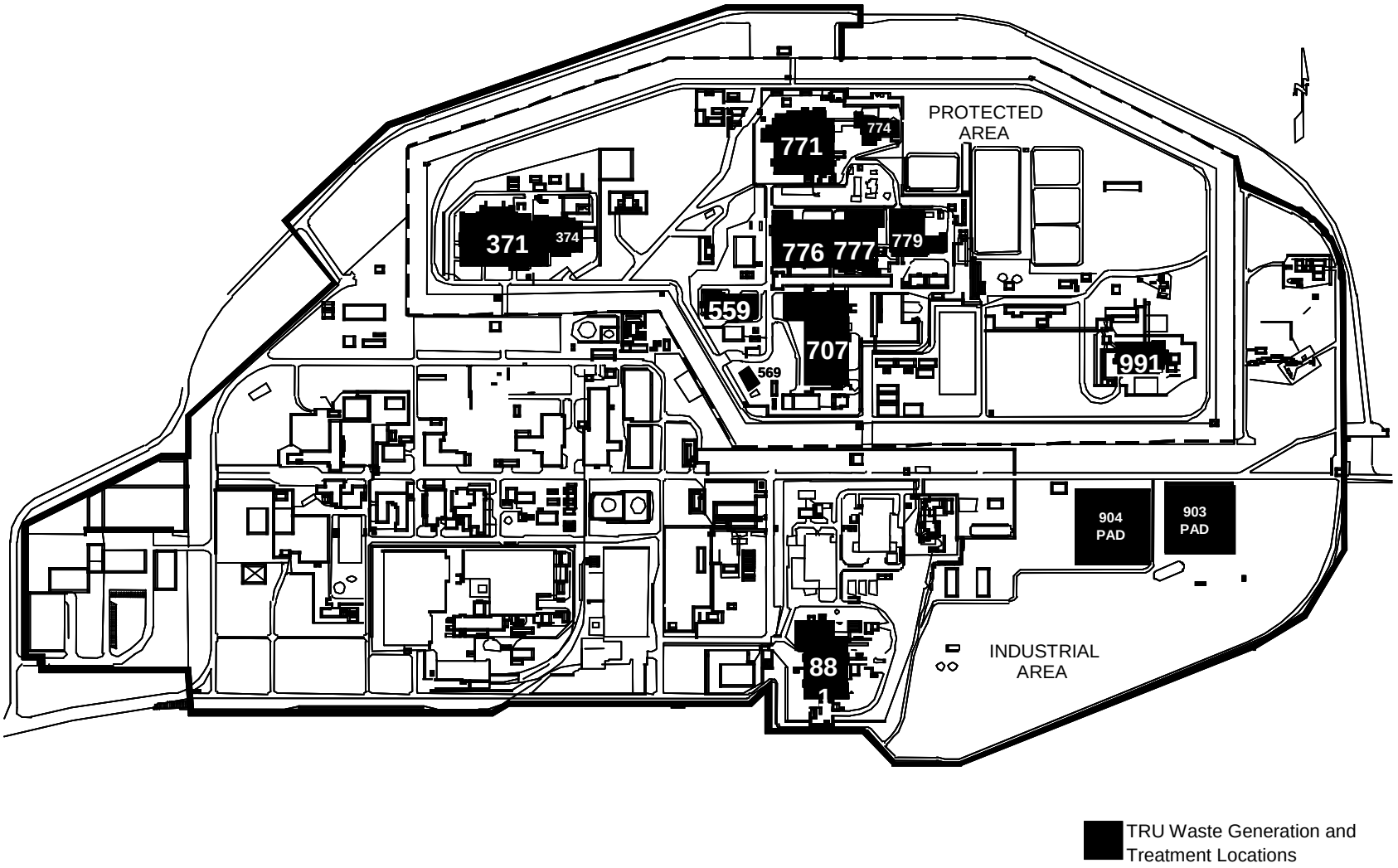

Figure 3-1. Rocky Flats Plant.

3.1.1 Defense Waste Determination

The U.S. DOE Carlsbad Field Office (CBFO) defines defense waste as nuclear waste derived from the manufacture of nuclear weapons and operation of naval reactors. *Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, DOE/WIPP-02-3122 (CH-WAC) [P327] 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:

1. Naval reactors development
2. Weapons activities, including defense inertial confinement fusion
3. Verification and control technology
4. Defense nuclear materials production
5. Defense nuclear waste and materials by-products management
6. Defense nuclear materials security and safeguards and security
7. Defense research and development.

Virtually all of the TRU waste generated at Rocky Flats was generated through defense program weapons activities. Furthermore, 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. 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 Rocky Flats can be clearly classified as defense-generated TRU waste and is therefore eligible for disposal at the WIPP [C188, C190, C191].

3.2 TRU Waste Operations

Waste materials contaminated with transuranic radionuclides were generated during the fabrication, assembly, and processing of nuclear weapons components in the DOE weapons production complex [P028]. The term "transuranic" refers to the man-made actinide elements with atomic numbers greater than uranium (atomic number 92). Plutonium and americium are the primary transuranic actinides encountered in DOE weapons facilities [P020]. Since the mid-1980s, the DOE has defined transuranic waste as materials contaminated with greater than or equal to 100 nanocuries of alpha-emitting transuranic radionuclides with a half-life greater than 20 years per gram of waste matrix [P028].

In 1973, the DOE established 10 nanocuries per gram of alpha activity as the threshold at which waste would be defined as TRU. This definition included all radionuclides with "long" half-lives and the transuranic isotopes except plutonium-238 and -241. In addition, the uranium-233 isotope and daughter products were included in the definition. For this reason, the INEEL inventory contains waste that is low-level by the current DOE standard [P020].

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. After processing, approximately 70% of the volume of waste shipped off

site was low-level and 30% was TRU [P014]. Most of the low-level waste (LLW) was shipped to the Nevada Test Site.

The primary radionuclides contained in Rocky Flats TRU waste were weapons-grade plutonium, americium-241, and enriched uranium. In addition, wastes generated by liquid waste treatment operations did contain depleted uranium (see Section 3.2.4). The nominal isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are listed in Table 3-1 [C039, C130, P152, P161, P166, P169, P210, P227, U064].

Table 3-1. Nominal Compositions of Radionuclide Mixtures at RFP in Weight Percent.

Weapons-Grade Plutonium (WG Pu)		Enriched Uranium (EU)		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	~ 1.0%	^{234}U	~ 0.0006%
^{241}Pu[a]	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%		

a. Includes ^{241}Am daughter product.

TRU wastes generated at the RFP were primarily associated with operations that manufactured, recovered, and treated plutonium metal and plutonium containing materials. In addition, TRU waste was generated during activities that supported plutonium production, including maintenance, laboratory, and research and development operations. Non-routine events, including renovations, spills, fires, and decommissioning, also generated TRU waste. Plutonium-related operations conducted in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 generated the vast majority of the TRU waste at the plant. Table 3-2 briefly summarizes the operations of these buildings associated with the TRU waste inventory [P060, P061, P062, P070, P077, P078, P079, P081, P082].

In addition to the waste generated by plutonium operations, a small amount of TRU waste may have been generated by "special order" work in Building 881. The non-routine operations involved the machining of uranium-233 in an area normally used for uranium-235. Materials shipped to INEEL contaminated with uranium-233 would be managed as TRU waste. Some plutonium-contaminated waste may have also been generated during the leaching of uranium and beryllium site-return parts in Building 881. These parts were sprayed with nitric acid to remove surface plutonium contamination. The uranium and beryllium leaching process was moved to Building 771 between 1973 and 1975 [C072, C110, U057].

Table 3-2. Plutonium Operations.

Building	Operations	Primary Functions
371	Recovery	Electrorefining of non-specification plutonium metal [P067]
	Waste Treatment	Stabilization of incinerator sludge, heels (sand, slag, and crucibles), and resins [P067]
	Storage	Automated materials handling system [P067]
	Laboratory	Analytical and chemical standards laboratory [P053]

Table 3-2. (continued).

Building	Operations	Primary Functions
374	Waste Treatment	Aqueous waste treatment, sludge stabilization, and salt immobilization [P053]
559	Laboratory	Plutonium analytical laboratory conducting spectrochemical, chemical, and mass spectrometric analyses [P053]
707	Production	Plutonium foundry and casting [P053]
		Part rolling, cutting, forming, and machining [P053]
		Part assembly [P053]
		Part calibration, weighing, leak testing, and measurement [P053]
771	Recovery	Recovery of plutonium from solid wastes, liquids, and plutonium oxide using dissolution, incineration, leaching and ion exchange technology [P061]
	Laboratory	Radiochemistry, chemical standards, reagent preparation, and research and development (R&D) support [P061, P067]
	Research and Development	Plutonium metallurgy supporting production operations [P053]
		Chemical technology supporting actinide recovery, separation, and purification [P053]
774	Waste Treatment	Aqueous and organic liquid waste treatment and sludge stabilization [P077]
776	Recovery	Pyrochemical processing to extract, purify, and recover plutonium and americium using molten salt extraction, direct oxide reduction, pyroredox, and electrorefining technology [P078]
		Processing of pyrochemical salt to recover plutonium [P078]
	Research and Development	Development of coating technologies and pilot plant fluidized bed incinerator [P067]
	Waste Treatment	Fluidized bed incinerator for liquid and solid low-level waste [P067]
		Size reduction, sorting, washing, and packaging of solid waste materials [P053]
777	Production	Back-up and special assembly of parts using welding and joining technologies [P053]
		Disassembly, cleaning, and briquetting of site-return parts and metal for further processing [P053]
		Part machining, coating, and etching [P067]
		Dimensional, weight, radioscopy, density, stress, and pressure testing of parts for production control [P053, P067]
	Research and Development	Fabrication of classified parts and fitting specialty parts and materials [P053]
	Laboratory	Plutonium metallurgy and tritium analysis [P067]
779	Research and Development	Development and refinement of production, recovery, purification, and waste treatment technologies [P053]
	Recovery	Leaching of parts to remove and recover surface contaminants [P053, P062, P067]

3.2.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Building 707, constructed in 1972, was the primary weapons components production facility at the RFP. Building 707 was constructed after a fire in 1969 shut down foundry and machining operations in Building 776 [P053]. Figure 3-2 illustrates the general flow of plutonium through the production, recovery, and purification operations at the plant.

The foundry in Building 707 cast acceptable-purity metal into ingots that were shaped by rolling, forming, and machining processes. The resulting shapes were assembled into the finished parts. Rejected parts, metal scraps, and turnings were returned to the foundry to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to be recovered in Building 771. Assembled units were either sent to Pantex for final assembly or retained at the plant for testing or surveillance [P052].

3.2.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Dissolution and leaching technologies were used in Building 771 recovery operations to extract plutonium from waste materials and other residues. Plutonium purification was performed primarily in Buildings 371, 776, 771, and 779. Figure 3-2 illustrates the relationship between the production, recovery, and purification operations at the plant [P052].

Recovery operations in Building 771 used acid dissolution to dissolve solid materials containing plutonium. The resulting liquid was processed by a series of ion exchange, precipitation, evaporation, calcination, fluorination, and reduction operations to produce plutonium metal to be recycled back into production operations [P052]. Building 771 also recovered plutonium surface contamination from enriched uranium hemishells and recovered and purified americium-241 [P164].

Plutonium metal from returned parts and metal from other DOE facilities was purified at the RFP. Parts containing plutonium and enriched uranium returned to Rocky Flats were disassembled in Building 777 [P079]. Beginning in 1967, molten salt extraction was used in Building 776 to recover americium from plutonium metal using sodium chloride, potassium chloride, and magnesium chloride. The purified plutonium metal was sent either to the Building 707 foundry or the electrorefining processes in Building 371 or to Building 776 if the metal contained other impurities. Americium in the extraction salts were recovered using a variety of technologies including ion exchange and a salt scrub process that used a magnesium salt extractant [P052, P053, P113, U047].

Electrorefining operations in Buildings 371 and 776 were used primarily to purify metal from other production processes that did not meet the purity specification required by the foundry. The metal included non-specification metal from direct oxide reduction, molten salt extraction, plutonium fluoride reduction, and miscellaneous metal from the foundry. Electrorefined buttons were sent to the foundry to be batched and then cast. Anode heel from electrorefining operations was alloyed with aluminum for processing at the Savannah River Site [P052].

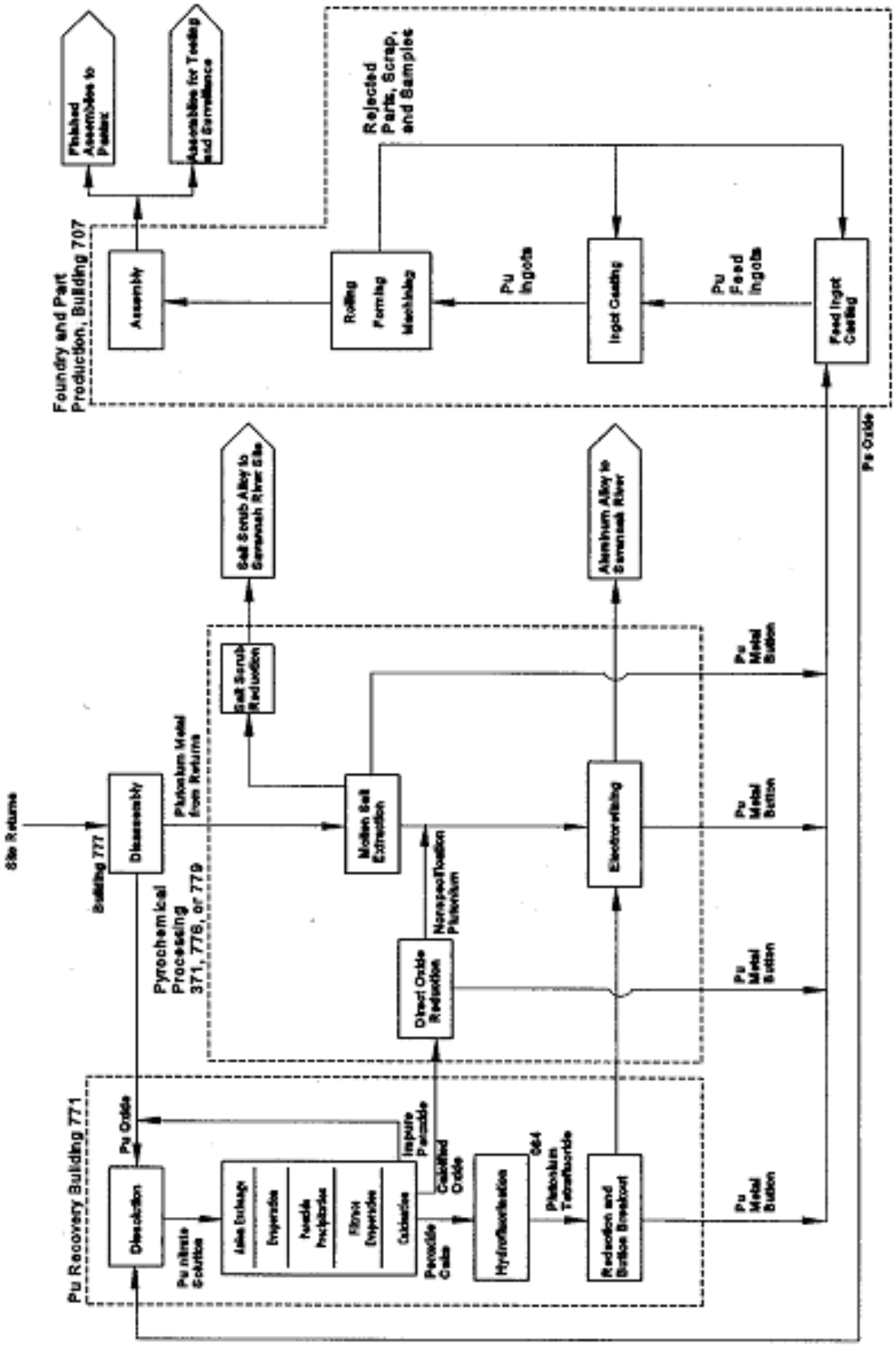

Figure 3-2. Plutonium Production, Recovery, and Purification Flow Diagram.

3.2.3 Laboratory Operations

The laboratories in Buildings 371, 771, and 559 supported production operations at the site. The primary function of the laboratories was to provide sampling and analytical support for production activities. In addition, the laboratories supported recovery, purification, and liquid waste treatment operations.

Building 371 had an analytical laboratory and a chemical standards laboratory. The chemical standards laboratory prepared standards for various users and inspected standards used in the other operations. The analytical laboratory analyzed samples from various operations on site [P081].

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process [P067].

Building 771 housed analytical and chemical standards laboratories. The chemical standards laboratory prepared control sample standards for the analytical laboratories in Buildings 371, 559, and 771. The analytical laboratory provided analytical support for plutonium operations [P061, P067].

3.2.4 Waste Treatment

Waste processing at Rocky Flats treated both liquid and solid process wastes. Liquid waste treatment was conducted in Building 774 (which was built in 1952) and Building 374 (which began operation in 1980) [P053]. Solid transuranic waste treatment was performed in Buildings 771 and 776.

Treatment of solid transuranic wastes was conducted in Buildings 771 and 776. Building 771 processed wastes containing recoverable amounts of plutonium. Building 776 processed wastes contaminated with quantities of plutonium that would not be economical to recover. Waste treatment operations in Building 776 consisted primarily of size reduction, sorting, washing, and packaging of solid waste materials for disposal. The fluidized-bed incinerator in Building 776 received low-level, plutonium-contaminated, combustible solid and liquid wastes [P052, P067]. Building 771 also housed an incinerator for processing combustible wastes [P053, P061, P067, U047].

Liquid waste treatment operations have had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building-771. Radionuclides were removed from the aqueous waste by precipitation technology [P053]. Liquid process waste streams contained varying amounts of most radioactive and chemical compounds used at the plant. The most common radioactive materials handled consisted of weapons-grade plutonium, americium, enriched uranium, and depleted uranium [P164]. Around 1965, an evaporator was installed in Building 774 to treat Building 774 second-stage liquids and wastewater from the solar ponds. The Building 774 evaporator was taken out in 1979, and these liquids were transferred to Building 374 for treatment. Prior to September 1984, Building 774 treated rinse waters from cyanide electroplating operations in Building 444 [P052, P067]. Building 774 also processed organic liquid wastes such as plutonium-contaminated oil and solvent mixtures generated from plutonium machining. The spent organic liquids were filtered and then mixed with a solidifying agent [P052, P053, U047].

Liquid waste streams containing depleted uranium originated primarily from operations conducted in Buildings 444, 447, 865, and 883. Uranium casting, machining, and assembly were performed in Building 444 until 1989 when the foundry in this building was shut down. Building 447 operations

included casting, welding, chemical milling, and heat treatment. Building 865 was built in 1972 to support research and development of beryllium and depleted uranium operations associated with casting, machining, rolling, heat treating, chemical etching, and cleaning. Uranium rolling, shearing, blanking, trepanning, forming, and heat treating were conducted in Building 883. Uranium processing in Building 883 increased considerably between 1980 and 1985 to support the manufacturing of hundreds of tons of depleted uranium for armor plates for the Army's M1A1 tank [P053].

In addition to uranium and plutonium contaminants, other radioactive elements may have been introduced from streams originating from special order work, laboratory, and research and development activities [P164]. Radionuclides that Rocky Flats has handled or had the potential to handle in kilogram quantities included americium-241, natural uranium and thorium, and uranium-233 [C159, U064]. Radioisotopes handled in gram quantities, primarily for research and analytical activities, included curium-244, neptunium-237, thorium-228, uranium-233, plutonium-238 and -242, low NGS plutonium (≈3% plutonium-240), and power grade plutonium (up to 20% ^{240}Pu and 1% ^{241}Pu) [C134, C137, C185, P179, U064].

Radioisotopes used for research and analytical activities included [U064]:

Actinium (^{228}Ac)
Aluminum (^{26}Al)
Americium (^{241}Am[a], ^{243}Am)
Antimony (^{125}Sb)
Argon (^{39}Ar)
Barium (^{133}Ba[a])
Bismuth (^{207}Bi)
Cadmium (^{109}Cd)
Californium (^{250}Cf, ^{252}Cf[a])
Carbon (^{14}C[a])
Cerium (^{139}Ce)
Cesium (^{134}Cs, ^{137}Cs[a])
Chlorine (^{36}Cl)
Cobalt (^{57}Co[a], ^{60}Co[a])
Curium (^{244}Cm, ^{246}Cm)
Europium (^{152}Eu, ^{154}Eu)
Holmium (^{166m}Ho[a])
Iodine (^{129}I, ^{131}I)
Iridium (^{192}Ir[a])
Iron (^{55}Fe[a])
Krypton (^{85}Kr)
Lead (^{210}Pb[a])
Manganese (^{54}Mn)
Mercury (^{203}Hg)
Neptunium (^{237}Np)
Nickel (^{63}Ni)
Plutonium (^{236}Pu, ^{238}Pu[a], ^{239}Pu[a], ^{240}Pu[a], ^{241}Pu[a], ^{242}Pu)
Polonium (^{210}Po[a])
Potassium (^{40}K)
Promethium (^{147}Pm[a])
Protactinium (^{231}Pa, ^{234}Pa)
Radium (^{226}Ra[a])
Ruthenium (^{106}Ru)
Selenium (^{75}Se[a])
Silver (^{110}Ag)
Sodium (^{22}Na)
Strontium (^{85}Sr, ^{90}Sr[a])
Technetium (^{99}Tc)
Thallium (^{204}Tl[a])
Thorium (^{228}Th, ^{230}Th)
Tin (^{113}Sn)
Tritium (^{3}H[a])
Uranium (^{232}U, ^{233}U[a], ^{235}U[a], ^{236}U)
Ytterbium (^{169}Yb[a])
Yttrium (^{88}Y, ^{90}Y)
Zinc (^{65}Zn)

a. Sources: sealed solids >10μCi, plated >1μCi, or liquids >10^{-3} μCi

3.2.5 Research and Development

R&D included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed much of the R&D operations at the plant. Other areas at the plant supporting R&D included Buildings 771, 776, 777, 865, and 881 [P053]. Table 3-3 provides a history of R&D and special order activities.

Table 3-3. Summary of Radionuclides Used For Research and Development and Special Order Work.

Date	Research and Development Activity
	Americium
1968–1986	Americium research projects included recovery of ^{241}Am by molten salt extraction (MSE) and from MSE salt residues and solid process wastes, separation of cerium and other rare earth elements from americium oxide, and preparation of americium metal from americium tetrafluoride [P178–P202].
July 1970	Development of the oxalate precipitation process for ^{241}Am purification began [P183].
October 1970	Development began on a tracer method using alpha spectroscopy and the addition of ^{243}Am spike for the determination of ^{241}Am in plutonium metal [P184].
November 1979–September 1981	^{241}Am-Ce disks were cast for the Lawrence Livermore National Laboratory (LLNL) Radiochemical Diagnostic Tracer Program [P196].
November 1980–September 1981	Recovery of ^{241}Am from the residues generated from the Tracer Program [P197].
October 1984–September 1985	Methods were investigated for the separation of plutonium and americium from contaminated coral from Johnston Island through a request by the Defense Nuclear Agency [P201].
Unknown	^{240}Am reportedly used as a tracer material [C159, P053].
	Californium
January 1973–June 1973	Study was conducted to determine the applicability of ^{252}Cf for reactor neutron interrogation of 55-gallon drums with ≤1 mg plutonium content [P191].
	Curium
1965-1970	Weapons-grade plutonium was alloyed with ^{244}Cm for use in the LLNL Radiochemical Diagnostic Tracer Program prior to 1970 [C159, P053, P164].
1965-1975	Residues from Tracer Program were chemically processed in Building 771 to recover the plutonium [C154, C171, P164].
	Neptunium
October 1968–June 1969	Studies conducted to investigate the voltammetry of neptunium complexes and the thermal behavior of neptunium (IV) oxalate hexahydrate [P178, P179, P180].
April 1969–September 1969	^{237}Np metal foil fabricated for Los Alamos Scientific Laboratory (LASL) [P179, P180].
	^{237}Np metal purified for Argonne National Laboratory-West (ANL-W) [P179, P180].
	^{237}Np oxide purified for Oak Ridge National Laboratory (ORNL) [P179, P180]

Table 3-3. (continued).

Date	Research and Development Activity
July 1969– September 1969	Experiments on the oxidation of alpha-phase neptunium metal foil in air were conducted [P180].
January 1972– June 1972	^{237}Np metal disks and ^{237}Np oxide diagnostic neutron detectors were prepared for the Liquid-Metal Fast Breeder Reactor neutron dosimetry program [P167, P189].
July 1974– December 1974	Studies conducted on the storage of ^{237}Np metal [P193].
November 1980– September 1982	Anion exchange and solvent extraction techniques were investigated for the separation and purification of plutonium from neptunium residues [P197, P198].
November 1980– September 1985	^{237}Np metal and oxide prepared for the LLNL Radiochemical Diagnostic Tracer Program [P197, P198, P199, P200, P201].
October 1982– September 1984	^{237}Np oxide was purified for the ORNL Isotope Pool [P199, P200].
	Plutonium
1970	Research was conducted on the synthesis of organoplutonium compounds for future applications in chemical vapor deposition and plutonium processing [P181, P182, P184].
April 1970– June 1970	Studies were done to determine the half-life of ^{239}Pu by calorimetry [P182]. Lead-plutonium alloys and oxides were received from Lawrence Radiation Laboratory (LRL) for plutonium recovery [P182].
July 1971– September 1971	Three metal disks fabricated from highly enriched (98%) ^{242}Pu metal for LASL [P187].
July 1972– December 1972	A plutonium metal plate was fabricated for LASL using low NGS material (97.7 wt% ^{239}Pu and 2.2 wt% ^{240}Pu), and recovery of the low NGS plutonium from the residues [P190]. ^{242}Pu metal target foil was fabricated for LLNL [P190].
January 1973– June 1973	Three ^{241}Pu metal target disks were fabricated for the Aerojet Nuclear Company [P191].
January 1977– June 1977	A plutonium metal rod (12 wt% ^{238}Pu and ~6 wt% ^{240}Pu) was prepared for LLNL [P195].
November 1979– October 1981	^{242}Pu tracer disks prepared for the LLNL Radiochemical Diagnostic Tracer Program [P196, P197].
October 1981– September 1982	Residues generated from the Tracer Program were processed to recover the plutonium [P198].
October 1983– September 1984	^{242}Pu oxide was purified and converted to metal for the LLNL Tracer Program [P200].
Unknown	^{238}Pu reportedly used as a tracer material [C159].

Table 3-3. (continued).

Date	Research and Development Activity
	Thorium
January 1975– June 1975	A 100-gram batch of high purity thorium oxide was received from ORNL for conversion to metal. Rocky Flats converted the oxide to metal and fabricated it into targets to be used for a particle accelerator experiment at ORNL [P194].
	Uranium
1968, 1977, and 1979-1984	Development of several processes for the separation and recovery of the uranium and plutonium [P178, P195–P200].
October 1968- December 1968	A single ^{236}U metal button was produced for ORNL [P178].
April 1969– June 1969	Prepared mixed plutonium and uranium oxide for ANL-W [P179].
July 1969– September 1969	^{233}U metal prepared from ^{233}U oxide for ORNL [P180]. Nickel and copper disks coated with ^{235}U oxide for LRL [P180].
July 1971– September 1971	Four ^{233}U metal disks were fabricated for ORNL [P187].
January 1972– June 1972	Three uranium buttons prepared for the Liquid-Metal Fast Breeder Reactor neutron dosimetry program. Each button was prepared with a different uranium isotope (^{235}U, ^{236}U, and ^{238}U) [P189].
July 1973– December 1973	A passive-active gamma-ray system for the nondestructive assay of waste packages containing ^{233}U was investigated [P192].
July 1974– June 1975	Research performed on removal of ^{232}U daughters from ^{233}U. The in-growth reaches equilibrium at 10.3 years [P193, P194].
November 1979– September 1982	A study was performed on the feasibility of reducing the plutonium in uranium oxide product shipped to ORNL for further processing [P197].
October 1980– September 1982	^{233}U tracer disks prepared for the LLNL Radiochemical Diagnostic Tracer Program [P197, P198].
October 1983– September 1984	Research was conducted on the adsorption of halogenated solvents on uranium dioxide [P200].

A description of the R&D areas is provided below. Most of the documentation pertaining to R&D activities does not specify the locations in which the work was performed. Therefore, unless otherwise noted, it was assumed that any of the radioisotopes identified in Table 3-3 could have been handled in the R&D areas of any of these buildings.

In Building 771, special recovery anion exchange separated plutonium from other materials that were not suitable for the regular recovery processes. Chemical technology conducted various aqueous R&D activities. Plutonium metallurgy operations in Building 771 included alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C154, P061].

The coatings laboratory in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium. This research and development facility supported production processes. The special weapons area in Building 777

assembled war reserve and other specially fabricated parts. The operation was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

The purpose of Building 779 R&D was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials, which might be used in plutonium operations. Other activities in Building 779 included developing improvements to the manufacturing process, and finding new ways to recover plutonium and associated actinides. Another function was to develop a better understanding of the aging and shelf life limitations of Rocky Flats products. Most of the materials used and wastes generated in this facility were the same as those in the production and recovery buildings, as much of the work conducted involved improvement of existing processes [P053].

Some radionuclide tracers consisting of neptunium, curium, and cerium were fabricated in Building 881 in the 1960s [U057]. The first neptunium processing was also done in this building [C154, U057]. Other transuranic radionuclides used in Building 881 in the 1960s included uranium-233 [C145]. There reportedly was some work performed with uranium-233 in 1975 as well [C134, C145].

3.2.6 Routine Maintenance

Routine maintenance at Rocky Flats consisted of a variety of activities supporting plant operations including utilities, filter testing and replacement, and change-out of oils, coolants, and Raschig rings. Most of the buildings contained maintenance operations for the building and peripheral areas. Utility operations included the upkeep of the heating, ventilation, and air conditioning (HVAC), fume scrubbers, and process vacuum systems. The Filter Testing group was responsible for in-place testing of plenum high efficiency particulate air (HEPA) filters [P053]. Waste produced by maintenance may have been contaminated by the materials and chemicals used in the area of generation.

3.2.7 Non-Routine Operations

Non-routine operations included spill clean up, strip-out operations, renovation, and activities associated with fires and other incidents. Spills of various materials occurred due to leaks or releases from tanks, piping, waste containers, or gloveboxes. Tanks or pipes may have contained acids, bases, or solvents used during normal process operations [P053]. Strip-out of glovebox lines, process piping, valves, and associated systems were also performed as required during renovation or decommissioning [P067, P108].

Other non-routine activities, which generated TRU waste materials included:

- the 1969 fire which spread through combustible materials in several hundred inter-connected gloveboxes in Buildings 776 and 777; [P053].

- the 1974 control valve release allowed radioactive particulates to escape from Module K in Building 707 because a glovebox window had been removed by maintenance; [P053] and

- the tritium release in 1973 in which tritium-contaminated plutonium was processed in Building 779 causing a tritium release to the atmosphere, as well as elevated tritium levels in surface waters, process wastes, equipment, gloveboxes, and exhaust plenums [P053].

3.3 TRU Waste Management

TRU waste management at the RFP was initiated at the point of waste generation and continued through final waste disposition. Waste management included segregation, packaging, storage,

transportation, RCRA characterization, and certification. Administrative controls were put in place to ensure that TRU waste was properly managed.

3.3.1 Organization and Administration

Plutonium Operations and Quality Engineering and Control were the primary organizations at Rocky Flats responsible for ensuring proper management of TRU waste. The Waste Operations Department within Plutonium Operations was responsible for activities related to waste generation and certification including operating programs, policies, and procedures. Quality Engineering and Control supported Waste Operations by performing various testing and inspection activities including nondestructive assay, real-time radioscopy (RTR), visual examination (VE), waste analyses, and equipment and instrument calibration [P014].

At the INEEL, the RFP waste containers were managed under the Radioactive Waste Management Complex (RWMC) permit, EPA No. ID4890008952, until the waste streams were characterized for shipment to WIPP.

3.3.2 Waste Segregation

When waste was initially packaged, it was segregated by the type of waste matrix using IDCs. IDCs (also referred to as Content Codes) are a series of numbers (001-999) used to identify nuclear material forms or process materials [P063]. Over the years, new IDCs have been added, obsolete IDCs have been deleted, and descriptions for some IDCs may have been modified [U014]. In addition, deleted IDCs may have been redefined. For example, IDC 807 was used originally for cemented incinerator sludge. After 1987, IDC 807 was reassigned to Building 374 Solidified Bypass Sludge [P043, P063, P064].

Waste was segregated for the purposes of assaying and controlling nuclear material [P014]. Full drums were sent to the appropriate drum counter to determine if they contained recoverable transuranic actinides, or contained TRU or low-level waste [P035, U016]. The determination of whether the drum contained recoverable material was based on an economic discard limit (EDL). The EDL compared the cost of manufacturing plutonium in a reactor to recovering the plutonium from specific process wastes and residues. EDLs were established by the DOE for each IDC [P035, P053].

Several types of assay were used at Rocky Flats including segmented gamma scan (SGS), passive/active neutron (PAN), and radiochemical analysis. Low resolution SGS was used on low weight drums such as combustibles or filters to determine if the waste was TRU or low-level. High-resolution SGS provided assay values for plutonium, americium, and uranium for other IDCs. PAN assay was used on most IDCs to make a TRU or low-level waste determination [U016]. The PAN system quantified the amount of TRU activity within a drum, and relative quantities were established based on the isotopic makeup of the waste. The SGS system was developed to verify actual radioisotopes present in the waste. When SGS was used in conjunction with PAN, actual quantities of individual isotopes could be established [P033]. Radiochemical analysis was the primary assay method for batch samples or individual container samples of sludge wastes. However, PAN assay was also used for sludge waste [U016].

Drum prefixes were assigned by the generator before the drum was sent to the counter. Prefixes can be used to identify the originating building or area within a building. The prefix corresponds to a material balance area (MBA) used to control the transfer of nuclear material. The title of an MBA usually corresponds to specific process operations. The prefix is identified by the first four digits of the container number (not including the letters “RF”) [U059]. The last five digits of the container number indicate the sequence in which drums were packaged within a given prefix.

3.3.3 TRU Waste Packaging, Storage, and Transportation

From 1970 to 1971, drummed TRU waste was packaged in U.S. Department of Transportation (DOT) 17H 55-gallon drums. Since 1971, DOT 17C 55-gallon drums have been used. The different types of gaskets installed in the drums are shown in Table 3-4 [C057].

Table 3-4. Drum Gasket Types.

Gasket Type	Time Frame
Standard Neoprene	Until 1977
Tubular	1977 to December 1982
Flow-In Ventable	December 1982 to October 1988
Tubular with Carbon Filter	October 1988 to Present

Approved liners were required in each TRU waste drum to provide contamination control, corrosion and puncture resistance, and radiation shielding. Other liners or packing materials may have been used inside of the required liners [P063]. Liner and packing material configurations are provided in this document for each waste group in the waste packaging discussions in Sections 5.0 through 26.0. Additional packaging information was identified during RTR and VE confirmation activities. This information is provided in the AK waste stream summaries (WSS) for each waste stream published as INEEL Engineering Design Files (EDFs). The various types of packaging materials used are shown in Table 3-5.

Table 3-5. Packaging Materials.

Item	Description
Inner packaging	3-mil plastic bag, 12 × 18 inches [P008]
	6-mil plastic bag, 18 × 24 inches [P008]
	12-mil plastic bag, 10 × 72 inches [P008]
55-gallon drum liners	90-mil rigid polyethylene liner [P039, P123]
	0.01 inch polyethylene round bottom liner [P008]
	0.0055 inch polyethylene liner [P008]
	0.051 inch fiberboard liner, 32 × 72 inches [P008]

TRU waste was temporarily stored in buildings at Rocky Flats designated by specific procedures. Drums were staged in areas during drum counting, inspection, and closing operations. Drums of TRU waste accepted for shipment were transferred to Building 664 before they were shipped off site [P004].

TRU waste was shipped to INEEL by ATMX railcar. Drums were placed in cargo containers that were loaded in the railcar. The cargo containers were secured by inflatable dunnage [P004].

3.3.4 Rocky Flats Plant Waste Characterization

In November of 1985, Rocky Flats submitted RCRA Part B permit applications to the EPA and Colorado Department of Health to comply with the requirements of RCRA. On June 4, 1986, an Agreement in Principle was signed which stipulated that a technical program would be developed to

obtain information regarding waste generation and waste management at the plant. From May 1986 to March 1987, every process and process support waste stream at the plant was identified and characterized. EPA hazardous waste numbers (HWNs) were assigned to low-level and nonradioactive wastes based on process knowledge or sampling and analysis of the waste stream. The information was compiled in the Waste Stream Identification and Characterization (WSIC) document. Because the final Compliance Agreement did not apply to transuranic waste, wastes that contained or were thought to contain transuranic materials were not segregated based on their hazardous constituents. Prior to the implementation of WSIC, no wastes (nonradioactive, low-level, or transuranic) were segregated based on their hazardous constituents [P067].

In October of 1989, WSIC was expanded to provide RCRA characterization of TRU waste streams and to address residues (above EDL materials) generated at Rocky Flats. This program, known as Waste Stream and Residue Identification and Characterization (WSRIC), provided details on the nature, quantities, and hazards associated with nonhazardous, hazardous, radioactive, and mixed wastes that resulted from all aspects of operations at Rocky Flats. Field investigations were conducted to identify, evaluate, and verify current Rocky Flats waste- and residue-generating processes, wastes and residues, and waste management units. Sampling and analysis was also performed to characterize mixed wastes and residues that were potentially hazardous based upon preliminary field investigations.

In December 1993, the Backlog Waste Reassessment (BWR) project was implemented. Existing characterization information was compiled for the stored inventory of wastes at Rocky Flats, and a reassessment of that information was conducted to recommend and document the correct RCRA characterization. The universe of wastes included nonradioactive wastes, hazardous wastes, low-level and low-level-mixed wastes, TRU and TRU-mixed wastes, and residues and mixed residues in Rocky Flats inventory. Characterization was accomplished primarily using process knowledge and analytical data as sources. Rocky Flats cognizant personnel were also interviewed which supplied additional information. In addition, WSRIC Building Books were reviewed for archived and active waste stream characterizations [P052].

3.3.5 INEEL Waste Characterization

In October 1996, the original revision of this document (the AK baseline document) was issued to specifically cover the RFP wastes that had been shipped to the INEEL from 1971 through 1988. The primary objective was to provide a consistent, defensible, and auditable AK record for the INEEL inventory stored at the INEEL TRU waste storage area. Characterization of the RF waste streams was based primarily on the AK record and confirmed with the results from the INEEL sampling program components; radioscopy, headspace gas sampling and analysis, nondestructive assay, and solid sampling and analysis, when appropriate. The confirmation data are described in detail in the individual sections of this document for characterized wastes.

INEEL characterization of the RFP homogeneous solids wastes was initiated in 1996 and drums from these waste streams were subsequently sampled (cored) at ANL-W. Solid sampling was split into two phases; phase I and phase II. Each phase involved samples selected at random, but the candidate drum population from which the samples were selected differed for the two phases. Phase II samples were randomly selected across the waste streams. The data were able to be used to characterize three homogeneous solids waste streams for the 3,100 m^3 Project, because the sampling plan and analytical procedures used were based on EPA protocol and were shown to be compliant with Waste Analysis Plan (WAP) requirements.

The INEEL homogeneous solids sampling plan is described in EDF-909, “Transuranic Waste Sampling Plan for the Idaho National Engineering and Environmental Laboratory” [P304]. A discussion

of the waste streams that were sampled and the collection of representative samples from those waste streams is included. Assessments of the solidified sampling and analysis data, including the pre-WAP data, were included in a series of reports, one for each of the waste streams that were sampled. Each report also incorporated AK, waste form sampling, chemical analyses, and headspace gas data. These reports are listed below.

- *Hazardous Waste Code Determination for First/Second Stage Sludge Waste Stream (IDCs 001, 002, 800),* INEEL/EXT-01-00015 [P219]

- *Characterization of Rocky Flats Plant Building 374 Sludge Waste Stream (IDCs 007, 803, 807),* INEEL/EXT-01-00517 [P220]

- *Characterization of Rocky Flats Plant Building Miscellaneous Cemented Sludge Waste Stream (292 and 807b),* INEEL/EXT-02-00112 [P287]

- *Characterization of Rocky Flats Plant Solidified Organics Waste Stream (IDCs 700 and 801), INEEL/EXT-02-00028, Draft* [U099].

Characterization activities; headspace gas sampling and analysis (HSG), radioscopy (RTR), nondestructive assay (NDA), visual examination (VE), and gas generation testing (GGT), were certified under the WAP by CBFO during fiscal year (FY) 2000. Homogeneous solid waste sampling and analysis procedures were certified in FY 2001. Characterization using RTR, NDA, and HSG data applied to all the drums in the inventory for the 3,100 m^3 Project. VE was performed on a random sampling of drums for each waste stream category group as required to determine miscertification rates. GGT was performed on containers of waste containing water and/or organic substances that could radiolytically generate combustible gases or were identified as test category wastes. Solid samples were collected on randomly selected homogeneous solid waste drums to complete characterization.

RTR data stored in the Transuranic Reporting, Inventory, and Processing System (TRIPS) are summarized in the report; "Summary RTR Data Collected During the 3,100 m^3 Project," EDF-3395 [P323]. During the life of the 3,100 m^3 Project approximately 20,000 containers were examined by RTR. The approximate over all success rate, defined by a final, approved status of "*WIPPOK*" was 89%. Data in this EDF are organized and presented for individual waste streams except for IDC wastes that were not included in waste steams or had not been planned for the project, in which case, the data are presented by IDC.

HSG data are presented in the report, "Summary Headspace Gas Data Collected During 3,100 m^3 Project," EDF-3396 [P324]. The data presented in this EDF are summaries of the HSG data for each waste stream generated by the Environmental Chemistry Laboratory (ECL) and stored in TRIPS. During the life of the 3,100 m^3 Project nearly 18,000 containers were sampled and the resulting samples analyzed. The overall success rate, defined by a final approved status of "*WIPPOK*" was 99.8%. Data in this EDF are organized and presented for the individual waste streams. An AK resolution was prepared to capture the statistical assessment of HSG data using a transformation approach as compared to the 3,100 m^3 Project normally distributed approach (per CBFO-approved Management Control Procedure (MCP)-2527, Appendix C) [C251].

NDA data are presented in the report, "Radioassay Data Collected During 3100 Cubic Meter Project," EDF-3374 [P322]. The radioassay data stored in TRIPS are summarized in this EDF. During the life of the 3,100 m^3 Project approximately 20,000 containers were assayed with an overall success rate of 82% of containers being labeled as "*WIPPOK.*" More than 30,000 assays were performed among the radioassay systems. Three radioassay systems were in operation during this time period. The PAN System

coupled with a gamma system was the primary quantitative radioassay system used during the project. Two gamma spectrometry systems, SWEPP Gamma-ray System (SGRS) and Waste Assay Gamma System (WAGS) were also used for direct quantitative assay in addition to providing isotopic distribution information for the PAN system. The PAN system assayed over 16,000 unique waste containers while SGRS and WAGS quantitatively assayed over 2,000 and 3,000 unique waste containers, respectively.

Targeted waste streams as listed below were characterized using data from RTR, HSG, NDA, and solid sampling and analysis (as appropriate). EPA HWNs were assigned to the wastes based on AK, and the confirmatory RTR, HSG, and solid sample data. HWN assignment discrepancies between AK, the RWMC-EDF-803, and the waste stream profile (WSP) were identified and described in WSP-specific AK resolutions. These AK resolutions were incorporated into waste stream summary sheets for each WSP and have been added to the AK Record.

Not all containers from waste streams with approved Waste Stream Profile Forms (WSPFs) could be certified for shipment or for disposal at the WIPP facility because of the presence of prohibited items, such as: liquid in excess of the WIPP CH-WAC limits, lead-acid batteries, or inner containers greater than 4 liters. These containers were not considered part of the WSPF waste stream and remain in storage at the INEEL to be dispositioned later. Such wastes retain only those HWNs originally assigned by the waste generator.

Fifteen WSPs were developed based on AK and confirmed during waste characterization activities at the INEEL. A list of WIPP approved WSPs follows:

- INW276.001 [P289] (February 1999) Nonhazardous debris – Graphite molds IDC 300
- INW276.002 [P289] (August 1999) Nonhazardous debris – Graphite molds IDC 300
- INW276.003 [P205, P211] (July 21, 2000) Nonhazardous debris – Graphite Molds IDC 300.
- INW276.004 [P212] (September27, 2000) Hazardous debris – Graphite Waste IDCs 300, 301, 303 and 312.
- INW296.001 [P213] (November 14, 2000) Hazardous debris – Light Metals Waste IDCs 480 and 481
- INW243.001 [P215] (March 28, 2001) Hazardous debris – Glass (except Raschig rings) Waste IDCs 440
- INW211.001 [P216] (April 24, 2001) Hazardous debris – Filter and Insulation Media IDCs 335, 376 and 490
- INW216.001 [P217, P219] (May 24, 2001) Hazardous solids – First and Second Stage Sludge IDCs 001, 002 and 800
- INW218.001 [P218, P220] (July 24, 2001) Hazardous solids – Building 374 Sludge IDCs 007, 803, and 807a
- INW247.001 [P214] (November 14, 2001) Hazardous debris – Raschig Rings IDCs 441 and 442
- INW169.001 [P284] (February 7, 2002) Hazardous debris – Combustible Waste IDCs 330 and 336

- INW198.001 [P285] (February 7, 2002) Hazardous debris – Plastics Waste IDC 337
- INW222.001 [P287, P288] (April 24, 2002) Hazardous solids – Miscellaneous Cemented Sludge IDCs 292 and 807b
- INW161.001 [P306] (October 3, 2002) Hazardous debris – Fire Brick/Coarse Fire Brick IDCs 371 and 377
- INW252.001 [P305] (November 15, 2002) Hazardous debris – Leaded Rubber Gloves and Aprons IDC 339.

3.4 TRU Waste Certification

In 1978 and 1979, the waste acceptance criteria for the WIPP were initially developed and documented in *Report of the Steering Committee on TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant* [P027]. During 1979 through 1995, the INEEL began characterizing TRU wastes stored on site and WIPP developed its experimental test program. In 1998 EPA certified WIPP open for receipt and disposal of nonhazardous waste, the INEEL generated the original certification to ship nonhazardous debris drums, and the nonhazardous debris waste stream INW276.003 for Graphite was approved by CBFO in 1999. WIPP received certification for hazardous debris and hazardous solid waste in 2000 and 2001, respectively. In 2002, the WIPP WAC was further delineated into the CH-WAC and the Remote Handled (RH) WAC. DOE facilities generating or storing TRU waste have implemented certification programs in order to comply with the WIPP CH-WAC. Although the WIPP RH-WAC has been submitted to regulators, it has not yet been approved. Sections 3.4.1 and 3.4.2 describe the certification activities that have been conducted by Rocky Flats and INEEL for CH-TRU wastes generated at Rocky Flats [P014].

3.4.1 Rocky Flats Certification

Rocky Flats implemented a program in May 1983 to certify CH-TRU waste for future shipment to WIPP. The TRU waste certification procedures emphasized an efficient, effective, and auditable program that would comply with all existing orders, guidelines, and regulations [P014].

Waste Operations was responsible for providing assistance to waste generators, and for the promulgation of TRU waste certification operating programs, policies, and procedures. Waste Operations also implemented the certification program, which included operator indoctrination, performance of internal departmental program audits, verification inspection, and final certification of waste packages [P014].

After containers were assayed, they were sent to Building 776 for inspection. Containers would undergo a physical inspection that included content verification, free liquid detection, and a waste packaging conformance check. Rejected waste packages were returned to the generator for corrective action [P014, P043]. As a final quality assurance verification, RTR was performed on each container to verify correct contents and the absence of free liquids [P001].

Quality Engineering and Control assisted Waste Operations in implementing, continually reviewing, and updating the Rocky Flats Certification Plan for TRU Waste. Quality Engineering and Control was responsible for formal periodic plant audits and surveys of the overall TRU waste certification programs and activities. This group was also responsible for interfaces, for review and approval functions for the development, design, procurement, manufacture, and utilization of waste containers, and for operational and certification procedures used by Waste Operations [P014].

3.4.2 INEEL Certification

In addition to the AK program, several programs and studies were conducted at INEEL to characterize and certify the CH-TRU waste inventory. The programs were established to increase knowledge of the waste inventories to properly manage the wastes until final disposal. Specific characterization activities included the review of process knowledge, RTR examinations, radioassay, drum headspace gas sampling, inner bag gas sampling, VEs, and core sampling and analysis [P033].

The Characterization and Categorization Program was implemented to confirm that drums shipped from Rocky Flats had been assigned appropriate IDCs. During 1979 and 1980, 70 drums were visually inspected and gas samples were collected from the bags in the containers [P033].

During the TRU Waste Sampling Program, conducted between 1983 and 1985, containers were examined and sampled to assess compliance of the waste with the WIPP CH-WAC and to test the INEEL RTR system. RTR examination of 209 containers was performed at INEEL and then the containers were sent to Rocky Flats to verify the RTR examinations with VEs. Drum pressure, drum void volume, and headspace gas composition were determined by sampling 212 drums. Sludge containers were analyzed for pH and by infrared spectroscopy to determine the general composition of the sludges [P015, P033].

The information from the TRU Waste Sampling Program was included as AK for the final phase of waste characterization for certification in compliance with the WIPP CH-WAC and CH-WAP.

Content codes were assessed by the INEEL to characterize and describe the transuranic waste inventory. Rocky Flats waste containers shipped to INEEL between 1985 and 1989 were reviewed in the assessment completed in July 1995. Analytical data and process knowledge were evaluated to determine if the waste met the WIPP CH-WAC [P016]. Succeeding programs, such as the WIPP Experimental Test Program and TRU Waste Characterization Program, from 1991 through the end of the 3,100 m^3 Project continued to use RTR and visual confirmation to assess parameters required to verify content codes. RTR characterization provides information on physical form, matrix parameters and weights, waste/packaging items and configurations, and other data necessary to confirm the waste stream description reflected in AK.

The Stored Waste Examination Pilot Plant (SWEPP) was constructed to provide nondestructive examination and certification capabilities for INEEL-stored CH-TRU waste. In addition to waste certification operations, SWEPP provided waste retrieval, repackaging, and storage capabilities since the facility opened for operations in 1986. From 1985 to 1989, 17,252 containers were examined by RTR and PAN assay in the SWEPP facility during production waste examination. In the same time frame, confirmatory VEs were performed on 81 containers shipped to Rocky Flats [P033].

RTR was used for a number of certification issues including estimating quantities of free liquids and particulates, verifying the content codes, and identifying the presence of pressurized containers. Visual Examination capabilities were developed at the ANL-W facility to facilitate drum certification for WIPP. VE was used to verify the RTR examination, to establish and update the miscertification rate, and to obtain data on waste acceptance criteria that cannot be determined nondestructively [P033]. The results of RTR and VEs performed from 1997 through 1999 are presented in "Description of the SWEPP Certified Waste Sampling Program," RWMC-EDF-363 [P303], and "Comparison of Real Time Radiography (RTR) and VE Results of the Stored Waste Examination Pilot Plant (SWEPP) Certified Waste Sampling Program," EDF-2710, and its associated database [P321]. The results of the comparisons were used to develop the original and annual reassessments of the site specific miscertification rates. These data have been incorporated into the AK record.

Originally, the WIPP Experimental Test Program encompassed three waste characterization programs conducted at INEEL from 1991 to 1996. These programs included the WIPP Waste Characterization Program (WWCP), the TRU Waste Characterization Program (TWCP), and the Bin Program. These programs utilized RTR, radioassay, headspace gas analysis, VE, and core sampling to support WIPP certification activities at INEEL. From 1979 to 1999, TRU waste certification and characterization programs had been developed at the INEEL in anticipation of TRU waste disposal at WIPP. The 3,100 m^3 Project was initiated in 1996, which included TRU waste characterization activities for shipment to WIPP under the TWCP. The 3,100 m^3 Project is the name given to the project intended to fulfill the commitment to certify and ship a minimum of 3,100 m^3 of TRU waste to the WIPP by December 31, 2002.

The INEEL was granted the original certification to ship nonhazardous debris waste in April 1998. Additional certifications for hazardous debris waste and for hazardous homogeneous solids waste or recertifications followed in 1999, 2000, 2001, and 2002.

The history of the major INEEL and Rocky Flats TRU waste certification and characterization programs from 1979 through 2002 are summarized in Table 3-6 [P033].

Table 3-6. Summary of TRU Waste Certification and Characterization Programs [P033].

Year	Program Description or Reference
1979	Characterization and Categorization Study of TRU waste for EG&G
1981	INEEL-Stored TRU Waste Characterization: Nonradiological Hazards Identification, WM-F1-81-015
1982	Content Code Assessments for INEEL Contact-Handled Stored TRU Waste, WM-F1-82-021
1985	TRU Waste Sampling Program: Volume I-Waste Characterization, EGG-WM-6503
1985	TRU Waste Sampling Program: Volume II-Gas Generation Studies, EGG-WM-6503
1985	Waste Characterization for INEEL Remote-Handled/Special-Case Stored TRU Waste, WM-PD-85-014
1985-89	SWEPP Operations (Production mode certification)
1989	Waste Drum Gas Generation Sampling Program at Rocky Flats, PSD88-037
1989	Hazardous Waste Constituents of INEEL Contact-Handled Stored TRU Waste, RWMC-EDF-369
1989	Description of the SWEPP Certified Waste Sampling Program, Rev. 2, RWMC-EDF-363
1990	Chemical Compatibility of Stored TRU Mixed Waste, RWMC-EDF-413
1990-94	WIPP Experimental Test Program No Migration Petition Quality Assurance Program Plan (QAPP) and QAPjP SWEPP Operation Headspace Gas Sampling Drum Content Examination Gas Generation and Transport Studies Development of Sampling and Analytical Protocols for Sludges
1990	EPA Hazardous Waste Codes for Transuranic Storage Area Item Description Codes (Rev. 3 in 1996), RWMC-EDF-421

Table 3-6. (continued).

Year	Program Description or Reference
1991	Program Plan for Certification of INEEL Contact-Handled Stored TRU Waste, WM-PD-88-011-4
1993	TRU Waste Questionnaire (Non-Rocky Flats Generators)
1994	Waste Generator Questionnaire, RWMC-EDF-676
1995	Chemical Constituents in Transuranic Storage Area Waste (Rev. 1 in 1996), RWMC-EDF-803
1995	INEEL Code Assessment of the Rocky Flats TRU Waste, INEL-95/028
1995	Summary of TRU Waste Characterization Programs at the INEEL, INEL-95/0397
1996	3,100 m^3 Project initiated
1997	AK baseline (INEEL-96/0280, Rev. 0) issued
	Coring of drums began at ANL-W
1998	INEEL generated original certification to ship nonhazardous debris drums
	EPA certified WIPP open for receipt and disposal of nonhazardous waste
1999	Nonhazardous debris waste stream 276.003 approved
2000	VE initiated at ANL-W
	CBFO granted INEEL certification for characterization and transport of hazardous debris
	Hazardous debris waste stream 276.004 Rev. 0 and Rev. 1 approved
	13 Shipments
2001	Hazardous debris waste streams: INW296.001, INW243.001, INW211.001, and INW247.001
	Hazardous solid waste streams: INW216.001 and INW218.001
	121 Shipments
2002	Hazardous debris waste streams: INW169.001, INW198.001, and INW161.001
	Hazardous solid waste streams: INW222.001
	Recovery option (Absorbent addition) approved
	375 Shipments
	Hazardous debris waste stream: INW252.001
	Recovery option (Blending) approved
	120 standard waste boxes (SWBs) processed and shipped = 51 shipments
	Total of 3,101.1 m^3 shipped

Various radioisotopes are tracked and monitored at the WIPP site as transuranic waste is received for permanent storage. Under the 3,100 m^3 Project, each waste container was radioassayed prior to shipment.

The INEEL PAN Assay System, operating in conjunction with a gamma system (operating in an isotopic-mass-ratio mode), was used to quantify the mass values for the following nuclides americium-241, plutonium-238, -239, -240, and-241, and uranium-233, -235, and -238. The PAN assay

system directly measured a fissile signal due to plutonium-239 or uranium-235 fission (active mode) or plutonium–240 spontaneous fission (passive mode). A gamma isotopic system supplemented the PAN measurements by providing the relative mass ratios for the other isotopes that were required to be reported to WIPP. Information on calibration, total measurement uncertainty, and other performance data were summarized in system description documents [P248, P249].

Initially, the PAN system was operated in conjunction with SGRS. In December 2002 WAGS was placed into operation and the PAN instrument could then be provided mass ratios from either SGRS or WAGS to support the PAN measurements. PAN/Gamma was certified to ship both debris and sludge waste to the WIPP.

Starting in May 2002 and through the end of the 3,100 m^3 Project, both the SGRS and WAGS systems began to also be used in the absolute or quantitative mode. During this time over 2000 drums were assayed through the SGRS system and 3000 drums through the WAGS system. The certifications for use included both debris and sludge waste types. The SGRS Absolute and WAGS Absolute detected and directly calculated the masses, activities, and concentrations of americium-241, plutonium-238, -239, -240, and -241, and uranium-233, -235, and -238.

In order to meet the WIPP CH-WAC nondestructive assay compliance requirements and quality assurance objectives, a determination of the total uncertainty of the radioassay results was required. In order to perform this evaluation, assessments of the physical and radiological characteristics of the various waste forms were performed to determine if they altered the response of the assay system [P243]. Parameters such as plutonium mass, moderator index, absorber index, net weight, fill height of the drum, and density were considered to be important to the determination of total measurement uncertainty and were investigated for each uncertainty evaluation. Information from RTR was used to support the measurement uncertainty analyses under a review process specifically designed for these studies [P242]. Other information used in uncertainty analyses included radiochemistry [U095]. A modified statistical approach was applied to some of these studies [P263, P264]. The results of these uncertainty evaluations were reported in a series of reports for the specific waste matrices evaluated [P154, P155, P156, P228, P229, P230, P231, P232, P233, P234, P235, P236, P255, P257, P258, P259, P260, P261, P262, P279, P294, P295, P296]. The availability of total measurement uncertainty data was a key requirement in the waste certification capabilities [C219, C220, C221, C222, C223].

In addition to measurement uncertainty, it was also necessary to determine the minimum detectable concentration (MDC) of the radioassay instruments for each waste matrix for which measurements would be performed. This was required to ensure that the radioassay systems in use for waste certification were capable of measurements at activity concentration levels consistent with the definition of TRU waste (>100 nCi/gram). Various reports gave the details of the general methodologies for determining the MDCs [P249, P250, P277, U096] as well as the determinations that were made for IDCs or groups of similar IDCs. [C210, C223, P245, P247, P251, P252, P253, P254, P255, P256].

The status and capabilities within the certification program at INEEL were summarized in "INEEL CH TRU Waste Certification Capabilities Implementation" EDF-924 [P243]. Just over 3,100 m^3 of RFP wastes were shipped to the WIPP facility from the INEEL. This represents a total of 14,909 55-gallon drums characterized under the TWCP, certified, and shipped under 12 WSPs.

3.5 TRU Waste Inventory

Originally, the Rocky Flats TRU waste inventory at INEEL addressed by this document consisted of 23,784 accessible storage drums generated from 1971 through 1988 [U092]. The inventory consisted of a wide variety of materials generated by the operations described above. Waste materials range from

relatively homogenous materials such as sludges from waste treatment operations to extremely heterogeneous wastes such as combustibles which consist of a wide spectrum of materials generated from numerous areas. The waste is stored at the RWMC Transuranic Storage Area (TSA) at the INEEL. A map of the RWMC is provided in the AK source document files [P209].

As described in Section 3.3.2, Rocky Flats wastes were segregated by IDC. During the review of AK, similar IDCs were combined to create the "waste groups" presented in Sections 5.0 through 26.0. These sections describe the composition, generation, packaging, and characterization for each waste group. The waste assessed for the development of this document including IDC, Title, dates of generation, and the EPA HWNs assigned is presented in Table 3-7.

Table 3-7. Rocky Flats Plant TRU Waste Inventory Stored at INEEL[a].

IDC	Title	Dates of Generation	Baseline EPA HWNs	WSPF – Title	Approved WSP HWNs
Absorbents (Section 5.0)					
375	Oil Dri	04-82 through 03-85	D004-D011, D022, F001-F003, and F005	N/A	
Americium Process Residue (Section 6.0)					
241	Americium Process Residue	N/A[b]	D001, D002, and D008	N/A	
Benelex and Plexiglas (Section 7.0)					
302	Benelex and Plexiglas	03-85 through 02-86	D005 and D008	N/A	
464	Benelex and Plexiglas	07-82	D005 and D008	N/A	
Blacktop, Concrete, Dirt, and Sand (Section 8.0)					
374	Blacktop, Concrete, Dirt, and Sand	01-73 through 06-88	D004-D011, D018, F001, F002, F005-F007, and F009	N/A	
Combustibles/Plastics (Section 9.0)					
330	Dry Combustibles	12-72 through 11-86	D006-D009, D011, D022, F001-F003, F005-F007, and F009	INW169.001–Combustibles [P284]	D006-D009, D011, D022, F001-F003, F005-F007, and F009
336	Wet Combustibles	12-72 through 09-85	D006-D009, D011, D022, F001-F003, F005-F007, and F009	INW169.001–Combustibles [P284]	D006-D009, D011, D022, F001-F003, F005-F007, and F009
337	Plastic	01-73 through 02-85	D006-D009, D011, D022, F001-F003, F005-F007, and F009	INW198.001–Plastics [P285]	D006-D009, D011, D022, F001-F003, F005-F007, and F009
Filters and Insulation (Section 10.0)					
335	Absolute Filters	01-73 through 07-87	D005, D007-D009, D011, D022, F001, F002, F005-F007, and F009	INW211.001–Filter and Insulation Media [P216]	D005, D007-D009, D011, D028, F001-F003, F005-F007, and F009
376	Processed Insulation and Filter Media	04-80 through 09-88	D005, D007-D009, D011, D022, F001, F002, F005-F007, and F009	INW211.001–Filter and Insulation Media [P216]	D005, D007-D009, D011, D028, F001-F003, F005-F007, and F009

Table 3-7. (continued).

IDC	Title	Dates of Generation	Baseline EPA HWNs	WSPF – Title	Approved WSP HWNs
490	Chemical Warfare Service (CWS) Filters	08-85 through 03-88	D005, D007-D009, D011, D022, F001, F002, F005-F007, and F009	INW211.001–Filter and Insulation Media [P216]	D005, D007-D009, D011, D028, F001-F003, F005-F007, and F009
328	Ful-Flo Incinerator Filters	04-82 through 02-83	D005, D007-D009, D011, F001-F003, and F005	N/A	
338	Insulation and CWS Filter Media	01-73 through 04-73	D005, D007-D009, D011, F001, and F002	N/A	
360	Insulation	N/A[b]	D005, D007-D009, D011, F001, and F002	N/A	
Glass (Section 11.0)					
440	Glass (except Raschig Rings)	11-72 through 12-86	D005, D008, D009, D022, F001, F002, and F005	INW243.001–Glass [P215]	D005, D008, D009, D022, F001, F002, and F005
Graphite (Section 12.0)					
300	Graphite Molds (Building 707 casting operations only)	01-73 through 06-88	None	INW276.001; INW276.002, and INW276.003–Graphite [P205, P211, P289]	None
300	Graphite Molds	12-72 through 08-86	D008, D029, D040, F001, F002, and F005	INW276.004–Graphite [P212]	D008, D029, D040, F001, F002, and F005
301	Graphite Cores	09-82 through 02-85	D008, D029, D040, F001, F002, and F005	INW276.004–Graphite [P212]	D008, D029, D040, F001, F002, and F005
303	Scarfed Graphite Chunks	03-85 through 04-88	D008, D029, D040, F001, F002, and F005	INW276.004–Graphite [P212]	D008, D029, D040, F001, F002, and F005
312	Coarse Graphite	01-84 through 06-84	D008, D029, D040, F001, F002, and F005	INW276.004–Graphite [P212]	D008, D029, D040, F001, F002, and F005
310	Graphite Scarfings	12-83 through 10-85	D008, D029, D040, F001, F002, and F005	N/A	
Grit (Section 13.0)					
372	Grit	11-82 through 01-84	D007	N/A	

Table 3-7. (continued).

IDC	Title	Dates of Generation	Baseline EPA HWNs	WSPF – Title	Approved WSP HWNs
Incinerator Waste (Section 14.0)					
292	Cemented Sludge	05-80 through 02-87	D004-D011, D022, F001-F003, F005-F007, and F009	INW222.001–Miscellaneous Cemented Sludge [P287, P288]	D004-D011, D022, F001-F003, F005-F007, and F009
807b (696)	Cemented Incinerator Sludge (Before March 20, 1987)	05-85 through 03-87	D004-D011, D022, F001-F003, F005-F007, and F009	INW222.001–Miscellaneous Cemented Sludge [P287, P288]	D004-D011, D022, F001-F003, F005-F007, and F009
371	Fire Brick	12-72 through 05-87	D004-D011, F001, F002, F003, and F005	INW161.001–Fire Brick [P306]	D004-D011, F001-F003, F005-F007, and F009
377	Coarse Fire Brick	03-85 through 06-87	D004-D011, F001, F002, F003, and F005	INW161.001–Fire Brick [P306]	D004-D011, F001-F003, F005-F007, and F009
420	Ash, Incinerator (Virgin)	12-83	D004-D011, F001, F002, F003, and F005	N/A	
421	Ash Heel	N/A[b]	D004-D011, F001, F002, F003, and F005	N/A	
422	Soot	03-82 through 02-86	D004-D011, F001, F002, F003, and F005	N/A	
423	Soot Heel	N/A[b]	D004-D011, F001, F002, F003, and F005	N/A	
425	Fluidized Bed Ash	07-81	D007 and F005	N/A	
818	Cemented Incinerator Ash	10-86	D004-D011, F001, F002, F003, and F005	N/A	
820	Cemented Soot	01-86 through 10-86	D004-D011, F001, F002, F003, and F005	N/A	

Table 3-7. (continued).

IDC	Title	Dates of Generation	Baseline EPA HWNs	WSPF – Title	Approved WSP HWNs
Lead Containing Waste (Section 15.0)					
339	Leaded Rubber Gloves and Aprons	08-80 through 07-88	D003 and D008	INW252.001–Leaded Rubber Gloves and Aprons [P305]	D008, D022, F001-F003, F005-F007, and F009
320	Tantalum	07-79 through 06-88	D008 and D009	N/A	
321	Lead	10-87 through 11-87	D002 and D008	N/A	
Metal (Section 16.0)					
480	Scrap Metal (Non-special source (SS))	12-72 through 05-88	D006-D009, D011, D028, F001-F003, F005-F007, and F009	INW296.001–Light Metals [P213]	D006-D009, D011, D028, F001-F003, F005-F007, and F009
481	Leached Metals (Non SS)	05-80 through 10-84	D006-D009, D011, D028, F001-F003, F005-F007, and F009	INW296.001–Light Metals [P213]	D006-D009, D011, D028, F001-F003, F005-F007, and F009
Miscellaneous Cemented Waste (Section 17.0)					
806	Cemented Filter Sludge	04-87 through 03-88	D004-D011, F001, F002, and F005	N/A	
823	Cemented Miscellaneous Sludge	01-87 through 03-87	D004-D011, F001, F002, and F005	N/A	
Pyrochemical Waste (Section 18.0)					
409	Molten Salt-30% Unpulverized	09-82 through 01-86	None	N/A	
411	Electrorefining Salt	04-82 through 08-86	None	N/A	
412	Gibson Salts	08-80	None	N/A	
414	Direct Oxide Reduction Salt	05-82 through 10-82	None	N/A	
416	Zinc Manganese Alloy Metals	06-80	None	N/A	

Table 3-7. (continued).

IDC	Title	Dates of Generation	Baseline EPA HWNs	WSPF – Title	Approved WSP HWNs
Raschig Rings (Section 19.0)					
441	Raschig Rings, Unleached	05-73 through 09-83	D008, F001, and F002	INW247.001–Raschig Rings [P214]	D008, F001, and F002
442	Raschig Rings, Leached	05-80 through 06-88	D008, F001, and F002	INW247.001–Raschig Rings [P214]	D008, F001, and F002
Resin (Section 20.0)					
432	Resin, Leached and Cemented	12-72 through 08-86	D007 and D008	N/A	
822	Cemented Resin	01-86 through 02-87	None	N/A	
Sand, Slag, and Crucible (Section 21.0)					
368	Magnesium oxide crucibles	10-86	None	N/A	
370	Leco Crucibles	10-80 through 06-82	None	N/A	
391	Crucible and Sand	06-80 through 08-83	None	N/A	
392	Sand, Slag, and Crucible		None	N/A	
393	Sand, Slag, and Crucible Heels	08-80 through 05-86	D007	N/A	
817	Cemented Sand, Slag and Crucible Heels	10-86 through 01-87	D007	N/A	
Solidified Aqueous Sludge – Building 374 (Section 22.0)					
007	Wet Sludge – Building 374	08-82 through 05-87	D006, D007, D008, D009, D010, D011, D032, F001, F002, F005-F007, and F009	INW218.001 – Building 374 Sludge [P218, P220]	D006-D011, D032, F001, F002, F005-F007, and F009
803	Solidified Sludge - Building 374	04-86 through 12-86	D006, D007, D008, D009, D010, D011, D032, F001, F002, F005-F007, and F009	INW218.001 – Building 374 Sludge [P218, P220]	D006-D011, D032, F001, F002, F005-F007, and F009
807a	Solidified Bypass Sludge – Building 374 (After March 18, 1987)	03-87 through 06-88	D006, D007, D008, D009, D010, D011, D032, F001, F002, F005-F007, and F009	INW218.001 – Building 374 Sludge [P218, P220]	D006-D011, D032, F001, F002, F005-F007, and F009

Table 3-7. (continued).

IDC	Title	Dates of Generation	Baseline EPA HWNs	WSPF – Title	Approved WSP HWNs
Solidified Aqueous Sludge Building 774 (Section 23.0)					
001	First Stage Sludge	12-72 through 09-88	D004-D011, D022, F001, F002, F005-F007, and F009	INW216.001–First and Second Stage Sludge [P217, P219]	D004-D011, D022, F001, F002, F005-F007, and F009
002	Second Stage Sludge	08-71 through 02-85	D004-D011, D022, F001, F002, F005-F007, and F009	INW216.001–First and Second Stage Sludge [P217, P219]	D004-D011, D022, F001, F002, F005-F007, and F009
800	First Stage Sludge-Cemented	04-86 through 09-88	D004-D011, D022, F001, F002, F005-F007, and F009	INW216.001–First and Second Stage Sludge [P217, P219]	D004-D011, D022, F001, F002, F005-F007, and F009
Solidified Laboratory Waste (Section 24.0)					
004	Special Setups	12-72 through 11-86	F001-F003, and F005	N/A	
802	Special Setups-Cemented	06-86 through 04-88	F001-F003, and F005	N/A	
Solidified Organic Waste (Section 25.0)					
003	Organic Setups, Oil Solids	01-73 through 03-86	D022, D029, D036, F001, F002, F003, and F005	N/A	
700	Oasis Waste	03-86 through 05-86	D022 and F001-F003	N/A	
801	Solidified Organics	02-86 through 09-88	D022 and F001-F003	N/A	
900-Series Waste (Section 26.0)					
900	Low specific activity (LSA) Paper, Plastics, Etc.	12-72 through 05-73	D004-D011, D029, F001, F002, and F005	N/A	
950	LSA Metal, Glass, Etc.	12-72	D004-D011, F001, F002, and F005	N/A	
960	Concrete, Asphalt, Etc.	12-72 through 01-73	D004-D011, F001, F002, and F005	N/A	
970	Wood	01-73	F001, F002, and F005	N/A	

a. N/A = not applicable. The wastes were not profiled by the 3,100 m^3 Project.

b. IDCs 241, 360, 421 and 423 do not exist in the INEEL accessible storage inventory.

4. REFERENCES

Over 680 sources of information were collected, and reviewed during the development of this document. The AK sources consist of published documentation, unpublished data, and correspondence. Published documentation consists primarily of controlled documents, previously controlled documents, and procedures, in addition to formal reports, studies, and databases. Unpublished data include draft documents, analytical data packages, log books, and inventory lists, in addition to internal reports, studies, and databases. Correspondence includes internal and external letters, memos, directives, telecommunication records, meeting minutes, personnel interview summaries, and discrepancy reports. Appendix A lists and describes the references used by this program. The references are categorized and grouped by "C," "P," and "U" sources, which coincide with the correspondence, published, and unpublished information, respectively.

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5. ABSORBENTS

This waste group consists of absorbent clay material generated in Buildings 559 and 771 [P001, U092]. Absorbents were used for cleanup of hazardous liquid waste spills, oil absorption, or absorption of other liquids as needed [P037, P049]. Absorbents were also added to waste packages and drums having the potential of containing or generating free liquid [P001, P014, P043]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented in Table 5-1 [U092].

Table 5-1. Absorbents Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
375	Oil-Dri Residue From the Incinerator [P024] Oil Dry [P032] Oil Dri [P001]	April 1982 – March 1985

Item Description Code 375, Oil-Dri: This waste consists of spent absorbent clay materials [P001, P012, P014, P032, P043]. One of the most common absorbents used at Rocky Flats was Oil-Dri® [P037, P049]. Other absorbents could include floor dry, vermiculite, sorbent booms, and rags [P037, P052].

5.1 Waste Generation

There are nine drums of absorbents (IDC 375) in the current INEEL accessible storage database [U059]. Absorbents from Building 771 consist of Oil-Dri® from the plutonium recovery incinerator sorting box [P024]. Combustible wastes fed to the incinerator were received from production processes in Buildings 371, 707, 771, 776, 777, and 779 [P012]. Oil-Dri®, which was added to wet combustible wastes when initially packaged, could not be incinerated and was segregated from the combustible waste and repackaged for disposal [P024]. These absorbents may be contaminated with the same compounds as the combustible wastes that were fed to the incinerator (Section 14.0, Incinerator Waste, contains incineration process descriptions and flow diagrams).

It is possible that the absorbents from the Building 559 analytical laboratory were generated from cleanup of a spill. The source or composition of the spill could not be identified, and the waste may contain any of the chemicals used in the analytical laboratories (Section 9.0, Combustibles and Plastic, contains analytical laboratory process descriptions and flow diagrams).

5.2 Waste Packaging

Oil-Dri® from the plutonium recovery incinerator sorting box was packaged in polyethylene bottles or metal paint cans and double-bagged out of the glovebox in polyvinyl chloride and polyethylene plastic bags [P012, P024]. Each bag was sealed with tape before placement in a prepared 55-gallon drum. The waste may also be packaged in a polyethylene Residue Process Container (clamshell) before being placed in the drum [P024].

The exact packaging configuration of absorbents from Building 559 is not known. However, standard glovebox bagout operations (double-bagged in plastic) were most likely used when packaging this waste [P001, P012].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. Use of 90-mil rigid polyethylene liners began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P024, P063, P064]. A fiberboard liner and discs may also have been used between the waste and the drum liners [P012]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P001, P012, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3–12 pounds according to the amount of waste contained in each drum [P024].

5.3 Waste Characterization

Absorbents were characterized based on knowledge of the material and knowledge of the processes generating the waste. This section provides a RCRA hazardous waste determination for absorbents as well as radionuclide contaminants and potential complexing agents contained in the waste. This waste is at least 50% (by volume) inorganic particulates, and is classified as a homogeneous waste [P141].

5.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The waste may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and chloroform. The wastes may have been mixed with halogenated and nonhalogenated solvents, and are therefore F-listed hazardous wastes. There is no evidence that absorbent wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or all of the absorbents waste group are presented by IDC in Table 5-2.

Table 5-2. Absorbents Waste Characterization.

IDC	Title	EPA HWNs
375	Oil-Dri	D004-D011, D022, F001, F002, F003, and F005

5.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquids, and liquids were prohibited by procedural control from being placed in the drums. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change. The materials are not compressed gases, and pressurized containers were prohibited by waste packaging procedures [P001, P012]. The materials are not U.S. Department of Transportation (DOT) oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The material is not a liquid, and corrosive liquids were prohibited by procedural control from being placed in the drums [P001, P012, P024]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P001, P012, P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. The wastes may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver metals, as well as chloroform.

Arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and chloroform were used in the Building 559 analytical laboratory. It is possible that the absorbent wastes contain any of these compounds. Therefore, absorbent wastes from the Building 559 analytical laboratory are assigned EPA HWNs D004-D011 and D022. A representative sample of this waste will be obtained for verification purposes.

Tetrachloroethylene, trichloroethylene, and carbon tetrachloride were commonly used solvents [P023]. The absorbent wastes could potentially have been mixed with these solvents. Since these compounds were typically used as solvents, the wastes are regulated as listed hazardous waste and not characteristic waste because these compounds are specifically addressed in the treatment standards for the listed hazardous waste [P080]. Since absorbent wastes are characterized as listed hazardous wastes due to spent solvent contamination, the waste is not a toxic waste due to the presence of these organic compounds.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating absorbent wastes. Therefore, the wastes in this group do not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

5.3.1.2 Listed Hazardous Waste. The materials in this waste group may have been mixed with a waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31). The wastes are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33).

F001-, F002-, or F005-listed solvents may have been used in the processes that generated absorbent wastes, or absorbent materials may have been used to clean up spills of these spent solvents. Therefore, the materials in this waste group are assigned EPA HWNs F001, F002, and F005.

Absorbent materials may have been used to clean up spills of F003-listed solvents in Building 559. F003-listed solvents are listed solely due to ignitability, and even though this waste does not exhibit that

characteristic, these solvents were ignitable at the point of generation. Therefore, the absorbent wastes from Building 559 are assigned EPA HWNs F003.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating absorbents. Therefore, this waste group is not an F004-listed hazardous waste.

The materials in this waste group are not hazardous waste from specific sources. They were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, or container residues (40 CFR 261.33). It is uncertain if the wastes were generated from cleanup of a commercial chemical product spill. However, it is highly unlikely that the cleanup of a commercial chemical product would result in the generation of TRU waste. Therefore, the materials in this waste group are not P- or U-listed hazardous waste.

5.3.2 Radionuclides

The absorbent wastes from the Building 559 analytical laboratory (container prefix 0029) could potentially be contaminated with any of the radioisotopes processed at Rocky Flats during the time in which these wastes were generated. The analytical laboratory performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, P076, U059, U073]. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0.

Documented assay results for absorbent wastes indicate the presence of plutonium; however, the wastes could also be contaminated with americium-241 or enriched uranium because the absorbent wastes from Building 771 (container prefix 0001) were generated by removing Oil-Dri® from combustible wastes that originated from numerous production processes on plant site [P024, P052].

Due to the potential variability of the absorbent wastes, documentation on the radionuclide form, particle size, and distribution, interfering waste contaminants, and physical matrix parameters has not been identified. The only exception to this is the assumption that hydrogen is present from plastic packaging materials.

5.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC [P327], Sections 3.1.4, 3.3.1, and 3.7.1[327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA systems used at the INEEL measured americium-241; plutonium-238, -239, -240, and –241; and uranium-233 -235, and -238 activities. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P322]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 "Document SWEPP NDA Compliance Development"[P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 5-3. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 5-3. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
375	371	0017	Aqueous Recovery	9/24/82	WG Pu, ^{241}Am
375	559	0029	Analytical Laboratory	8/10/84	WG Pu, EU, ^{241}Am, DU
375	707	0012	Foundry and Casting Operations	9/14/82	WG Pu
375	707	0028	Note a	4/23/82	WG Pu
375	771	0001	Aqueous Recovery	2/28/83	WG Pu, EU, ^{241}Am
375	771	0002	Aqueous Recovery	8/10/84	WG Pu
375	776	0025	Drum Repack	3/14/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
375	777	0023	Metal Fabrication-Machining	9/24/82–5/12/83	WG Pu, EU

a. This prefix was assigned to an MBA in Building 707 that was not defined or was redefined after this waste was generated. It was assumed that this waste could contain any of the radionuclides handled in Building 707 unless the IDC further defines what radionuclides are in the waste.

WG = weapons grade EU = enriched uranium DU = depleted uranium

5.3.2.2 ***Confirmatory Radioassay Data.*** During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN System, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SWEPP SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the absorbents waste stream are summarized in Table 5-4. The overall yield for this radioassay data was not calculated. Four (4) absorbents waste containers were assayed over the life of the 3,100 m^3 Project. The radionuclide and related radioassay information is presented in Table 5-4. The data for the individual radioassay systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 5-4. Radionuclide and Related Quantities for Absorbents Waste.[a]

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	5.673E+00	9.810E+00	1.065E-01	2.033E+01	4
TRU Activity (Ci)	5.687E+00	9.834E+00	1.067E-01	2.038E+01	4
TRU Activity Concentration (nCi/g)	1.311E+05	2.162E+05	5.471E+03	4.539E+05	4
Thermal Power (W)	1.797E-01	3.110E-01	3.355E-03	6.446E-01	4
Thermal Power Density (W/ft^3)	2.445E-02	4.232E-02	4.565E-04	8.770E-02	4
Plutonium Fissile Gram Equivalent (g)	5.805E+01	9.771E+01	1.185E+00	2.038E+02	4
Americium-241 (g)	3.179E-01	5.868E-01	3.985E-03	1.197E+00	4
Plutonium-238 (g)	9.132E-03	1.557E-02	1.315E-04	3.238E-02	4
Plutonium-239 (g)	5.728E+01	9.746E+01	1.178E+00	2.028E+02	4
Plutonium-240 (g)	3.579E+00	6.091E+00	7.165E-02	1.267E+01	4
Plutonium-241 (g)	8.547E-02	1.452E-01	2.167E-03	3.022E-01	4
Plutonium-242 (g)	1.530E-02	2.589E-02	5.386E-04	5.396E-02	4
Uranium-233 (g)	ND	ND	ND	ND	0
Uranium-234 (g)	1.053E-03	1.411E-03	5.471E-05	2.051E-03	2
Uranium-235 (g)	9.792E-01	1.313E+00	5.090E-02	1.908E+00	2
Uranium-238 (g)	ND	ND	ND	ND	0

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

5.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA (ethylenediaminetetraacetic acid) is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant, including wiping down filter frames. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, P079, U043]. Oxalic acid was also used for americium recovery [P113]. Absorbents could contain these complexing agents if they were used during decontamination activities or spill clean up.

5.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. A total of nine (9) absorbents waste containers were subjected to RTR examination. The yield of successful RTR examinations was 100% [P323]. Conversely, none of the containers were dispositioned as *Treatment* [P323]. Visual examination indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

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6. AMERICIUM PROCESS RESIDUE

NOTE: *This section is for historical purposes only as this waste does not exist in the INEEL accessible storage inventory.*

This waste group consists of metal, glass, plastic, combustible, and other miscellaneous waste generated from the renovation of the americium recovery line in Building 771 at the Rocky Flats Plant [P024]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 6-1 [P127, U092].

Table 6-1. Americium Process Residue Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
241	Americium Process Residue [P024] Mixed Waste-Paper, Metal, Glass, etc. [P015]	N/A[a]

a. This IDC does not exist in the INEEL accessible storage inventory.

Item Description Code 241, Americium Process Residue: This waste consists of metal, glass, plastic, combustible, and other miscellaneous wastes. Metal waste items may include piping, flanges, valves, tools, and equipment. Glassware may consist of flasks and broken ion-exchange columns. Plastic items such as polyvinyl chloride (PVC) sheeting and polyethylene bottles are also included in this waste. The bottles may contain liquids. Other wastes may include HEPA, Ful-Flo, and glass filters; leaded glovebox gloves; rags; and wipes [P012, P015, P024].

6.1 Waste Generation

In 1963 and 1964, an americium recovery system was installed in Building 771. The process recovered and purified americium from plutonium peroxide precipitation filtrate using anion- and cation-exchange, evaporation, precipitation, and calcination techniques. Nitric acid, hydrochloric acid, ammonium thiocyanate, oxalic acid, and water were used in the recovery process [C047, P113, U047]. Americium process residues (IDC 241) were generated from the renovation of the americium recovery line [C115, P024]. Small amounts of process chemicals were washed from equipment with water and then dried with rags or wipes prior to removal from the glovebox line [P024]. Filters removed from the line may contain nitrate salts from the presence of nitric acid [U060]. A process flow diagram cannot be created for this waste as it was generated from renovation activities.

6.2 Waste Packaging

Americium process residue drums (IDC 241) were lined with lead shielding and a 90-mil rigid liner, then by two polyethylene drum bags. The waste items were double bagged in PVC inner and polyethylene outer bags that were sealed with tape. Oil-Dri® was placed outside of the drum bags in the bottom of the rigid liner. The drum bags were sealed with tape and the rigid liner lid was sealed on the rigid liner [P015, P024].

6.3 Waste Characterization

Americium process residue is characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. This section provides a RCRA hazardous waste determination for americium process residue as well as radionuclide

contaminants and potential complexing agents contained in the waste. This waste contains at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and is therefore a heterogeneous waste [P141].

6.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes may exhibit the characteristics of ignitability due to cellulosic materials contaminated with nitrate salts, and corrosivity from the presence of acidic free liquids. The wastes may also exhibit the characteristic of toxicity for lead. The wastes were not mixed with listed hazardous waste, nor is there any evidence that americium process residue wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to the americium process residue waste group are presented by IDC in Table 6-2.

Table 6-2. Americium Process Residue Waste Characterization.

IDC	Title	EPA HWNs
241	Americium Process Residue	D001, D002, and D008

6.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as an ignitable waste (40 CFR 261.21), as a corrosive waste (40 CFR 261.22), and as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristic of reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group may meet the definition of ignitability as defined in 40 CFR 261.21 due to cellulosic materials contaminated with nitrate salts. The material is not a liquid, and absorbents were added to wastes having the potential of generating free liquids (i.e., filters used in acid glovebox lines) [P012, P015, P024]. However, VE of the waste identified liquids in polyethylene bottles [P015]. Ignitable liquids were not used in the americium recovery process, or in the renovation of the process. The materials are not compressed gases, nor do the containers contain compressed gases as confirmed by VE [P015]. Filters used in the americium recovery line may have visible nitrate salt contamination, and for this reason, a risk of spontaneous combustion has been identified. The materials in this waste group are assigned EPA HWN D001 [U060].

Corrosivity: The waste materials are not liquid, but bottles of free liquids were identified in one drum during VE. The liquids were not sampled due to the high dose rate of the drum [P015]. However, nitric and hydrochloric acids were used in the glovebox from which the waste originated, and may be contained in the bottles [C115]. The material in this waste group may meet the definition of corrosivity as defined in 40 CFR 261.22 and are therefore assigned EPA HWN D002 [U060].

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P015, P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and

organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. The wastes may exhibit the characteristic of toxicity for lead metal.

During the renovation of the glovebox line, leaded glovebox gloves may have been discarded in the drums. Therefore, the materials in this waste group are assigned EPA HWN D008 since a representative sample of this waste cannot be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating americium process residue. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Toxicity characteristic organic compounds were not used in the process which generated americium process residue. Therefore, this waste group does not exhibit the characteristic of toxicity due to organic compounds (D018-D043).

6.3.1.2 Listed Hazardous Waste. The materials in this waste group are not, or were not mixed with, hazardous wastes listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31), as hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

The materials in this waste group are not hazardous waste from non-specific sources since F-listed solvents were not used in processes that generated americium process residue. Headspace analysis was performed on one drum of this waste and no F-listed solvents were detected [P015]. Therefore, the wastes are not F-listed hazardous wastes.

The materials in this waste group are not hazardous waste from specific sources since it was not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

6.3.2 Radionuclides

The process that generated americium process residue recovered the americium decay product from plutonium used in weapons production and, therefore, the waste was contaminated with weapons-grade plutonium and significant quantities of americium-241 [P053, P164]. The waste matrix and other physical parameters that could affect radioassay are summarized in Table 6-3.

Table 6-3. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	The americium was in a chloride, thiocyanate, hydroxide, nitrate, oxalate, and oxide chemical form during different steps of the process [P053, P113]. Documentation on the source particle size and distribution was not identified, but is likely highly variable due to the heterogeneous nature of this waste.
Hydrogen Content	Hydrogen content was measured at 14.4 vol% in a drum of IDC 241, and hydrocarbons were measured at only 0.34 vol%. The drum also contained a moderate amount of combustibles and plastics, including packaging materials [P015].

Table 6-3. (continued).

Parameter	Results of Evaluation
Other Interfering Waste Contaminants	Impurities such as aluminum and chromium were removed from the americium during the process [P113]. It is possible that these compounds could be present in Ful-Flo filters which were identified in a drum [P015].
Physical Matrix Parameters	This waste is extremely heterogeneous and contains a wide variety of waste items. There will likely be a great amount of void space throughout the waste, and the waste contaminants will presumably be unevenly distributed.

6.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

Oxalic acid was used in the americium recovery glovebox line where this waste was generated [C115, P113, U047]. Americium process residue may contain minor quantities of this complexing agent.

6.3.4 Real Time Radioscopy

RTR examinations that occurred during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. However, none of the americium process residue wastes were part of a candidate waste stream selected for characterization by the 3,100 m^3 Project. Therefore, no RTR data were generated.

7. BENELEX AND PLEXIGLAS

This waste group consists of Benelex and Plexiglas waste which were used for radiation shielding around gloveboxes and tanks [P052]. The waste may have been generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 at the Rocky Flats Plant [P012]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 7-1 [U092].

Table 7-1. Benelex and Plexiglas Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
464	Benelex and Plexiglas [P012]	July 1982
302	Benelex and Plexiglas [P001]	March 1985 – February 1986

Item Description Code 302, Benelex and Plexiglas. Benelex is a dense, laminated, lignocellulose hardboard made from wood chips and particles. Benelex was usually coated with fire-retardant paint and sometimes had lead sheeting (1/8 to 1/4 inch thick) attached to it [P012, P024]. It was usually two inches thick, although occasionally two 2-inch thick pieces were bolted together to increase shield thickness [P052]. Plexiglas is a trade name for a transparent plastic material made from methyl methacrylate. Plexiglas glovebox windows were two to four inches thick and were cut to fit the glovebox window. In addition to Benelex and Plexiglas, leaded glass and limited amounts of surgical gloves, metal hinges on Benelex gloveport doors, pieces of angle iron attached to larger pieces of Benelex, and rubber gaskets from glovebox windows may be present [P024].

Item Description Code 464, Benelex and Plexiglas. This waste consists of the same material as IDC 302. IDC 464 was replaced by IDC 302 in 1973 [P024].

7.1 Waste Generation

Benelex was used as neutron radiation shielding around gloveboxes and tanks. The shielding was attached to gloveboxes as door coverings for glovebox glove-ports, and as solid shielding mounted on the floor around processes [P024]. Plexiglas was used as radiation shielding in glovebox windows and equipment enclosures. Benelex and Plexiglas were generated during replacement of shielding or strip-out of unnecessary shielding during the installation of new gloveboxes [P052]. Process flow diagrams for Benelex and Plexiglas waste generating processes are provided in archived WSRIC information [P060, P061, P062, P070, P077, P078, P079, P081, P082].

7.2 Waste Packaging

Benelex and Plexiglas wastes were usually contained in plastic bags or wrapped in plastic sheeting before being placed in a prepared 55-gallon drum. All wastes were dry when packaged, however, absorbent (Oil-Dri®) may have been added to the waste drums as a precautionary measure [P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or one or two polyethylene drum bags [P008, P012, P016, P024, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners for puncture protection [P008, P012, P016, P064]. When a drum was

full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. Visual examination of containers of Benelex and Plexiglas wastes identified a variety of items including paper labels and forms, tape, rubber gaskets, and lead sheeting [P015, U011].

7.3 Waste Characterization

Benelex and Plexiglas wastes were characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. This section provides a RCRA hazardous waste determination for Benelex and Plexiglas as well as radionuclide contaminants and potential complexing agents contained in the waste. These wastes contain at least 50% by volume materials that meet the CH-WAP criteria for classification as debris, and are therefore heterogeneous waste [P141].

7.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes may exhibit the characteristic of toxicity for barium and lead. The wastes are not listed hazardous waste, and there is no evidence that Benelex and Plexiglas wastes exhibit any other characteristic of hazardous waste [C093]. EPA HWNs applicable to some or all of the Benelex and Plexiglas waste group are presented by IDC in Table 7-2. These conclusions are supported by the evaluation in Sections 7.3.1.1 and 7.3.1.2.

Table 7-2. Benelex and Plexiglas Waste Characterization.

IDC	Title	EPA HWNs
302	Benelex and Plexiglas	D005 and D008
464	Benelex and Plexiglas	D005 and D008

7.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C, as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and absorbents were added to wastes having the potential of generating free liquids [P012]. Visual examination identified free liquids in one drum; however, sampling and analysis indicated that the liquid was aqueous with a pH of 6 [P015]. The materials are not compressed gases, nor does the waste contain compressed gases [P012, P015, P024]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change

[P012, P024]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not a liquid, and absorbents were added to wastes having the potential of generating free liquids [P012]. Visual examination identified free liquids in one drum; however, sampling and analysis indicated that the liquid was aqueous with a pH of 6 [P015]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P015, P024, U011]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for barium and lead metals.

Leaded glass, which may be found in waste packages of Benelex and Plexiglas wastes, has been analyzed using the Toxicity Characteristic Leaching Procedure and found to exceed the regulatory limits for lead and barium [P108]. Additionally, some drums may contain lead shielding that was laminated to the Benelex [P024]. Therefore, the materials in this waste group are assigned EPA HWNs D005 and D008 since a representative sample of this waste cannot be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating Benelex and Plexiglas wastes. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene may have been used to clean Benelex and Plexiglas shielding. However, Benelex and Plexiglas are nonporous material and should not retain toxicity characteristic levels of organics. Therefore, this waste group does not exhibit the characteristic of toxicity due to organic compounds (D018-D043).

7.3.1.2 Listed Hazardous Waste.

The materials in this waste group are not, or were not mixed with, waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31), as hazardous waste from specific sources (40 CFR 261.32), or as discarded commercial chemical product, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were commonly used for cleaning and degreasing. Methylene chloride was used primarily for paint removal. Other solvents such as acetone, methanol, xylene, benzene, and toluene were used primarily in laboratory operations. During process operations, Benelex and Plexiglas wastes may have come in contact with these compounds, or may have been cleaned with these solvents. However, Benelex and Plexiglas wastes that were wiped down with solvents for decontamination purposes are not regulated as listed hazardous wastes. This was clarified by the Colorado

Department of Public Health and Environment [C093]. Therefore, this waste group is not F001-, F002-, F003-, or F005-listed hazardous waste.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating Benelex and Plexiglas wastes. Therefore, this waste group is not F004-listed hazardous waste.

Although the wastes in this group are not F-listed hazardous waste, headspace analysis performed on samples of Benelex and Plexiglas wastes obtained at INEEL confirmed the presence of organic solvents. The detected compounds in which the 90% upper confidence limit (UCL_{90}) was above the Program Required Quantitation Limit (PRQL) included [P033]:

- 1,1,1-trichloroethane
- toluene
- trichloroethylene.

The materials in this waste group are not hazardous waste from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

7.3.2 Radionuclides

The radioisotopes potentially contained in the waste are identified in this section. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0.

The feed materials to the recovery and purification processes (container prefixes 0001 and 0002) in Building 771 were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated were contaminated primarily with weapons-grade plutonium [P163, U059].

Pyrochemical technology (container prefix 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations and, therefore, wastes generated in this area were contaminated with weapons-grade plutonium and americium-241 [P062, U059].

The Size Reduction Vault (SRV) in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P078, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, P078].

The waste matrix and other physical parameters that could affect radioassay are summarized in Table 7-3.

Table 7-3. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	The form of radionuclide contaminants depended on the process from which the waste originated. For waste generated in Building 771, the forms may include plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal [P163]. The forms in Building 771 represent almost every actinide form found in waste generated in other buildings.
Hydrogen Content	Benelex and Plexiglas are both hydrogen-containing materials. In addition, headspace gas analysis indicated hydrogen content of 0.03-4.06 vol% [P015]. Trace quantities of hydrocarbons were also detected [P015, P033].
Other Interfering Waste Contaminants	No other interfering waste contaminants were identified.
Physical Matrix Parameters	Type 402 Benelex has a specific weight of 90 lb/ft^3 [P024].

7.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix.

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 7-4. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 7.4. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
302	771	0002	Aqueous Recovery	8/27/85	WG Pu
302	776	0019	Size Reduction	4/19/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
302	776	0025	Drum Repack	3/14/85–4/17/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
302	779	0052	Pyrochemistry Process Development	2/12/86	WG Pu, ^{241}Am
464	777	0023	Metal Fabrication-Machining	7/27/82	WG Pu, EU

WG = weapons grade EU = enriched uranium DU = depleted uranium

7.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be

added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, U043]. Oxalic acid was also used for americium recovery [P113]. Benelex and Plexiglas may contain trace quantities of these complexing agents.

7.3.4 Real Time Radioscopy

RTR examinations that occurred during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. However, none of the Benelex and Plexiglas wastes were part of a candidate waste stream selected for characterization by the 3,100 m^3 Project. Therefore, no RTR data was generated.

8. BLACKTOP, CONCRETE, DIRT, AND SAND

This waste group consists of blacktop, concrete, dirt, and sand materials generated by a variety of cleanup and construction activities in Buildings 371, 374, 559, 707, 771, 774, 776, 779, 991, and the 904 Pad. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 8-1 [U092].

Table 8-1. Blacktop, Concrete, Dirt, and Sand Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
374	Blacktop, Concrete, Dirt, and Sand [P024] Blacktop/Concrete/Dirt [P016] Soil and Cleanup Debris [P052]	January 1973 – June 1988

***Item Description Code 374, Blacktop, Concrete, Dirt, and Sand*:** This waste consists of blacktop, concrete, reinforced concrete, cinder blocks, brick, dirt, sand, rock, and construction rubble [P016, P024, P032]. The drums may also contain some combustible wastes such as Kimwipes and surgical gloves [P024].

8.1 Waste Generation

Blacktop, concrete, dirt, and sand (IDC 374) was generated from cleanup of spills and leaks, and from construction, demolition, maintenance, decontamination, and decommissioning operations in Buildings 371, 374, 559, 707, 771, 774, 776, 779, 991, and the 904 Pad [P014, P016, P024, P032, P049, P052, P114, U092, U059]. The 904 Pad was a waste storage area, and the containers from this area could have been generated from almost any area on plant site. Because this type of waste was generated on a nonroutine basis, only a limited amount of information describing specific generation activities is available. For this same reason, process flow diagrams cannot be created for this waste.

Much of the waste was generated from the plutonium recovery area of Building 771, machining operations in Building 776/777, cleanup operations from the 1969 fire in Building 776, and cleanup of any plutonium area by Building 776 size reduction personnel [P024].

Another source of this waste was from cleanup of the 903 Pad spill [P090]. The 903 Pad was a temporary drum storage area for radioactively contaminated organic liquids. The liquids included carbon tetrachloride, trichloroethylene, tetrachloroethylene, acetone, and still bottoms. An estimated 5,000 gallons of the liquids leaked from the drums into the soil. The drums were removed and the area was covered with an asphalt pad to prevent further spreading of contaminated soil [P053]. In the 1970s, soil was excavated from the lip area beside the asphalt pad [P090].

Common chemicals used for decontamination activities included 1,1,1-trichloroethane, trichloroethylene, and paint thinner for cleaning, and methylene chloride for paint removal [P023, P053, P083, P114]. Solvents such as carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene were common solvents used during plutonium operations. These solvents were used in large quantities and may be present in the waste [P023, P053]. Solvent and non-solvent contaminated wastes were not segregated [P114].

Information regarding metal contaminants in the waste is extremely limited. Soil and cleanup debris generated in Buildings 374 and 774 may be contaminated with sludge from liquid waste treatment operations. These sludges contain toxic metals (a detailed description of the sludge waste is provided in

Sections 22.0 and 23.0). Mercury was used in instruments such as barometers, thermometers, plant machinery, and mercury switches [P053]. Lead-based paint is another source of metal contamination. The waste may include demolished floors and walls that were painted with lead-based paint.

Benzene was reportedly used in a tank in Building 777 for ultrasonic testing of components. The tank, which was used until 1975, periodically leaked [P053].

8.2 Waste Packaging

Packaging of blacktop, concrete, dirt, and sand waste (IDC 374) varied depending on the waste-generating area. The waste may be single- or double-bagged in PVC and/or polyethylene plastic bags, in Fibre-Paks, or placed directly into prepared 55-gallon drums [P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might have been used to line the inner drum bag. Use of 90-mil rigid polyethylene liners began in 1972 [P024]. A rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P024, P064]. A PVC O-ring bag and a polyethylene bag placed inside the rigid liner were used if the drum was attached to a glovebox [P016]. A fiberboard liner and discs may also have been used between the waste and the drum liners for puncture protection [P008, P012, P016, P064]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

8.3 Waste Characterization

Blacktop, concrete, dirt, and sand are characterized based on knowledge of the material, knowledge of the processes generating the waste, general chemical usage at Rocky Flats, and headspace gas analysis. This section provides a RCRA hazardous waste determination for blacktop, concrete, dirt, and sand as well as radionuclide contaminants and potential complexing agents contained in the waste. This waste is at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and is classified as a heterogeneous waste [P141].

8.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and benzene. The wastes may have been mixed with halogenated and nonhalogenated solvents, and are therefore F-listed hazardous waste. There is no evidence that blacktop, concrete, dirt, and sand wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or all of this waste group are presented by IDC in Table 8-2.

Table 8-2. Blacktop, Concrete, Dirt, and Sand Waste Characterization.

IDC	Title	EPA HWNs
374	Blacktop, Concrete, Dirt, and Sand	D004-D011, D018, F001, F002, F003, F005, F006, F007, and F009

8.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and liquids were prohibited by procedural control from being placed in the drums. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change. The materials are not compressed gases, and pressurized containers were prohibited by waste packaging procedures [P012]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquids, and corrosive liquids were prohibited by procedural control from being placed in the drums [P012]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain sulfides and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P024]. Explosives were not handled or used around radioactive material. The waste may contain very small amounts of cyanide in wastewater treatment sludges from the treatment of electroplating wastes. However, the cyanide levels in the sludges are not expected to be sufficient to cause the sludge to be reactive. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver metals, as well as benzene.

Possible sources of toxic metals in soil and cleanup debris waste include Buildings 374 and 774 sludges, mercury containing instruments, and lead-based paint. Because specific information regarding chemical contaminants in the waste is limited, it is possible that toxic metals could be present in the waste from unidentified sources. Therefore, the materials in this waste group are assigned EPA HWNs D004-D011 since a representative sample of this waste cannot be obtained for verification purposes.

Soil and debris wastes from Building 777 may exhibit the characteristic of toxicity for benzene due to cleanup of the periodic leakage of the tank used for ultrasonic testing. The wastes are not F-listed waste for benzene because it was not used for its solvent properties. Therefore, the materials in this waste group are assigned EPA HWN D018 since a representative sample of this waste cannot be obtained for verification purposes.

Tetrachloroethylene, trichloroethylene, and carbon tetrachloride were commonly used solvents [P023]. Soil and debris wastes could potentially be contaminated with these solvents. These compounds were typically used as solvents, and are specifically addressed in the treatment standards for the listed hazardous waste. The wastes are regulated as listed hazardous waste and not characteristic waste [P080]. Since blacktop, concrete, dirt, and sand wastes are characterized as listed hazardous wastes due to spent solvent contamination, the waste is not a toxic waste due to the presence of these organic compounds.

8.3.1.2 Listed Hazardous Waste. The materials in this waste group may have been mixed with waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31). The wastes are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33).

Solvents such as carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, and methylene chloride may be present in soil and debris waste as a result of being used for decontamination and decommissioning operations. The wastes may also be contaminated with these compounds from spill cleanup. Therefore, the materials in this waste group are assigned EPA HWNs F001 and F002.

Soil and debris wastes generated from cleanup of the 903 Pad may be contaminated with acetone. Because specific information regarding chemical contaminants in the waste is limited, it is possible that other F003-listed solvents could be present in the waste from unidentified sources. Analyses of headspace gas samples collected during the 3,100 m^3 Project, indicate the presence of two additional F003 listed solvents, ethyl benzene and xylene, in concentrations resulting in UCL_{90}s above the Program Required Quantitation Limits (PRQLs). (Table 8-3) Although these compounds were not identified in AK documents for this waste and this waste group does not exhibit the characteristic of ignitability, for this waste to be in compliance with the WIPP-WAP, EPA HWN F003 should be assigned.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating blacktop, concrete, dirt, and sand wastes. Therefore, this waste group is not F004-listed hazardous waste.

Toluene and methyl ethyl ketone were common components of paint and lacquer thinners commonly used for cleaning. The wastes may also be contaminated with these compounds from spill cleanup. Therefore, the materials in this waste group were assigned EPA HWN F005.

Headspace analyses performed on samples of blacktop, concrete, dirt, and sand wastes at INEEL for the 3,100 m^3 Project confirmed the presence of F-listed solvents as presented in Table 8-3.

Table 8-3. Statistical Evaluation of Headspace Gas Results from Blacktop, Concrete, Dirt and Sand Containers (IDC 374).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	135	117	43.4	116	1,000	57.1	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	135	0	0.185	0.480	4.16	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	135	18	12.2	139	1,620	56.0	10	F001/F002 [e]
1,1-Dichloroethane	134	5	1.44	12.8	148	10.2	10	N/A
1,1-Dichloroethylene	132	55	6.54	14.8	100	9.12	10	N/A
1,2,4-Trimethylbenzene	135	37	0.435	1.44	15.0	0.744	10	N/A
1,2-Dichloroethane	134	0	0.265	0.630	5.00	b	10	N/A
1,3,5-Trimethylbenzene	134	29	0.315	0.764	7.06	0.501	10	N/A
Acetone	135	103	8.12	17.6	174	10.4	100	N/A
Benzene	135	35	0.444	0.927	6.76	0.649	10	D018[d]
Bromoform	135	0	0.105	0.331	3.14	b	10	N/A
Butanol	135	73	12.1	18.2	84.0	14.9	100	N/A
Carbon tetrachloride	135	77	1.55	14.5	168	3.68	10	F001/F002[d]
Chlorobenzene	135	0	0.245	0.601	4.66	b	10	N/A
Chloroform	135	2	0.244	0.617	4.43	1.59	10	N/A
Cis-1,2-dichloroethylene	134	0	0.270	0.608	4.21	b	10	N/A
Cyclohexane	134	20	0.345	0.642	4.61	0.535	10	N/A
Ethyl benzene	134	87	12.6	35.7	385	17.6	10	F003[e]
Ethyl ether	134	0	0.269	0.579	4.45	b	10	N/A
Methanol	135	0	9.80	10.7	39.9	b	100	N/A
Methyl ethyl ketone	135	29	1.11	2.40	13.8	1.70	100	F005[c]
Methyl isobutyl ketone	135	87	12.8	41.4	278	18.5	100	N/A
Methylene chloride	134	21	63.8	449	4,675	194	10	F001/F002[c]
Tetrachloroethylene	135	23	0.224	0.526	4.10	0.369	10	F001/F002[d]
Toluene	135	127	22.5	36.7	276	26.7	10	F005[c]
Trans-1,2-dichloroethylene	135	1	0.213	0.479	3.80	b	10	N/A
Trichloroethylene	135	89	9.25	21.3	220	12.2	10	F001/F002 [c]
m&p-Xylene	135	109	38.7	95.4	990	50.5	10	F003 [e]
o-Xylene	134	91	8.80	20.8	218	11.6	10	F003 [e]

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the upper 90% confidence limit cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. HWN not identified in AK but assigned based on confirmatory data with UCL_{90}s>PRQL.

Aqueous waste treatment operations in Buildings 374 and 774 treated spent stripping, cleaning, and plating solutions from Building 444 electroplating operations [P052]. The Building 444 electroplating operations utilized cyanide [P067], and therefore the Buildings 374 and 774 wastewater treatment operations received F007 and F009 wastes, and generated an F006 wastewater treatment sludge. Blacktop, concrete, dirt, and sand may be contaminated with wastewater treatment sludges from spill cleanup or construction activities, and therefore are assigned EPA HWNs F006, F007, and F009.

The materials in this waste group are not hazardous waste from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33). It is uncertain if the wastes were generated from cleanup of a commercial chemical product spill. However, it is highly unlikely that the cleanup of a commercial chemical product would result in the generation of TRU waste. Therefore, the materials in this waste group are not P- or U-listed hazardous waste.

8.3.2 Radionuclides

This section identifies the radioisotopes potentially contained in the waste. In addition, Table 8-4 summarizes matrix and other physical parameters which could affect radioassay. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0.

About half of the IDC 374 wastes were generated in Building 777 (container prefixes 0004, 0023, and 0024) and Building 771 (container prefix 0002) [U059]. Building 777 disassembled site-return parts and conducted fabrication operations, including machining, briquetting, and assembly. The waste from this area could be contaminated with weapons-grade plutonium and enriched uranium [C184, P052, P079]. The feed materials to the Building 771 recovery and purification processes were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated were contaminated primarily with weapons-grade plutonium [P052, P163]. Other areas generating IDC 374 are identified below along with the potential radionuclides expected in the waste:

- Weapons-grade plutonium and americium-241 from electrorefining and aqueous recovery areas in Building 371 [C184, P164]

- Weapons-grade plutonium, americium-241, and enriched and depleted uranium from the analytical and chemical standards laboratories in Buildings 371 and 559 [P053, P081]

- Liquids containing weapons-grade plutonium, americium-241, and enriched and depleted uranium were treated in Buildings 374 and 774 [P164]

- Weapons-grade plutonium from Building 707 foundry, casting, and final assembly operations [P053]

- Weapons-grade plutonium, americium-241, enriched and depleted uranium, uranium-233, neptunium-237, and plutonium-242 were processed during research and development activities in Buildings 771 and 779 [C171, C185, P164, P198]

- Weapons-grade plutonium and americium-241 from the Building 776 pyrochemical operations area [P078, P163]
- Weapons-grade plutonium from the pilot-scale fluidized-bed incinerator in Building 776 [P024]
- Weapons-grade plutonium from Building 779 hydriding operations [P164].

In addition, the SRV in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers may contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, P078].

Table 8-4. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	The form of radionuclide contaminants depends on the process from which the waste originated. Actinide contaminants from Building 777 may be in metal or oxide form [P079]. For waste generated in Building 771, the forms may include plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal [P163]. The forms in Building 771 represent almost every actinide form that will be found from waste generated in other buildings.
Hydrogen Content	The primary source of hydrogen was from the plastic packaging materials (see Section 8.3). Headspace gas analysis indicates hydrogen content of less than 0.5 vol% and only trace quantities of hydrocarbons [P015, P033].
Other Interfering Waste Contaminants	No other interfering waste contaminants were identified.
Physical Matrix Parameters	Void space and distribution of waste contaminants will vary widely due to the heterogeneous nature of this waste.

8.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1[P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA systems used at the INEEL measured americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235 and -238 activities. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high-resolution gamma spectrometric measurements of Rocky Flats Plant (RFP) wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high-resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P327]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P249, P322]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 8-5. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number in this table. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 8-5. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
374	any	0089	Any Building identified	4/13/73–5/16/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
374	371	0030	Operations in Building 371	2/19/82	WG Pu, EU, ^{241}Am, DU
374	371	0032	Aqueous Recovery	1/6/84–9/30/87	WG Pu, ^{241}Am
374	371	0048	Operations in Building 371	4/3/84–12/9/86	WG Pu, EU, ^{241}Am, DU
374	371	0071	Analytical/Standards Laboratory	2/17/85	WG Pu, EU, ^{241}Am, DU
374	371	0076	Operations within Building 371	4/20/81	WG Pu, EU, ^{241}Am, DU
374	371	0092	Aqueous Recovery	2/6/85–9/11/87	WG Pu, ^{241}Am
374	374	0749	Liquid Waste Treatment	10/21/84–10/21/84	WG Pu, EU, ^{241}Am, DU
374	559	0029	Analytical Laboratory	5/1/84–6/22/88	WG Pu, EU, ^{241}Am, DU
374	707	0012	Foundry and Casting Operations	11/5/81–7/14/86	WG Pu
374	707	0022	Metal Fabrication-Machining	4/28/83–9/28/87	WG Pu
374	771	0001	Aqueous Recovery	1/8/73	WG Pu
374	771	0002	Aqueous Recovery	7/16/80–2/5/88	WG Pu
374	771	0042	Chemical Technology	2/27/81–3/26/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
374	771	0078	Plutonium Metallurgy Development	2/18/82–2/18/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
374	771	0078	Plutonium Metallurgy Development	2/2/83–4/14/83	WG Pu, EU, ^{241}Am, DU
374	774	0746	Liquid Waste Treatment	9/23/86–3/6/87	WG Pu, EU, ^{241}Am, DU
374	776	0003	Pyrochemical Operations	10/9/87	WG Pu, ^{241}Am
374	776	0019	Size Reduction	6/22/83–4/23/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
374	776	0025	Drum Repack	8/5/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
374	776	0041	Waste Processing/Final Packaging	4/23/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
374	776	0075	Waste Processing Development	7/21/81–7/24/81	WG Pu
374	777	0004	Radioscopy	4/23/82	WG Pu, EU

Table 8-5. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
374	777	0023	Metal Fabrication-Machining	6/9/81–5/18/88	WG Pu, EU
374	777	0024	Metal Fabrication-Disassembly	1/13/86–3/18/86	WG Pu, EU
374	779	0054	Research and Development	1/18/83–11/6/85	WG Pu, EU, ^{241}Am, DU
374	779	0055	Hydride Operations	8/6/81–8/18/81	WG Pu
374	991	0013	Storage & Off-Site Ship. & Rec.	6/23/86	WG Pu

Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompassed all RF buildings and processes that generated blacktop, concrete, dirt, and sand transuranic wastes. The characterization brackets the blacktop, concrete, dirt, and sand wastes generated in these time periods and identified by these IDCs and container prefixes.

WG = weapons grade DU = depleted uranium EU = enriched uranium

8.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the Blacktop, Concrete, Dirt, and Sand waste are summarized in Tables 8-6 and 8-7. The overall yield for this radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 8-6 and Table 8-7 present the yield and the radionuclide and related radioassay information, respectively. The data for the individual radioassay systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 8-6. Overall Radioassay Yield for Blacktop, Concrete, Dirt, and Sand Waste.

Total number of:	Number	Percentage of Total
Containers	78	
"*WIPPOK*" containers	0	0%
"*Treatment*" containers	5	6%
"Deficient/Permanently Rejected" containers	73	94%

Table 8-7. Radionuclide and Related Quantities for Blacktop, Concrete, Dirt and Sand.[a]

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	4.964E-02	2.280E-01	-4.459E-03	1.488E+00	58
TRU Activity (Ci)	4.972E-02	2.285E-01	-4.472E-03	1.491E+00	58
TRU Activity Concentration (nCi/g)	8.333E+02	4.293E+03	-4.231E+01	3.146E+04	58
Thermal Power (W)	1.509E-03	7.053E-03	-1.361E-04	4.675E-02	60
Thermal Power Density (W/ft^3)	2.053E-04	9.597E-04	-1.852E-05	6.360E-03	60
Plutonium Fissile Gram Equivalent (g)	5.786E-01	2.669E+00	-7.490E-02	1.740E+01	58
Americium-241 (g)	2.262E-03	8.118E-03	-8.351E-05	3.675E-02	39
Plutonium-238 (g)	6.345E-05	2.917E-04	-8.316E-06	1.931E-03	58

Table 8-7. (continued).

Quantity	Average	Standard	Range		Events
Plutonium-239 (g)	5.638E-01	2.613E+00	-7.449E-02	1.730E+01	58
Plutonium-240 (g)	3.430E-02	1.589E-01	-4.530E-03	1.052E+00	58
Plutonium-241 (g)	1.038E-03	4.806E-03	-1.370E-04	3.182E-02	58
Plutonium-242 (g)	2.563E-04	1.195E-03	-3.406E-05	7.909E-03	58
Uranium-233 (g)	8.047E-03	N/A	8.047E-03	8.047E-03	1
Uranium-234 (g)	2.449E-04	4.140E-04	5.647E-06	7.229E-04	3
Uranium-235 (g)	6.682E-01	N/A	6.682E-01	6.682E-01	1
Uranium-238 (g)	1.631E+00	2.279E-01	1.377E+00	1.817E+00	3

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation was the statistical variation of the population for which measurements were available. N/A = Not Applicable. The standard deviation is not applicable for a single measurement.

c. The negative low values were from the "Deficient / Permanently Rejected" category. These assays were outside the systems capabilities. Since this report merely summarized the data stored in the TRIPS, the values were left in for completeness.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

8.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P068]. Blacktop, concrete, dirt, and sand could contain trace quantities of KW which was used during a variety of decontamination activities at the plant.

8.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the blacktop, concrete, dirt, and sand wastes, the yield of successful RTR examinations was approximately 95.5% [P323]. Conversely, approximately 4.5% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: did not meet the criteria for protection against sharp objects; the layers of confinement were exceeded for the assigned shipping category; presence of pressurized containers; presence of excess free liquids; presence of inner container(s) > 4 liters; and the IDC could not be verified [P323]. Visual examination indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

9. COMBUSTIBLES AND PLASTIC

This waste group consists of combustibles and plastic wastes generated by the production, recovery, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations. The waste was generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P001, P012, P016]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 9-1 [U092].

The combustible and plastics wastes were characterized in two CBFO-approved WSPs for containers shipped to the WIPP facility. The WSPs were INW169.001 for Combustible Waste and INW198.001 for Plastics Waste [P284, P285].

Table 9-1. Combustibles and Plastic Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
330	Combustibles-Dry [P032] Paper and Rags-Dry [P024]	December 1972 – November 1986
336	Combustibles-Wet [P032] Paper and Rags-Moist [P024]	December 1972 – September 1985
337	Plastics [P012] Plastics (Teflon, PVC, Poly, etc.) [P032] Plastic (Teflon, PVC, etc.) and Nonleaded Rubber [P024]	January 1973 – February 1985

Item Description Code 330, Dry Combustibles: This waste consists of dry combustibles generated by the plutonium production, recovery, treatment, laboratory, and maintenance operations in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012]. Dry combustibles consist primarily of cloth, paper, and wood wastes including items such as wipes, towels, rags, coveralls, booties, gloves, and wood filter frames. Dry combustibles may contain up to 50% plastic and 10% of other waste items including metal, glass, and leaded gloves. Dry combustibles may be contaminated with any of the solvents, acids, bases, and other reagents used in the processes from which they were generated [P001, P024, P032, P052].

Items that have been identified in a small percentage of the containers during INEEL examination of dry combustibles waste for the 3,100 m^3 Project are listed in Table 9-2 [P282]. Typical waste material parameters for dry combustibles waste (IDC 330) for the 3,100 m^3 Project, including typical packaging materials are listed in Table 9-3 [P282].

Table 9-2. Items Identified During RTR of Dry Combustibles Waste (IDC 330) for the 3,100 m^3 Project.

Item[a]	Comment
DC motor	Iron based metals and other metals. A DC motor was evaluated for its potential to carry additional HWNs. No additional HWNs were applicable.
Concrete	The VE identified a chunk of concrete.
Sheetrock	The VE identified a small piece of sheetrock.
Ceramic insulator disks with metal and plastic leads	The VE identified ceramic insulator disks with metal and plastic leads.

Table 9-2. (continued).

Item[a]	Comment
Fibre-Pak	RTR examination identified fiber packs as cellulosic waste material. The fiber packs do not consist of material that is inherently hazardous.
Miscellaneous lead items	The RTR examination identified lead and lead tape.
Dry cell battery	D-cell batteries may exhibit the toxicity characteristic for mercury.
Pressurized containers	Containers with items prohibited by the WIPP (WAC) were not shipped to WIPP.
Light bulbs	The RTR examination identified light bulbs as other inorganic material. The bulbs may contain a small amount of lead.

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to the WIPP.

Table 9-3. Typical Waste Material Parameters for Dry Combustibles Waste (IDC 330) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Cellulosics	Cardboard liner, fiberboard liner and disks, paper, cloth, and wood items
Plastics (waste material) and rubber	Plastic, rubber, and latex items
Other inorganic materials	Vermiculite, Oil-Dri®, Raschig rings, glass
Other metals	Lead liner, lead sheeting
Iron metals/alloys	Metal waste items

Item Description Code 336, Wet Combustibles: This waste consists of wet combustibles generated by the plutonium production, recovery, treatment, laboratory, and maintenance operations in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012]. Wet combustibles consist primarily of cloth, paper, and wood wastes including items such as wipes, towels, rags, coveralls, booties, gloves, and wood filter frames. Wet combustibles contained discernable amounts of process liquids. Wet combustibles may contain up to 50% plastic and 10% of other waste items including metal, glass, and leaded gloves. Wet combustibles may be contaminated with any of the solvents, acids, bases, and other reagents used in the processes from which they were generated [P001, P024, P032, P052].

Items that have been identified in a small percentage of the containers during INEEL examination of wet combustibles waste for the 3,100 m^3 Project are listed in Table 9-4 [P282]. Typical waste material parameters for wet combustibles waste (IDC 336) for the 3,100 m^3 Project, including typical packaging materials, are listed in Table 9-5 [P282].

Table 9-4. Items Identified During RTR of Wet Combustibles Waste (IDC 336) for the 3,100 m^3 Project.

Item[a]	Comment
Miscellaneous lead items	The RTR examination identified lead tape.
Pressurized containers	A drum contained a pressurized container. Containers with items prohibited by the WIPP WAC were not shipped to WIPP.
Asphalt	RTR examination identified a 5 pound piece of asphalt.
Light bulbs	The RTR examinations identified light bulbs as other inorganic material. The bulbs may contain a small amount of lead.

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to the WIPP.

Table 9-5. Typical Waste Material Parameters for Wet Combustibles Waste (IDC 336) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Cellulosics	Cardboard liner, fiberboard liner and disks, paper, cloth, and wood items
Plastics (waste material) and rubber	Plastic, rubber, and latex items
Other inorganic materials	Vermiculite, Oil-Dri®, Raschig rings, glass
Other metals	Lead liner, lead sheeting
Iron metals/alloys	Metal waste items

Item Description Code 337, Plastics: This wastes consist of plastics generated by the plutonium production, recovery, treatment, laboratory, and maintenance operations in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012]. Plastic wastes consist primarily of polypropylene, polyethylene, polyvinyl chloride, Teflon, Hypalon, Tygon, rubber, and latex items including respirator parts, supplied air suits, filters, hoses, nonleaded glovebox gloves, surgeons gloves, bags, tape, and sheeting. Plastics may contain up to 10% of other waste items including combustibles, metal, glass, and leaded gloves. Plastic wastes may be contaminated with any of the solvents, acids, bases, and other reagents used in the processes from which they were generated [P001, P024, P032, P052].

Items that have been identified in a small percentage of the containers during INEEL examination of plastics waste are listed in Table 9-6 [P283]. Typical waste material parameters for dry combustibles waste (IDC 337) for the 3,100 m^3 Project, including typical packaging materials, are listed in Table 9-7 [P283].

Table 9-6. Items Identified During RTR of Plastics Waste (IDC 337) for the 3,100 m^3 Project.

Item[a]	Comment
Miscellaneous cellulosics	Cardboard items (e.g., disk), wooden items (e.g., handles), filters, and cellulosic waste materials were identified during RTR as cellulose.
Miscellaneous lead-containing items	Lead glass and lead seals were identified by RTR.
Miscellaneous metal items	Miscellaneous metal items were evaluated for their potential to carry additional HWNs. No additional HWNs are applicable.
Inorganic liquids	The presence of free liquid in an inner container was identified during RTR examination. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP.
Pressurized containers	The presence of pressurized cans were identified during RTR examination. Containers with items prohibited by the WIPP WAC were not shipped to WIPP.
D-Cell batteries	D-cell batteries were identified during RTR examination. D-cell batteries may exhibit the toxicity characteristic for mercury.

a. All containers were screened for light ballasts. Any container identified with light ballasts were not shipped to the WIPP.

Table 9-7. Typical Waste Material Parameters for Plastics Waste (IDC 337) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Plastics (waste material)	Plastic, rubber, and latex items
Cellulosics	Cardboard liner, fiberboard liner and disks, paper, cloth, and wood items
Other inorganic materials	Vermiculite, Oil-Dri®, Raschig rings, glass
Other metals	Lead liner, lead sheeting
Iron metals/alloys	Metal waste items

9.1 Waste Generation

Combustibles and plastic wastes were generated by production, recovery, purification, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations at the site. Process flow diagrams for combustibles and plastic waste generating processes are provided in archived WSRIC information [P060, P061, P062, P070, P077, P078, P079, P081, P082].

9.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the

construction of Building 707 in 1972. Building 707 was constructed after the 1969 fire in Building 776 shut down foundry and machining operations in that building [P053].

The foundry in Building 707 cast molten plutonium into classified components, subassemblies, and assemblies. Other parts were manufactured by rolling, forming, and machining plutonium ingots also cast in the foundry. Components were assembled using a number of welding and joining techniques in Buildings 707, 777, and 779. Production support operations in Buildings 707 and 777 included a variety of inspection, calibration, measurement, weighing, leak testing, and cleaning activities to assure that the parts met stringent specifications. Rejected plutonium parts, scraps, and turnings were returned to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to Building 771 to be recovered [P052, P053].

Halogenated solvents were used in production operations to clean and degrease plutonium parts and metal. In addition, the solvents were used with cutting oils to cool plutonium parts during machining. Carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloroethylene, and methylene chloride were the primary solvents historically used during plutonium production. Tetrachloroethylene was replaced by 1,1,1-trichloroethane for degreasing during the 1973 time frame. Several nonhalogenated solvents were also used for cleaning and degreasing, primarily during efforts to reduce use of halogenated solvents [P023, P052]. These solvents included isopropyl alcohol, ethanol, and acetone [P052, P067, P053]. Building 777 housed the carbon tetrachloride and 1,1,1-trichloroethane systems that collected and filtered solvents generated during production operations. In addition to parts cleaning and degreasing, solvents were also used to clean plutonium operation glovebox lines [P053].

9.1.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Building 771 housed operations that recovered plutonium from waste materials and other sources [P053]. Plutonium purification was performed primarily in Buildings 371, 771, 776, and 779 [P052].

Recovery operations in Building 771 used acid to dissolve solid materials containing plutonium. The resulting solutions were processed by a series of ion exchange, precipitation, calcination, fluorination, and reduction operations to produce purified plutonium metal to be recycled back into production operations. Potassium hydroxide, potassium fluoride, hydrogen peroxide, and nitric, hydrochloric, and hydrofluoric acids were the primary reagents used for plutonium recovery operations [P053, P061, P067, P083, U047].

Plutonium metal from returned parts and metal from other DOE facilities was purified at Rocky Flats. Plutonium-241 decays to americium-241, which decreases the effectiveness of the plutonium parts. Plutonium parts were disassembled in Building 777 [P053, P113]. Beginning in 1967, the MSE process in Building 776 recovered americium from plutonium metal using sodium chloride, potassium chloride, and magnesium chloride [P053]. Americium was separated from the MSE residue salts using potassium hydroxide precipitation followed by an ammonium thiocyanate anion exchange process. In 1975, the process changed to cation exchange followed by anion exchange (no thiocyanate) and then precipitation using oxalic acid [P113, U047]. The process changed again the following year to the salt scrub process which used a magnesium/zinc or a magnesium/aluminum extractant [U047]. The purified plutonium metal from MSE was either sent to the foundry in Building 707 or sent to the electrorefining process in Building 371 or Building 776 if the metal contained other impurities [P053, U047].

Spray leaching (Building 771) and hydride leaching (Building 779) also used acids to remove plutonium surface contamination from uranium metal and other metals or beryllium contamination from plutonium metal. These processes used nitric, hydrochloric, sulfuric, and sulfamic acids [P053, P061, P062].

9.1.3 Laboratory

Buildings 371, 559, and 771 housed the main analytical laboratories at the site. The laboratories' primary function was to provide analytical support to production activities in addition to supporting recovery, purification, and liquid waste treatment operations. Each of the laboratories used numerous acids, bases, solvents, and other chemical reagents.

Building 371 had an analytical laboratory and a chemical standards laboratory. The chemical standards laboratory prepared standards for various users and inspects standards that have been used in the field. The analytical laboratory analyzed samples from various operations on site. The types of analyses performed included [P081]:

- Total alpha activity
- Isotopic analysis
- X-ray emission
- X-ray diffraction
- Plutonium, uranium, and americium content
- Corrosivity
- Ignitability

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process. The types of analyses performed included [P067]:

- Emission spectroscopy
- Atomic absorption
- Infrared analysis
- Gallium analysis
- Plutonium assay
- Carbon analysis
- Uranium analysis
- Raschig ring analysis
- Tritium analyses
- Nonroutine chemical analysis
- Anion/cation solution analysis
- Isotopic analysis
- Thermal analysis
- Gas analysis
- Spark source mass spectroscopy
- X-ray analysis

Building 771 housed analytical and chemical standards laboratories. The chemical standards laboratory prepared control sample standards for the analytical laboratories in Buildings 371, 559, and 771 [P061]. The analytical laboratory provided analyses in support of plutonium operations. The types of analyses performed included [P061, P067]:

- X-ray fluorescence
- Alpha/gamma scintillation
- Spectrophotometry
- Calorimetry

- Atomic absorption
- Laser fluorimetry
- Gamma spectroscopy
- Titrations

The laboratories used a variety of reagents and solvents including:

Acids/Bases

- boric [P067]
- hydrochloric [P061, P067, P081]
- hydrofluoric [P061, P067, P081]
- nitric [P061, P067, P081]
- perchloric [P067]
- phosphoric [P067]
- sodium hydroxide [P061, P067, P083]
- sulfamic [P067]
- sulfuric [P067, P083]
- tartaric [P067]

Reagents

- ammonium hydroxide [P083]
- ammonium molybdate [P067]
- ceric ammonium nitrate [P067]
- ceric sulfate [P083]
- ferrous sulfamate [P067]
- ferric chloride [P067]
- potassium bromide [P083]
- potassium chloride [P067]
- sodium fluoride [P067]
- total ionic strength adjusting buffer (contains diaminocyclohexane tetraacetic acid) [P061]
- trioctyl phosphene oxide [P061, P081]

Organic Solvents

- acetone [P083]
- benzene [P053]
- carbon disulfide [P083]
- carbon tetrachloride [P053, P067, P083]
- chloroform [P053, P067, P083]
- cyclohexane [P061]
- ethanol [P083]
- isooctane [P083]
- isopropanol [P083]
- methanol [P083]
- methylene chloride [P053, P083]
- petroleum ether [P083]
- toluene [P083]
- tributyl phosphate [P083]
- 1,1,1-trichloroethane [P083]
- trichloroethylene [P083]
- 1,1,2-trichloro-1,2,2-triflouroethane [P067, P083]
- xylene [P083]

9.1.4 Research and Development

Research and Development included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed much of the research and development (R&D) operations at the plant. Other areas at the plant supporting R&D included Buildings 559, 771, 776, 777, and 881 [P053].

The purpose of Building 779 was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials, which might be used in plutonium operations. Other activities in Building 779 included developing improvements to the manufacturing process and finding new ways to recover plutonium and associated actinides. Another function was to develop a better understanding of the aging and shelf-life limitations of Rocky Flats products. Most of the materials used and wastes generated in this facility were the same as those in the production and recovery buildings, as much of the work conducted involved improvement of existing processes [P053]. However, processing of neptunium, curium, and cerium was also conducted [P053, U047].

The plant conducted special order work for other facilities in the DOE complex, the U.S. Department of Defense (DOD), or other federal departments or agencies. One example is the introduction of radionuclide tracers into pits destined for off-site test shots. This work took place in the 1960s and well into the 1970s. Materials such as americium-240, plutonium-238, neptunium, curium, and cerium were blended in with the regular component materials for the purpose of studying performance of the different weapon components based on post-test distribution of the rare tracers. These tracer materials were kept separate from the regular production material streams, and special recovery operations in Building 771 specialized in recovering these more exotic materials [C072, P053].

From approximately 1959 to the mid-1970s, Rocky Flats was involved in "Project Plowshare." The mission of the program was to develop technology for using nuclear explosives for peaceful applications such as excavation and uncovering of deep mineral deposits. Materials used in the manufacturing of these components were the same as those used in the production buildings [P053].

9.1.5 Waste Treatment

Waste processing at Rocky Flats included both liquid and solid process wastes. Liquid waste treatment operations had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building 771. Radionuclides were removed by precipitation, and the resulting slurry filtered. The solids removed from filters were combined with cement or other solidifying agents. The aqueous waste from this first stage goes through a second precipitation [P053]. These processes used sodium hydroxide, ferric sulfate, magnesium sulfate, and calcium chloride [P109]. See Section 23.0, Solidified Aqueous Sludge Building 774, for a detailed description of these processes.

Around 1965, an evaporator was installed in Building 774 to treat liquids from the second stage treatment and from the solar ponds. The concentrate from the evaporator was introduced into a steam-heated, double-drum drier, which produced a salt waste. The Building 774 evaporator was removed in 1979, and the liquids from the second stage treatment and solar ponds were transferred to Building 374 for additional treatment [P053].

Building 774 also processed organic liquid wastes. Plutonium-contaminated organic liquids were generated from plutonium machining [P053]. The spent organic liquid was filtered and then mixed with a solidifying agent. The process was later changed to a one step process in which the organic liquid was mixed with Envirostone (gypsum cement) and allowed to set up [P109]. See Section 25.0, Solidified Organic Waste for a detailed description of these processes.

Treatment of solid transuranic wastes was conducted in Buildings 771 and 776. Building 771 processed wastes containing plutonium above the EDL while Building 776 processed wastes below the EDL.

Operations in Building 771 processed wastes including Raschig rings, high-efficiency particulate air (HEPA) filters, and sludges from the filter plenum and from process piping. Filters were disassembled to remove plutonium-contaminated dust. Process piping removed from service was cut up and cleaned of built-up sludge. Sludge from the process piping and from the filter plenum was dissolved in nitric acid to recover plutonium. Until 1984, plutonium was recovered from Raschig rings by nitric acid leaching [P061].

Size reduction in Building 776 removed materials from drums and sorted them in an airlock vault. Materials such as light metals, filters, glass, combustibles, and Raschig rings were then put into containers with like materials. Light metals and leaded gloves were washed in a ball mill [P067].

Advanced size reduction operations in Building 776 disassembled or cut plutonium-contaminated gloveboxes and miscellaneous large equipment into sizes that could be packaged in approved containers [P110].

The fluidized-bed incinerator in Building 776 received low-level plutonium-contaminated combustible solid and liquid wastes [P052, P067]. Building 771 also housed an incinerator for processing combustible wastes [P061, U047]. See Section 14.0, Incinerator Waste, for a detailed description of the incineration processes.

9.1.6 Routine Maintenance

Routine maintenance at Rocky Flats included: utilities; change-out of oils, coolants, filters, and Raschig rings; and other general maintenance activities.

Utility systems included HVAC systems, fume scrubbers, and process vacuum systems. The HVAC systems contained air supply units for filtering incoming air and plenums for filtering exhaust air. HVAC equipment was lubricated, generating waste oil and oily wipes. KW detergent was used for periodic maintenance inside and outside the plenums. Scrubbers housed in Buildings 371, 559, 771, and 779 used potassium or sodium hydroxide to neutralize acid fumes from various process off-gas streams and glovebox exhaust streams. Process vacuum systems provided an absolute pressure at a vacuum header which served as a means to transfer fluids on demand by valving arrangements [P061, P067].

Oils, coolants, filters, and Raschig rings were used in numerous processes and required periodic change out. During oil and coolant changes, wipes were generated from spill cleanup. During Raschig-ring removal, wipes, gloves, or other combustible materials may have been contaminated with oils, solvents, acids, or bases. Other general maintenance activities included repair or replacement of gloveboxes, tanks, valves, pumps, and pipes [P108, P061, P067, P109].

9.1.7 Non-Routine Operations

Non-routine operations include spill clean up, strip-out operations, and activities associated with fires and other contaminant releases.

Occasionally, spills of various materials occurred due to leaks in tanks and piping or from material releases from gloveboxes. Tanks or pipes may have contained acids, bases, or solvents used during normal process operations. A paint stripper containing methylene chloride was often used for decontamination. Combustible and plastic wastes containing paint (possibly containing lead), paint stripping compound, and process solutions were generated from this type of activity [P053, P067].

Another non-routine activity was the strip-out of glovebox lines, process piping, valves, and associated systems. Strip-out activities were performed when a glovebox line was scheduled to be replaced or during renovation. Solvents such as trichloroethylene or 1,1,1-trichloroethane may have been used during this type of operation for decontamination [P067, P108].

Other non-routine activities, such as fires and other contaminant releases, include:

- the 1969 fire which spread through combustible materials in several hundred inter-connected gloveboxes in Building 776/777 [P053];
- the 1974 control valve release in Building 707 which allowed radioactive particulates to escape from an exhaust stack on the roof and into Module K [P053]; and
- the tritium release in which tritium-contaminated plutonium was processed from April 9, 1973 through April 25, 1973 in Building 779 causing a tritium release to the atmosphere, as well as elevated tritium levels in surface waters, process wastes, equipment, gloveboxes, and exhaust plenums [P053].

9.2 Waste Packaging

Combustibles and plastic wastes were double-bagged out of the glovebox or placed in polyethylene bottles and double-bagged out of the glovebox [P012].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners [P008, P012, P016, P064]. Lead drum liners were also used in some instances [P015, P024]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

During characterization for the 3,100 m^3 Project it was observed that several combinations of drum bags, poly bags, and O-ring bags were used to package IDC 330, IDC 336, and IDC 337 wastes. Some drums did not contain a rigid drum liner. The various combinations of liners and plastic packaging do not impact acceptability of a drum provided that four layers of containment were not exceeded for IDC 336 and five layers of containment were not exceeded for IDC 330 and IDC 337. Drums that exceeded transuranic package container (TRUPACT)-allowed containment layers were flagged for *Treatment* in the TRIPS [P282, P283].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. Visual examination of combustibles and

plastic containers identified a variety of metal and glass items including Raschig rings, nails, cans, vials, bottles, lead sheeting, bolts, pipes, welding rods, batteries, tools, and wire [P015, P024].

Wet combustibles were sorted from dry combustibles based on the criteria that wet combustibles contained a discernable amount of moisture. This definition was ambiguous and may have resulted in incorrect assignments between IDC 330 and IDC 336 in some cases. This observation was supported by inspections conducted on drums in inventory. Some drums of wastes assigned to IDC 336 were found to no longer contain discernable liquids, while drums assigned IDC 330 were found to be wet or contain free liquids [P008, P015].

9.3 Waste Characterization

Combustibles and plastic wastes were characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. This section provides a hazardous waste determination based on RCRA and the WIPP WAP requirements for combustibles and plastic wastes as well as radionuclide contaminants and potential complexing agents contained in the waste in compliance with the WIPP CH-WAC. The wastes contain at least 50% (by volume) materials that meet the Contact-Handled Waste Analysis Plan (CH-WAP) criteria for classification as debris, and are therefore heterogeneous wastes [P141].

9.3.1 Hazardous Waste Determination

The materials in the combustible and plastic waste streams presented in this section do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. Historical AK indicates that the wastes may exhibit the characteristic of toxicity for cadmium, chromium, lead, mercury, silver, and chloroform. The wastes were mixed with halogenated and nonhalogenated solvents and electroplating wastes, and are therefore F-listed hazardous wastes. There is no evidence that the combustibles and plastic wastes exhibit any other characteristic of hazardous waste [C078]. IDCs 330, 336, and 337 were assessed in this document as a single population due to the considerable amount of mixing of combustibles and plastic wastes. However, the wastes were characterized for shipment to WIPP under separate WSPs. EPA HWNs applicable to some or all of the combustibles and plastic waste group are presented by IDC in Table 9-8.

Table 9-8. Combustibles and Plastic Waste Characterization.

IDC	Title	EPA HWNs[a]
330	Dry Combustibles	D006–D009, D011, D022, F001–F003, F005-F007, and F009
336	Wet Combustibles	D006–D009, D011, D022, F001–F003, F005-F007, and F009
337	Plastic	D006–D009, D011, D022, F001–F003, F005-F007, and F009

a. These HWNs were assigned to the wastes in WSPs INW169.001 and INW198.001 based on AK and confirmed by headspace gas (HSG) as described in the following sections [P284, P285].

9.3.1.1 Characteristic Waste. The materials in the combustible and plastic waste streams may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C, as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristic of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23). The origin of the specific wastes for which the characteristic HWNs were assigned to the combustible and plastic waste streams as indicated by the historical AK data are listed in Table 9-9. The table includes only the HWNs for which specific sources were identified in the historical AK. In the WSPs for the 3,100 m^3 Project, no attempt was made to discriminate between dates of generation or waste sources in the assignment of HWNs. Instead, the HWNs were assigned to the entire waste streams covered by the WSP [P284, P285].

Table 9-9. Origin of Characteristic Hazardous Waste Numbers.

IDC	EPA HWNs	Areas or Dates of Generation
330	D006, D007, D008, D009, and D011	Building 774
330	D022	Analytical Laboratories-Buildings 371, 559, and 771
336	D006, D007, D008, D009, and D011	Building 774
336	D022	Analytical Laboratories-Buildings 371, 559, and 771
337	D006, D007, D008, D009, and D011	Building 774
337	D022	Analytical Laboratories-Buildings 371, 559, and 771

Ignitability: The materials in the waste streams do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and packaging procedures prohibited the addition of liquids to the containers [P016]. In addition, absorbents were added to wastes having the potential of generating free liquids (i.e., wet combustibles or plastic bottles containing liquid) [P012, P015, P024]. Free liquids were identified in drums of combustibles and plastic (IDCs 330, 336, and 337); however, analysis of the liquids indicated that they were not ignitable [P015]. The materials are not compressed gases, nor does the waste contain compressed gases [P012, P014, P015, P024]. The materials are not capable of causing fire through friction or absorption of moisture [P012, P024].

Prior to 1974, nitric acid was not rinsed from combustibles prior to removal from the glovebox and therefore wet combustibles (IDC 336) drums generated prior to 1974 may be contaminated with minimal amounts of nitrate salts [C076, P024, U060, U097]. However, nitration of material does not result from casual or incidental contact [U097]. The conditions needed to produce nitrocellulose were not and are not present, and the fact that, were the formation of nitrocellulose to occur, ignition would be immediate. Further, any potential for self ignition due to nitrate salt formation would have occurred within a relatively short time-frame (e.g., prior to shipment to INEEL); there has been no apparent chemical reaction over the past 20 or more years [U097, P239, P282, P283, P284, P285].

Although the headspace gas analysis submitted in support of the WSP for plastics indicated the presence of cyclohexane at a UCL_{90} greater than the PRQL [P285], this plastic waste stream is a solid debris waste stream and does not exhibit the characteristic of ignitability. The statistical analysis of the confirmatory HSG data for all containers in IDC 337 with complete, valid HSG data confirmed the presence of cyclohexane at a UCL_{90} greater than the PRQL [P324]. The materials in this waste group are not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. These wastes are not liquid, and packaging procedures prohibited the addition of liquids to the containers [P016]. In addition, absorbents were added to wastes having the potential of generating free liquids [P012, P015, P024]. The wastes are solid debris and are not aqueous liquids. Because none of the drums shipped contained 20% by volume, aqueous waste (20% by volume is required in order to measure pH per the prescribed method in 40 CFR 261.22), the corrosive characteristic did not apply to either waste stream. Only WIPP CH-WAC compliant drums were shipped to WIPP (i.e., with liquids less than or equal to 1% [0.55 gal or 2082 ml] total volume and less than or equal to 1 inch of liquid in internal containers) [P282, P283, P284, P285]. Although free liquids were identified in drums of combustibles and plastic (IDCs 330, 336, and 337) wastes, analyses of nonrepresentative waste samples (i.e., free liquids only) indicated pH values from 5 to 12, which are not corrosive by definition [P015, U060]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain sulfides, and are not capable of detonation or explosive reaction. The wastes may contain trace quantities of cyanide derived from electroplating wastes but this will not cause the resulting waste to be reactive [P284, P285]. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P015, P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. The wastes may exhibit the characteristic of toxicity for cadmium, chromium, lead, mercury, and silver, and chloroform.

RTR has identified drums of combustibles and plastic wastes containing lead items. Visual examination of the waste revealed lead items such as glovebox gloves, tape, and sheeting [P015]. Combustibles and plastic wastes from Building 774 may be contaminated from contact with liquids or sludges containing cadmium, chromium, and silver from liquid waste treatment operations [C079]. D-cell batteries, which may contain mercury, may be present in some of the waste containers [P282, P283, P284, P285]. Combustibles and plastic wastes may exhibit the characteristic of toxicity for these metals. Therefore, the materials in this waste group are assigned EPA HWNs D006, D007, D008, D009, and D011, since a representative sample of this waste cannot be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating combustibles and plastic. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Chloroform was used in laboratory operations and may be present in containers of either the combustible and plastic waste streams [P053, P067]. For this reason, combustibles and plastic wastes generated from laboratory operations may exhibit the characteristic of toxicity for this compound. The HSG analytical data submitted in support of the WSPs indicated that the UCL_{90}s for chloroform for both the combustibles and plastic waste were above the PRQL [P284, P285]. Therefore, the combustibles and plastic wastes were assigned EPA HWN, D022. The statistical analyses of the confirmatory HSG data for all containers in the combustibles and plastics waste streams confirmed the presence of chloroform at a UCL_{90} greater than the PRQL in both waste streams [P324]. These data are presented below (Tables 9-10 and 9-11).

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene were used for cleaning and degreasing. Benzene was used in laboratory analyses. These compounds were typically used as solvents and are specifically addressed in the treatment standards for listed hazardous wastes. Therefore, the combustible and plastic waste streams are regulated as listed hazardous wastes and not as characteristic wastes for these compounds [P080].

9.3.1.2 Listed Hazardous Waste

The materials in this waste group are listed hazardous wastes because they were mixed with a hazardous waste from non-specific sources as listed in 40 CFR 261, Subpart D (40 CFR 261.31). The materials are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), or

with discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were used primarily in production, laboratory, and maintenance operations that generated the combustibles and plastic waste streams. Confirmatory HSG sampling was performed on the combustible and plastic waste streams for the 3,100 m^3 Project. The analytical results from HSG samples collected from containers of combustible wastes confirmed the presence of these compounds. Statistical evaluations of the confirmatory data for the combustibles and plastics waste streams are presented in Tables 9-10 and 9-11, respectively. The HSG data submitted with the original WSP listed UCL_{90}s greater than the PRQLs for 1,1,1-trichloroethane, carbon tetrachloride, methylene chloride, and trichloroethylene [P284]. In addition to these compounds, the statistical evaluation of all HSG data from the 3,100 m^3 Project for combustibles waste also showed the UCL_{90}s for 1,1,2-trichloro-1,2,2-trifluoroethane and tetrachloroethylene to be greater than the respective PRQLs [P324]. The HSG data for samples from containers of plastic wastes submitted with the original WSP listed UCL_{90}s greater than the PRQLs for 1,1,1-trichloroethane, carbon tetrachloride, and trichloroethylene [P285]. In addition to these compounds, the statistical evaluation of all HSG data from the 3,100 m^3 Project for plastics waste also showed the UCL_{90}s for 1,1,2-trichloro-1,2,2-trifluoroethane to be greater than its PRQL [P324]. The combustibles and plastic waste streams were therefore assigned EPA HWNs F001 and F002 based on AK and/or confirmatory HSG data.

Acetone, methanol, and xylene were used primarily in laboratory operations. Acetone may also have been used during production operations. Although the combustible and plastic waste streams are not ignitable wastes, the waste streams were assigned the F003 code because F003 solvents may have been commingled with other listed solid wastes at the point of generation (e.g., application to the combustible waste materials). Acetone, methanol, and xylenes were detected in headspace gas samples collected from containers from both waste streams. None of the UCL_{90}s for these compounds exceeded the respective PRQLs in the HSG data submitted with the original WSP for combustibles [P284]. In the statistical evaluation of all HSG data for combustibles waste, the UCL_{90} for acetone was well below the PRQL, but for methanol and m&p-xylene the UCL_{90}s exceeded the PRQLs [P324]. With the exception of m&p-xylene in the data submitted with the original WSP, the HSG data for samples collected from the plastics waste stream showed the UCL_{90}s for acetone, methanol and xylene to be below the PRQLs [P285, P324]. The EPA HWN, F003, was assigned to both combustibles and plastic waste streams based on AK and confirmatory sampling results.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating the combustibles and plastic wastes. Therefore, these wastes are not F004-listed hazardous wastes.

Table 9-10. Statistical Evaluation of all HSG Data for Combustibles Waste from the 3,100 m^3 Project [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (pmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	121	118	157	540	5700	222	10	F001[c]
1,1,2,2-Tetrachloroethane	117	0	0.496	0.757	4.10	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	117	21	71.9	515	4700	221	10	F001[c]
1,1-Dichloroethane	114	18	1.27	3.56	35.0	2.39	10	N/A
1,1-Dichloroethylene	110	10	1.60	5.58	56.6	4.04	10	N/A
1,2,4-Trimethylbenzene	116	19	0.665	1.13	9.65	1.01	10	N/A
1,2-Dichloroethane	114	7	0.649	0.791	4.55	1.08	10	N/A
1,3,5-Trimethylbenzene	117	10	0.643	1.02	5.00	1.09	10	N/A
Acetone	120	82	29.2	52.3	380	36.7	100	F003[d]
Benzene	115	22	1.09	1.99	12.0	1.65	10	F005[d]
Bromoform	117	0	0.314	0.533	2.90	b	10	N/A
Butanol	121	40	3.68	8.05	64.0	5.34	100	N/A
Carbon tetrachloride	118	42	442	3,442	37,000	1134	10	F001[c]
Chlorobenzene	115	2	0.499	0.697	4.14	2.01	10	N/A
Chloroform	119	36	13.6	64.8	640	27.7	10	D022[c]
Cis-1,2-dichloroethylene	113	7	0.800	1.46	11.0	1.60	10	N/A
Cyclohexane	115	19	1.03	1.69	13.0	1.54	10	N/A
Ethyl benzene	114	20	2.56	13.2	130	6.48	10	N/A
Ethyl ether	112	0	0.870	0.827	4.35	b	10	N/A
Methanol	122	11	71.5	669	7,400	348	100	F003[e]
Methyl chloride	27	4	6.91	20.0	85.0	23.3	10	N/A[f]
Methyl ethyl ketone	120	42	6.55	29.8	323	12.5	100	N/A
Methyl isobutyl ketone	122	18	5.52	29.5	250	14.8	100	N/A
Methylene chloride	115	31	67.9	525	5,600	192	10	F002[c]
Tetrachloroethylene	118	53	7.34	34.4	330	13.5	10	F001[c]
Toluene	117	111	17.3	70.4	763	25.9	10	F005[c]
Trans-1,2-dichloroethylene	73	1	0.675	0.750	3.40	b	10	N/A
Trichloroethylene	119	97	253	1,202	13,000	411	10	F001[c]
m&p-xylene	114	30	6.45	36.4	356	15.2	10	F003[e]
o-xylene	114	17	1.84	8.75	85.0	4.68	10	F003[e]

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the upper 90% confidence limit cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. HWN assigned based on confirmatory HSG data.

f. Methyl chloride, a tentatively identified compounds detected in greater than 25% of HSG sample, was added as a target analyte. This compound does not carry an EPA HWN.

Table 9-11. Statistical Evaluation of All HSG Data for Plastics Waste from the 3,100 m^3 Project [P324].

Analyte	Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	153	152	107	386	4,700	147	10	F001[c]
1,1,2,2-Tetrachloroethane	150	0	0.264	0.384	2.40	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	152	17	8.72	71.8	850	32.0	10	F001[c]
1,1-Dichloroethane	150	19	0.663	1.88	18.0	1.24	10	N/A
1,1-Dichloroethylene	148	16	1.28	6.87	76.0	3.58	10	N/A
1,2,4-Trimethylbenzene	150	12	0.339	0.501	3.40	0.536	10	N/A
1,2-Dichloroethane	150	6	0.362	0.469	3.20	0.645	10	N/A
1,3,5-Trimethylbenzene	150	10	0.308	0.399	2.45	0.483	10	N/A
Acetone	151	121	9.32	18.7	140	11.5	100	F003[e]
Benzene	150	46	0.673	1.39	12.0	0.939	10	F005[d]
Bromoform	148	0	0.144	0.200	1.20	b	10	N/A
Butanol	151	31	1.15	2.95	32.0	1.85	100	N/A
Carbon tetrachloride	152	35	471	4,862	59,000	1,545	10	F001[c]
Chlorobenzene	150	2	0.263	0.311	1.95	0.941	10	N/A
Chloroform	151	118	24.9	77.7	840	34.1	10	D022[c]
Cis-1,2-dichloroethylene	148	6	0.384	0.728	6.90	0.823	10	N/A
Cyclohexane	150	45	6.26	25.0	200	11.1	10	N/A
Ethyl benzene	150	35	1.99	8.87	75.0	3.95	10	N/A
Ethyl ether	148	0	0.536	0.825	4.90	b	10	N/A
Methanol	153	48	59.7	106	570	79.6	100	F003[e]
Methyl chloride	22	2	4.17	13.2	63.0	32.9	10	N/A[f]
Methyl ethyl ketone	150	74	2.43	5.20	42.0	3.21	100	N/A
Methyl isobutyl ketone	152	13	0.605	2.15	21.5	1.41	100	N/A
Methylene chloride	150	26	2.06	12.4	150	5.27	10	F002[c]
Tetrachloroethylene	151	26	2.76	21.4	240	8.29	10	F001[c]
Toluene	150	150	10.4	8.49	52.0	11.3	10	F005[c]
Trans-1,2-dichloroethylene	101	1	0.343	0.544	3.50	b	10	N/A
Trichloroethylene	153	97	129	987	12,000	259	10	F001[c]
m&p-xylene	148	43	5.12	24.0	190	9.89	10	F003[e]
o-xylene	148	34	1.18	4.54	34.0	2.19	10	F003[e]

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL or a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the upper 90% confidence limit cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. The F003 HWN was only retained because the F003 compounds were likely co-mingled at the point of generation.

f. Methyl chloride, a tentatively identified compounds detected in greater than 25% of HSG sample, was added as a target analyte. This compound does not carry an EPA HWN.

Benzene, carbon disulfide, and toluene were used primarily in laboratory operations. Combustibles and plastic wastes generated from laboratory operations were contaminated with these compounds. For both the combustibles and plastic waste streams, recent headspace gas sampling detected the presence of benzene in several samples. The presence of toluene was confirmed by HSG results for both waste streams with UCL_{90}s greater than the PRQL [P284, P285, P324]. The EPA HWN, F005, was assigned to both combustibles and plastic waste streams based on AK and confirmatory sampling results.

In addition to the 3,100 m^3 Project headspace gas sampling results, headspace analyses performed on samples of combustibles and plastic wastes obtained at the INEEL in 1995 were used as baseline AK for the development of the WSPs. The results from the 1995 samples also confirmed the presence of F-listed solvents in the combustible and plastic waste streams; carbon tetrachloride, chloroform, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, 1,1,2-trichloro-1,2,2-trifluoroethane and toluene [P033].

F-listed solvents, 1-butanol, ethyl benzene, toluene and o-xylene, also were detected in headspace samples of combustible waste and carbon tetrachloride and toluene were detected in HSG samples of plastic wastes obtained at Rocky Flats in 1996 [U030].

Aqueous waste treatment operations in Buildings 374 and 774 treated spent stripping, cleaning, and plating solutions from Building 444 electroplating operations [P052]. The Building 444 electroplating operations utilized cyanide [P067], and therefore the Buildings 374 and 774 wastewater treatment operations received F007 and F009 wastes, and generated F006 wastewater treatment sludge. The combustibles and plastic wastes generated from these operations may have been mixed with these electroplating wastes, and the EPA HWNs F006, F007, and F009 were assigned to the two waste streams.

The materials in the two waste streams included in this waste group are not hazardous wastes from specific sources. They were not generated from any of the processes listed in 40 CFR 261.32 and the materials in these wastes are not K-listed hazardous wastes.

The materials in the combustible and plastic waste streams are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

9.3.2 Radionuclides

The radioisotopes potentially contained in the combustible and plastic wastes, as well as the chemical form of radionuclide contaminants and radioassay interferences, are described in the following sections. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0. Wastes from some of the processes described below may not be contained in the inventory based on the assigned prefixes. However, as explained in Section 9.3.2.6, it is assumed that repackaged drums could contain waste generated from any process.

9.3.2.1 Plutonium Production. Radionuclide contamination in waste from Building 707 primarily consisted of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers [C171, C174, C184, C185, P053, P164, P167].

Building 777 performed disassembly of site-return parts and fabrication operations including machining, briquetting, assembly, and production support processes (container prefixes 0004, 0023, and 0024) [C184, P052, U059, P079]. Wastes from fabrication operations were contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations were contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053].

Buildings 707 and 777 handled actinides in metal or oxide form only [P060, P079]. The actinide metals have partially or completely oxidized because of the reaction with dry air, and some could possibly have formed a hydroxide layer from reaction with moist air. Radioassay interferences may include beryllium from Part V metal fabrication in Building 707, and calcium fluoride which was sprayed onto graphite molds in Building 707 prior to casting [C184, P060]. Other interfering waste contaminants include aluminum, beryllium, and stainless steel (chromium) which were machined in Building 777 [P079].

9.3.2.2 Plutonium Recovery and Purification. Wastes from recovery operations in Building 371 contain weapons-grade plutonium primarily from electrorefining [C184, P067]. A limited amount of the waste also could have been generated from aqueous recovery operations that only ran for a short time in 1982. Aqueous recovery operations were designed for recovering and purifying weapons-grade plutonium [C184, P164].

The feed materials to the recovery and purification processes (container prefixes 0001 and 0002) in Building 771 were impure plutonium residues that were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated will be contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Radionuclides from aqueous recovery operations will vary widely in chemical form depending on the specific process the waste originated, and because the majority of the aqueous processes were performed within one large material balance area (MBA) (container prefixes 0001 and 0002), the specific process can not be determined. The different actinide forms are plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Wastes in containers from the americium recovery glovebox lines (container prefix 0006) in Building 771, used for extraction of americium from site-return plutonium, contain a significant amount of americium-241 [C184, P053, P164, U059]. The americium was in a chloride, hydroxide, nitrate, oxalate, and oxide chemical form during different steps of the process. Prior to 1975, ammonium thiocyanate also was used [P053].

The Oralloy leach process (container prefix 0074) in Building 771 chemically separated plutonium surface contamination from enriched uranium hemishells using nitric acid. The chemical form of the radionuclides are plutonium nitrate and uranyl nitrate [C184, P061, P163, U059].

Wastes in containers generated from Building 771 filter plenum maintenance were assigned container prefix 0009 [C184, P052]. It was assumed that the wastes contain any of the radioisotopes processed in the building.

Site-return metal and other non-specification plutonium were processed by pyrochemical operations in Building 776 (container prefix 0003) to produce plutonium for use in the foundry [C184, P053, U059]. The molten salt extraction process removed americium-241 from site-return and other non-specification plutonium. Electrorefining was used to purify plutonium metal that did not meet foundry specifications. Since metal was the feed and product to the MSE and electrorefining processes,

wastes generated from these processes were contaminated with actinide metals which probably have formed an oxide or hydroxide layer from reaction with dry and moist air. Direct oxide reduction was developed to convert plutonium dioxide to plutonium metal [P163, P175]. MSE residue salts, which contain actinide chlorides, were the feed to the salt scrub process. Metal was the product of this process as well, so the radionuclide contaminants could be in a metal, oxide, and/or hydroxide form. Radioassay interferences may include chloride salts (i.e., sodium, potassium, magnesium, calcium, and zinc) [P163].

Hydride operations in Building 779 (container prefix 0055) recovered plutonium from various substrates by reacting plutonium metal with gaseous hydrogen in an argon-inerted glovebox [P052, U059, P062, P163]. Hydriding produced plutonium metal for use in the foundry or nonspecification feed to pyrochemical operations, in addition to plutonium oxides sent for aqueous recovery [C184, P062]. The hydriding process formed plutonium hydride which was converted to plutonium dioxide by oxidizing the material in an air atmosphere [P163].

9.3.2.3 Laboratory. The analytical laboratory in Building 371 (container prefix 0071) provided analytical support for process control and performed analyses on feed materials and residues from recovery operations in Building 371 [P053, U059, P081]. The laboratory also analyzed samples from various operations at the site, but primarily from Building 374 [P081]. The Building 371 chemical standards laboratory prepared standards for various users and inspected standards that were used throughout the plant site [P053]. Wastes from these laboratories were contaminated with weapons-grade plutonium and enriched and depleted uranium.

The Building 559 analytical laboratory (container prefix 0029) performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, P076, U059, U073]. The primary mission of this laboratory was analysis of site-return and feed materials, in addition to recovery, purification, and foundry products [P053].

The Building 771 analytical laboratory (container prefix 0037) received samples from recovery operations in the building as well as from the foundry [P067, U059]. The samples included plutonium metal turnings, plutonium oxide, acidic plutonium solutions, and various process residues [P061]. In addition, the analytical laboratory analyzed samples from research and development (R&D) laboratories in Buildings 771 and 779 (see Section 9.3.2.4) [P067, P061]. The chemical standards laboratory (container prefix 0038) prepared uranium, plutonium, and americium nitrates used as control standards for the Buildings 371, 559, and 771 analytical laboratories [P067, P061]. The laboratory also produced nondestructive assay standards used at drum counters and fluoride standards for chemical operations [P061].

The metallography laboratory (container prefix 0021) in Building 777 prepared and examined metallographic specimens in support of R&D operations (plutonium metallography, nuclear and non-nuclear joining, quality engineering, and product physical chemistry) and, therefore, contain any of the radionuclides used during R&D activities (see Section 9.3.2.4) [C184, U059, P079]. The Building 777 tritium surveillance laboratory analyzed solid, liquid, and gas samples from throughout the plant site for tritium content [U078].

Because the laboratories supported all phases of weapons production, the chemical form of the radionuclide contaminants and radioassay interferences vary widely depending on the type of sample analyzed.

9.3.2.4 Research and Development. Projects using transuranic radionuclides were done in Buildings 771, 776, 777, 779, and 881. Most of the documentation pertaining to R&D activities does not specify locations in which the work was performed, and unless otherwise noted, it was assumed that any

of the radioisotopes could have been handled in the R&D areas of any of these buildings. In addition to weapons-grade plutonium, americium-241, and enriched and depleted uranium, the following radioisotopes were processed during R&D activities [C134, C137, C185, P053, P164, P167, P189, P190, P194, P195, P198, P200, U064]:

- americium-240
- curium-244
- neptunium-237
- plutonium-238, -240, -241, and -242
- low NGS plutonium (≈3% Pu-240)
- power grade plutonium (up to 20% Pu-240 and 1% Pu-241)
- thorium-228
- uranium-233, -235, -236, and –238.

A summary of the projects and time periods that these and other radionuclides were used is presented in Section 3.0.

In Building 771, special recovery anion exchange (container prefix 0045) separated plutonium from other materials that were not suitable for the regular recovery processes [C154, P052, P061]. Chemical technology (container prefix 0042) conducted aqueous R&D activities while plutonium metallurgy operations (container prefix 0078) performed alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C184, U059, P061]. These processes may have used numerous radioisotopes.

A pilot-scale fluidized-bed incinerator (container prefix 0075) was developed in Building 776 to treat low-level waste [C184, U059]. The waste fed to the incinerator was contaminated with low levels of plutonium [P024].

The coatings laboratory (container prefix 0016) in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium [P052, U059, P079]. This research and development facility supported production processes [P052, P079]. The special weapons area (container prefix 0066) in Building 777 was a research and development facility which assembled war reserve and other specially fabricated parts [U059, P079]. The process was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

Pyrochemical technology (container prefixes 0010 and 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations [P067, U059, P062]. These processes included direct oxide reduction, molten salt extraction, electrorefining, salt scrub for MSE, salt scrub for electrorefining, pyrochemical salt recycle, anode alloy, and pyroredox [C182, P062]. Most of the materials used in Building 779 were the same as those in the weapons-production areas and, therefore, were contaminated primarily with weapons-grade plutonium and enriched uranium [P053]. However, other R&D activities in the building may have used a variety of other radionuclides [C171, C184].

9.3.2.5 Liquid Waste Treatment. Aqueous waste treatment operations in Buildings 374 and 774 received wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. Other radionuclides also may be found in the waste streams from R&D, analytical, and special order work [P164]. Radionuclide contaminants were removed from the aqueous wastes by precipitation using sodium hydroxide and, therefore, were primarily in the form of hydroxides [P163]. Radioassay interferences may include magnesium sulfate and calcium chloride reagents used in the process [P106, P163].

Building 774 also processed organic liquid wastes. Organic wastes were comprised of a variety of oils and solvents. Most of the oils were from spent lathe coolant used in the plutonium machining area and lubricating oils used in machines throughout the plant [P164]. The majority of the transuranic organic liquids were oils and solvents from plutonium machining and degreasing operations in Buildings 707 and 777 and, therefore, were contaminated with actinide metals and oxides [P052]. A more detailed discussion of the wastes treated in these buildings is provided in Sections 22.0 through 25.0.

A log entry from Building 774 indicates the presence of tritium in liquid received from Building 779. The liquid appears to have been cemented and then buried in a combustible wastes drum (IDRF074607832) [U043].

9.3.2.6 Size Reduction/Repackaging/Solid Waste Treatment. Repack operations (container prefix 0076) in Building 371 involved the repackaging of residues for off-site shipment to other U.S. Department of Energy (DOE) facilities and the repackaging of wastes and residues for on-site storage [P081, U059]. Residues and wastes repacked for off-site shipment include plutonium oxides, incinerator ash, molten salt, electrorefining salt, cell scrape out, and anode heels. Wastes and residues were received from either the stacker/retriever (container prefix 0043) in Building 371 or from one of several 10- and 55-gallon drum storage areas within Building 371 [P081, U059].

The SRV in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, U077]. Size reduction included cutting up gloveboxes or ducting, and crushing HEPA filters. Solid waste treatment activities included washing leaded gloves and scrap metal with hot water in a ball-mill washer to recover plutonium [C053, P024, P067, P164].

9.3.2.7 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1 [P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235, and -238 activities. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly.

Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, uranium-235, and uranium-238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P282, P283].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 9-12. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 9-12. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
330	any	0089	Note a	1/11/73 - 2/12/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	any	0090	Note a	4/27/73 - 5/10/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	any	0065	Note a	1/30/73 - 5/5/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	371	0017	Operations in Building 371	2/5/73 - 5/11/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	371	0032	Operations in Building 371	2/7/73 - 5/16/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	371	0036	Operations in Building 371	12/29/72 - 2/28/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	371	0043	Stacker/Retriever	1/16/85	WG Pu, EU, ^{241}Am, DU
330	371	0048	Operations in Building 371	5/18/83	WG Pu, EU, ^{241}Am, DU
330	371	0076	Operations in Building 371	6/5/80	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	371	0076	Repackaging Residues	2/19/82 - 2/19/82	WG Pu, EU, ^{241}Am, DU
330	707	0012	Foundry and Casting Operations	12/15/84	WG Pu
330	707	0022	Metal Fabrication-Machining	12/10/81 - 12/10/81	WG Pu
330	707	0028	Operations in Building 707	8/26/82 - 8/26/82	WG Pu
330	707	0031	Metal Fabrication-Assembly	11/11/80 - 3/18/82	WG Pu
330	771	0001	Aqueous Recovery	12/6/72 - 1/15/73	WG Pu
330	771	0002	Aqueous Recovery	1/17/73 - 3/26/82	WG Pu, EU[d]
330	771	0038	Chemical Standards Laboratory	9/10/81 - 4/20/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
330	771	0042	Chemical Technology	1/16/85 - 9/11/85	WG Pu, EU, ^{241}Am, DU
330	771	0047	Operations in Building 771	3/18/83	WG Pu, EU, ^{241}Am, DU
330	771	0078	Plutonium Metallurgy Development	6/28/82	WG Pu, EU, ^{241}Am, DU, ^{233}U

Table 9-12. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
330	774	0744	Liquid Waste Treatment	7/15/83	WG Pu, EU, ^{241}Am, DU
330	776	0003	Pyrochemical Operations	12/29/84 - 11/19/86	WG Pu, ^{241}Am
330	776	0019	Size Reduction	10/18/83 - 12/5/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
330	776	0041	Waste Processing/Final Packaging	6/8/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
330	776	0075	Waste Processing Development	5/16/73 - 7/24/81	WG Pu
330	779	0027	Operations in Building 771	5/12/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
330	779	0054	Research and Development	2/19/82 - 2/19/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
330	779	0054	Research and Development	1/16/85	WG Pu, EU, ^{241}Am, DU
330	779	0055	Hydride Operations	7/16/80 - 3/18/82	WG Pu, EU[d]
330	779	0072	Joining Tech-Joining D-38	6/11/82	WG Pu, DU
330	865	0046	Material Tech.– General Metallurgy	12/8/81	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
330	any	0046	Note a		WG Pu, EU, ^{241}Am, DU, ^{233}U
330	any	0067	Note a		WG Pu, EU, ^{241}Am, DU, ^{233}U
336	any	0089	Note a	12/18/72 - 5/9/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
336	any	0090	Note a	4/11/73 - 5/2/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
336	any	0065	Note a	4/23/73 - 4/24/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
336	371	0011	Operations in Building 371	5/1/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
336	371	0017	Operations in Building 371	11/13/80	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
336	371	0017	Aqueous Recovery	2/15/83	WG Pu, ^{241}Am, EU[d], DU[d]
336	371	0039	Operations in Building 371	4/28/83 - 6/3/83	WG Pu, EU, ^{241}Am, DU
336	371	0048	Operations in Building 371	8/27/82	WG Pu, EU, ^{241}Am, DU
336	371	0076	Repackaging Residues	4/28/83	WG Pu, EU, ^{241}Am, DU
336	371	0092	Aqueous Recovery	6/23/82	WG Pu, ^{241}Am
336	707	0012	Foundry and Casting Operations	1/15/73 - 4/10/73	WG Pu
336	707	0031	Metal Fabrication-Assembly	2/7/73	WG Pu
336	771	0001	Aqueous Recovery	12/11/72 - 1/10/73	WG Pu, EU[d], DU[d]
336	771	0002	Aqueous Recovery	1/17/73 - 9/11/85	WG Pu, EU[d], DU[d]
336	771	0005	Aqueous Recovery	9/15/80 - 4/23/82	WG Pu, EU[d], DU[d]
336	771	0006	Aqueous Recovery (Americium)	12/19/84 - 1/31/85	WG Pu, ^{241}Am
336	771	0009	Aqueous Recovery (Filter Plenums)	2/15/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
336	771	0037	Analytical Laboratory	1/19/73 - 2/12/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
336	771	0038	Chemical Standards Laboratory	7/22/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
336	771	0042	Chemical Technology	8/3/81 - 8/6/82	WG Pu, EU, ^{241}Am, DU, ^{233}U

Table 9-12. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
336	771	0074	Oralloy Leach	7/27/82	EU, WG Pu
336	771	0078	Plutonium Metallurgy Development	1/20/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
336	771/881	0045	Operations in Buildings 771 and 881	3/26/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
336	774	0746	Liquid Waste Treatment	4/28/83 - 8/22/83	WG Pu, EU, ^{241}Am, DU
336	776	0003	Pyrochemical Operations	7/29/80	WG Pu, ^{241}Am
336	776	0025	Drum Repack	11/11/80 - 11/11/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
336	777	0023	Metal Fabrication-Machining	1/22/73 - 5/18/83	WG Pu, EU
336	779	0072	Joining Tech-Joining D-38	3/26/82	WG Pu, DU
337	any	0089	Note a	1/16/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
337	any	0091	Note a	4/13/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
337	371	0017	Operations in Building 371	4/23/73 - 5/4/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
337	371	0017	Aqueous Recovery	7/18/84	WG Pu, ^{241}Am
337	371	0043	Stacker/Retriever	1/16/85 - 1/17/85	WG Pu, EU, ^{241}Am, DU
337	371	0076	Repackaging Residues	10/13/81	WG Pu, EU, ^{241}Am, DU
337	559	0029	Analytical Laboratory	4/20/83	WG Pu, EU, ^{241}Am, DU
337	707	0022	Metal Fabrication-Machining	2/9/73 - 4/25/73	WG Pu
337	707	0028	Operations in Building 707	8/26/82	WG Pu, ^{233}U[d]
337	707	0031	Metal Fabrication-Assembly	1/18/73 - 2/22/84	WG Pu, EU[d], DU[d]
337	771	0001	Aqueous Recovery	1/11/73 - 1/16/73	WG Pu
337	771	0002	Aqueous Recovery	1/17/73 - 4/23/73	WG Pu, EU[d], DU[d]
337	771	0006	Aqueous Recovery (Americium)	2/12/80 - 2/21/85	WG Pu, ^{241}Am
337	771	0037	Analytical Laboratory	1/2/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	771	0042	Chemical Technology	7/29/80 - 12/8/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	771	0042	Chemical Technology	1/16/85 - 1/17/85	WG Pu, EU, ^{241}Am, DU
337	774	0743	Liquid Waste Treatment	4/18/84	WG Pu, EU, ^{241}Am, DU
337	774	0744	Liquid Waste Treatment	1/2/73 - 12/17/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	774	0744	Liquid Waste Treatment	2/7/83 - 7/25/83	WG Pu, EU, ^{241}Am, DU
337	774	0746	Liquid Waste Treatment	1/30/73 - 4/25/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	776	0019	Size Reduction	5/28/80 - 6/5/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	776	0025	Drum Repack	2/8/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	776	0041	Waste Processing/Final Packaging	4/28/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
337	777	0023	Metal Fabrication-Machining	1/8/73	WG Pu, EU
337	779	0055	Hydride Operations	10/8/81 - 6/3/83	WG Pu, EU[d], DU[d]
337	881	0033	Operations in Building 881	6/25/82	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
337	any	0090	Note c		WG Pu, EU, ^{241}Am, DU, ^{233}U

Table 9-12. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
337	776	0019	Note c		WG Pu, EU, ^{241}Am, DU, ^{233}U
337	777	0021	Note c		WG Pu, EU, ^{241}Am, DU, ^{233}U
337	776	0041	Note c		WG Pu, EU, ^{241}Am, DU, ^{233}U
337	776	0091	Note c		WG Pu, EU, ^{241}Am, DU, ^{233}U

a. Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompassed all RF buildings and processes that generated combustible and plastic transuranic wastes. The characterization brackets the combustible and plastic wastes generated in these time periods and identified by these IDCs and container prefixes.

b. Because historical information did not definitively identify radionuclides for these container prefixes, all TRU radionuclides (WG Pu, EU, ^{241}Am, DU, and ^{233}U) are listed as a conservative measure.

c. Drums with these prefixes were originally assigned to another IDC but was determined during RTR that the majority of the waste in the container was greater than 50% combustibles or plastics and the IDC was changed accordingly.

d. Isotopes added by confirmatory radioassay.

WG = weapons grade DU = depleted uranium EU = enriched uranium

9.3.2.8 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for combustibles wastes are summarized in Tables 9-13 and 9-14. The overall yield for combustibles radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 9-13 and Table 9-14 present the yield and the radionuclide and related radioassay information, respectively.

Radioassay data collected in the 3,100 m^3 Project for plastics wastes are summarized in Tables 9-15 and 9-16. Again, the overall yield for plastics radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 9-15 and Table 9-16 present the yield and the radionuclide and related radioassay information, respectively. The data for the individual radioassay systems information for both waste streams are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 9-13. The Overall Radioassay Yield for the Combustibles Waste Stream (INW169.001) [P322].

Container Status	Total Number of Containers	Percent Yield
Containers examined by radioassay	575	
"*WIPPOK*" containers	162	28%
"*Treatment*" containers	100	17%
"Deficient / Permanently Rejected" containers	320	56%

Table 9-14. Radionuclide and Related Quantities for the Combustibles Waste Stream[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	1.942E-01	7.989E-01	-3.845E-05	7.725E+00	386
TRU Activity (Ci)	1.928E-01	7.961E-01	-3.853E-05	7.726E+00	385
TRU Activity Concentration (nCi/g)	4.076E+03	1.463E+04	-1.231E+00	1.439E+05	385
Thermal Power (W)	5.776E-03	2.508E-02	-1.207E-06	2.572E-01	413
Thermal Power Density (W/ft^3)	7.861E-04	3.413E-03	-1.642E-07	3.499E-02	413
Plutonium Fissile Gram Equivalent (g)	1.675E+00	6.015E+00	-4.548E-04	6.425E+01	409
Americium-241 (g)	3.942E-02	2.191E-01	-8.318E-07	2.088E+00	191
Plutonium-238 (g)	2.194E-04	7.795E-04	-5.049E-08	7.150E-03	333
Plutonium-239 (g)	1.834E+00	6.376E+00	-4.523E-04	6.384E+01	333
Plutonium-240 (g)	1.121E-01	3.889E-01	-2.750E-05	3.869E+00	333
Plutonium-241 (g)	3.327E-03	1.352E-02	-8.318E-07	1.381E-01	333
Plutonium-242 (g)	7.173E-04	2.810E-03	-2.068E-07	2.937E-02	347
Uranium-233 (g)	1.406E+00	1.545E+00	3.128E-01	2.498E+00	2
Uranium-234 (g)	1.370E-03	4.764E-03	3.009E-06	2.844E-02	75
Uranium-235 (g)	9.793E-01	2.748E+00	1.842E-03	1.422E+01	65
Uranium-238 (g)	5.532E+02	1.822E+03	2.756E-01	8.040E+03	35

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation was the statistical variation of the population for which measurements were available.

c. The negative low values listed were from the "Deficient / Permanently Rejected" category. These assays were outside the systems capabilities. Since this report merely summarized the data stored in TRIPS the values were left in the summation.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

Table 9-15. The Overall Radioassay Yield for the Plastics Waste Stream (INW198.001).

Container Status	Total Number of Containers	Percent Yield
Containers examined by radioassay	363	
"*WIPPOK*" containers	255	70%
"*Treatment*" containers	26	7%
"Deficient / Permanently Rejected" containers	84	23%

Table 9-16. Radionuclide and Related Quantities for the Plastics Waste Stream[a].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	2.159E-01	5.600E-01	-2.736E-02	5.574E+00	328
TRU Activity (Ci)	2.118E-01	5.518E-01	-2.742E-02	5.562E+00	328
TRU Activity Concentration (nCi/g)	8.550E+03	2.009E+04	-1.288E+03	2.093E+05	328
Thermal Power (W)	6.605E-03	1.777E-02	-8.648E-04	1.879E-01	336
Thermal Power Density (W/ft^3)	8.992E-04	2.419E-03	-1.177E-04	2.559E-02	336
Plutonium Fissile Gram Equivalent (g)	2.254E+00	5.722E+00	-3.020E-01	5.548E+01	335
Americium-241 (g)	1.548E-02	1.108E-01	-1.098E-03	1.549E+00	268
Plutonium-238 (g)	2.449E-04	5.381E-04	-4.711E-05	4.598E-03	313
Plutonium-239 (g)	2.260E+00	5.239E+00	-2.950E-01	4.907E+01	313
Plutonium-240 (g)	1.378E-01	3.219E-01	-1.844E-02	2.966E+00	313
Plutonium-241 (g)	3.328E-03	7.375E-03	-4.397E-04	6.260E-02	313
Plutonium-242 (g)	7.194E-04	1.657E-03	-7.852E-05	1.374E-02	315
Uranium-233 (g)	4.111E-03	1.363E-02	-5.525E-03	1.375E-02	2
Uranium-234 (g)	3.770E-04	1.371E-03	1.514E-06	9.496E-03	124
Uranium-235 (g)	3.544E-01	1.294E+00	1.409E-03	8.834E+00	120
Uranium-238 (g)	2.346E+01	5.116E+01	5.970E-01	1.856E+02	15

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

9.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, P079, U043]. Oxalic acid was also used for americium recovery [P113]. Combustibles and plastic wastes may be contaminated with minor quantities of these complexing agents.

9.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and verified the absence of prohibited items. For combustibles wastes, the yield of successful RTR examinations was approximately 53% [P323]. Conversely, approximately 47% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: did not meet criteria for protection against sharp objects; presence of excess free liquids; the absence of prohibited items could not be verified; the IDC could not be verified; presence of pressurized containers; and, the presence of sealed inner containers greater than 4 liters. All other reasons were less than 1% in total [P323].

For the plastics wastes, the yield of successful RTR examinations was approximately 74% [P323]. Conversely, approximately 26% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: did not meet criteria for protection against sharp objects; presence of excess free liquids; the absence of prohibited items could not be verified; the IDC could not be verified; presence of pressurized containers; the presence of sealed inner containers greater than 4 liters; and, the layers of confinement were exceeded for the assigned shipping category [P323].

Visual examination indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

10. FILTERS AND INSULATION

This waste group consists of filters and insulation generated by the production, recovery, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations. The waste was generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P001, P012, P016]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 10-1 [U092].

IDCs 335, 376 and 490 were characterized together under the CBFO-approved WSP, INW211.001, and corresponding containers were shipped to the WIPP facility by the 3,100 m^3 Project [P216, P225]. IDC 328 and IDC 338 were not included in the WSP because of the limited number of containers from these IDCs that were available for characterization. Containers of IDC 360 waste are not in the INEEL accessible storage inventory and were not available for characterization by the 3,100 m^3 Project.

Table 10-1. Filters and Insulation Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
328	Filters, Ful-Flo from Building 771 Incinerator [P032] Ful-Flo Filters [P061]	April 1982–February 1983
335	Filters Absolute 8 × 8 [C063] Absolute Drybox Filters [C063] Absolute Drybox Filters, Not Acid Contaminated [P001]	January 1973–July 1987
338	Insulation [P014] Filter Media [P032] Insulation and Filter Media [P001]	January 1973–April 1973
360	Insulation [P024]	January 26, 1973
376	Cemented Insulation and Filter Media [P014] Processed Filter Media [P032] Processed Insulation and Filter Media [P001]	April 1980–September 1988
490	CWS Filters [P024] HEPA Filters [P014] HEPA Filters (24 × 24), Not Acid Contaminated [P001]	August 1985–March 1988

Item Description Code 328, Filters, Ful-Flo from Building 771 Incinerator: This waste consists of Ful-Flo filters from the recovery incinerator in Building 771. Ful-Flo filters were in-line cartridge filters designed to remove particulates from liquid streams [P001, P037, P052]. The filters were one-piece, molded filters about 10 inches long by 3 1/2 inches in diameter. Filter media consisted of a red fibrous material which filtered particulates greater than 5 microns [P052]. 1 micron and 5 micron fibrous polypropylene filters were also used [P001, P052]. Ful-Flo filters may contain caustic free liquids [P052]. Ful-Flo filters were processed as IDC 376 [P001].

Item Description Code 335, Absolute Drybox Filters: This waste consists of glovebox air intake and exhaust HEPA filters. Filter sizes include 8×8×6 inches, 8×8×4 inches, and 12×12×6 inches. Filter frames are constructed of either fire-retardant plywood or particleboard. The filter media is made of Nomex (glass and aromatic polyamide fibers), fiberglass, or asbestos [P001, P016, P024, P052]. This waste includes acid-, nonacid-, and solvent-contaminated filters [C103]. The waste may also contain limited amounts of combustible materials [P024]. Beginning in approximately 1989, acid- and nonacid-contaminated absolute drybox filters were sorted. IDC 335 was assigned to nonacid-

contaminated filters, and acid-contaminated filters were assigned IDC 342. There are no IDC 342 wastes in the INEEL accessible storage. Absolute filters contaminated with plutonium above the EDL were processed in Building 771 as IDC 338. Filters below the EDL, which were wet or had been exposed to corrosive fumes, were sent to Building 776 and processed as IDC 376 [P001, P016, P024].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the absolute drybox filters waste (IDC 335) are listed in Table 10-2 [P225]. Typical waste material parameters, including packaging materials for the IDC 335 waste as identified for the 3,100 m^3 Project are presented in Table 10-3 [P225].

Table 10-2. Items Identified by RTR for Absolute Drybox Filters Waste (IDC 335) During the 3,100 m^3 Project [P225].

Item[a]	Comment
Miscellaneous Metal Debris	Includes iron based metals/alloys, aluminum based metals/alloys, and other metals. Miscellaneous metals were evaluated for their potential to carry additional hazardous waste numbers. No additional hazardous waste numbers were determined to be applicable.

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to the WIPP.

Table 10-3. Typical Waste Material Parameters for Absolute Drybox Filters Waste (IDC 335) for the 3,100 m^3 Project [P225].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gal drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Vermiculite, Oil-Dri®, filter media
Plastics (waste materials)	Small poly bags
Aluminum-Based Metals/Alloys	Filter media, filter frames
Cellulosics	Filter media, wooden filter frames
Iron-Based Metals/Alloys	Filter frames

Item Description Code 338, Insulation and Filter Media: This waste consists primarily of filter media removed from various filters, but also includes asbestos or fiberglass pipe and furnace insulation, fire blankets, and asbestos gloves [P043]. Filter media that was wet or had been exposed to corrosive fumes was processed in Building 776 as IDC 376 [P001, P032, P043].

Item Description Code 360, Insulation: This waste consists of asbestos-type pipe insulation, asbestos gloves and fire blankets, and fiberglass and asbestos prefilter and filter media. The waste may contain limited amounts of combustible materials such as surgical gloves. IDC 360 was replaced by IDC 338 in 1973 [P024].

Item Description Code 376, Processed Insulation and Filter Media: This waste consists of Ful-Flo incinerator filters (IDC 328), absolute drybox filters (IDC 335), and insulation and filter media (IDC 338) that were wet or had been exposed to corrosive fumes. Beginning in approximately 1975, filters and insulation were sent to size reduction in Building 776 where dry Portland cement was added to the waste [C103, P024]. After adding cement, the waste was assigned IDC 376 [P001]. Prior to 1979, IDC 376 consisted primarily of filter media removed from various filters. Waste generated since 1979

consists of filter media and whole filters [P024]. The waste also includes asbestos or fiberglass pipe and furnace insulation, fire blankets, and asbestos gloves [P024, P032].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the processed insulation and filter media waste (IDC 376) are listed in Table 10-4 [P225]. Typical waste material parameters, including typical packaging materials for the IDC 376 waste as identified for the 3,100 m^3 Project are presented in Table 10-5 [P225].

Table 10-4. Items Identified by Real-Time Radioscopy (RTR) for Processed Insulation and Filter Media Waste (IDC 376) During the 3,100 m^3 Project [P225].

Item[a]	Comment
Miscellaneous Metal Items	Includes all metal waste items identified by RTR/visual.
Blank rifle cartridge	A drum with a blank rifle cartridge was flagged for *Treatment* because the cartridge is considered to be an explosive device, which is a prohibited item. The rifle cartridge is considered an explosive device, and therefore does not meet WIPP WAC. This and other drums containing materials prohibited by the WIPP WAC were not shipped.
Miscellaneous Plastics	Includes all plastic waste materials identified by RTR/visual. Typical items included tape roll, plastic tubing, O-ring and poly bags, poly bottles, and labels.
PCB Label	The label was discovered during a VE. Investigation concluded neither the drum contents nor the waste stream was contaminated with PCBs.
Inorganic Liquid	Two pints of free liquid were detected and assigned to other inorganic materials by RTR. The quantity of free liquid did not exceed waste acceptance criteria limits. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP. Free liquid was confirmed using radioscopy and VE.
Lead-containing items	The RTR examination identified a leaded rubber glove.
Miscellaneous cellulosics	RTR identified Fibre-Paks, canvas gloves, and caulking tubes as cellulosic waste material.
Glass containers	RTR identified a glass jar and lid.

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to the WIPP.

Table 10-5. Typical Waste Material Parameters for Processed Insulation and Filter Media Waste (IDC 376) for the 3,100 m^3 Project [P225].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gal drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Vermiculite, Oil-Dri®, filter media
Plastics (waste materials)	Small poly bags
Aluminum-Based Metals/Alloys	Filter media, filter frames
Cellulosics	Filter media, wooden filter frames

Item Description Code 490, HEPA Filters: This waste consists primarily of 24×24×12 inch HEPA filters from ventilation intake and exhaust filter plenums. The waste may also include various other sizes of plenum HEPA filters, prefilters, and glovebox HEPA filters [P024, U009]. Filter frames are constructed of either fire-retardant plywood or particleboard. The filter media is made of Nomex (glass and aromatic polyamide fibers), fiberglass, or asbestos [P001, P016, P024, P052]. The waste may also contain metal canister filters that were used for respiratory protection during chemical spill cleanup. At one time, IDC 490 was referred to as CWS filters [C103, C104, P024]. The waste included filters that had been potentially contaminated with acid vapors (acid-contaminated), solvent vapors (solvent-contaminated), and filters that are not expected to have been contaminated with either acid or solvent vapors (nonacid-contaminated). In the mid-1980s, prefilters were sorted from HEPA filters and were assigned IDC 491. Beginning in approximately 1989, acid- and nonacid-contaminated plenum HEPA filters were sorted. IDC 490 was assigned to nonacid-contaminated filters, and acid-contaminated filters were assigned IDC 492. There are no containers of IDC 491 and IDC 492 wastes in INEEL accessible storage. Prior to 1974, HEPA filters were packaged at each waste generating area [P024]. HEPA filters contaminated with plutonium above the EDL were processed in Building 771 as IDC 338. Filters below the EDL, which were wet or had been exposed to corrosive fumes, were sent to Building 776 and processed as IDC 376 [C104, P001, P016, P024, U009].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the HEPA filters waste (IDC 490) are listed in Table 10-6 [P225]. Typical waste material parameters, including typical packaging materials for the IDC 490 waste as identified for the 3,100 m^3 Project are presented in Table 10-7 [P225].

Table 10-6. Items Identified by RTR for HEPA Filters Waste (IDC 490) During the 3,100 m^3 Project [P225].

Item[a]	Comment
Miscellaneous Plastics	The RTR examination identified plastic waste material.

a. All containers were screened for light ballasts. Any container identified with light ballasts were not shipped to WIPP.

Table 10-7. Typical Waste Material Parameters for HEPA Filters Waste (IDC 490) for the 3,100 m^3 Project [P225].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gal drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Vermiculite, Oil-Dri®, filter media
Plastics (Waste Materials)	Small poly bags
Aluminum-Based Metals/Alloys	Filter media, filter frames
Cellulosics	Filter media, wooden filter frames
Iron-Based Metals/Alloys	Filter frames

10.1 Waste Generation

Filters and insulation wastes were generated by production, recovery, purification, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations at the site. Process flow diagrams for filters and insulation waste generating processes are provided in archived WSRIC information [P060, P061, P062, P070, P077, P078, P079, P081, P082].

10.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the construction of Building 707 in 1972. Building 707 was constructed after the 1969 fire in Building 776 which shut down foundry and machining operations in that building [P053].

The foundry in Building 707 cast molten plutonium into classified components, subassemblies, and assemblies. Other parts were manufactured by rolling, forming, and machining plutonium ingots that were cast in the foundry. Components were assembled using a number of welding and joining techniques in Buildings 707, 777, and 779. Production support operations in Buildings 707 and 777 included a variety of inspection, calibration, measurement, weighing, leak testing, and cleaning activities to assure that the parts met stringent specifications. Rejected plutonium parts, scraps, and turnings were returned to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to Building 771 to be recovered [P052].

Halogenated solvents were used in production operations to clean and degrease plutonium parts and metal. In addition, the solvents were used with cutting oils to cool plutonium parts during machining. Carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloroethylene, and methylene chloride were the primary solvents historically used during plutonium production. Tetrachloroethylene was replaced by 1,1,1-trichloroethane for degreasing during the 1973 time frame. Several nonhalogenated solvents were also used for cleaning and degreasing, primarily during efforts to reduce use of halogenated solvents [P023, P052]. These solvents included isopropyl alcohol, ethanol, and acetone [P052, P053, P067]. Building 777 housed the carbon tetrachloride and 1,1,1-trichloroethane systems that collected and filtered solvents generated during production operations. In addition to parts cleaning and degreasing, solvents were also used to clean plutonium operation glovebox lines [P023].

10.1.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Building 771 housed operations that recovered plutonium from waste materials and other sources [P053]. Plutonium purification was performed primarily in Buildings 371, 771, 776, and 779 [P052].

Recovery operations in Building 771 used acid to dissolve solid materials containing plutonium. The resulting solutions were processed by a series of ion exchange, precipitation, calcination, fluorination, and reduction operations to produce purified plutonium metal to be recycled back into production operations. Potassium hydroxide, potassium fluoride, hydrogen peroxide, and nitric, hydrochloric, and hydrofluoric acids were the primary reagents used for plutonium recovery operations [P053, P061, U047].

Plutonium metal from returned parts and metal from other DOE facilities was purified at Rocky Flats. Plutonium-241 decays to americium-241, which decreases the effectiveness of the plutonium parts. Plutonium parts were disassembled in Building 777 [P053, P113]. Beginning in 1967, the MSE process in Building 776 recovered americium from plutonium metal using sodium chloride, potassium chloride, and magnesium chloride [P053]. Americium was separated from the MSE residue salts using potassium hydroxide precipitation followed by an ammonium thiocyanate anion exchange process. In 1975, the process changed to cation exchange followed by anion exchange (no thiocyanate) and then precipitation using oxalic acid [P113, U047]. The process changed again the following year to the salt scrub process which used a magnesium/zinc or a magnesium/aluminum extractant [U047]. The purified plutonium metal from MSE was either sent to the foundry in Building 707 or sent to the electrorefining process in Building 371 or Building 776 if the metal contained other impurities [P053, U047].

Spray leaching (Building 771) and hydride leaching (Building 779) also used acids to remove plutonium surface contamination from uranium metal and other metals or beryllium contamination from plutonium metal. These processes used nitric, hydrochloric, sulfuric, and sulfamic acids [P053, P061, P062].

10.1.3 Laboratory

Buildings 371, 559, and 771 housed the main analytical laboratories at the site. The laboratories' primary function was to provide analytical support to production activities in addition to supporting recovery, purification, and liquid waste treatment operations. Each of the laboratories used numerous acids, bases, solvents, and other chemical reagents.

Building 371 had an analytical laboratory and a chemical standards laboratory. The chemical standards laboratory prepared standards for various users and inspects standards that have been used in the field. The analytical laboratory analyzed samples from various operations on site [P081].

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process [P067].

Building 771 housed analytical and chemical standards laboratories. The chemical standards laboratory prepared control sample standards for the analytical laboratories in Buildings 371, 559,

and 771 [P061]. The analytical laboratory provided analyses in support of plutonium operations [P061, P067].

10.1.4 Research and Development

Research and Development included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed much of the R&D operations at the plant. Other areas at the plant supporting R&D included Buildings 559, 771, 776, 777, and 881 [P053].

The purpose of Building 779 was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials, which might be used in plutonium operations. Other activities in Building 779 included developing improvements to the manufacturing process and finding new ways to recover plutonium and associated actinides. Another function was to develop a better understanding of the aging and shelf-life limitations of Rocky Flats products. Most of the materials used and wastes generated in this facility were the same as those in the production and recovery buildings, as much of the work conducted involved improvement of existing processes [P053]. However, processing of neptunium, curium, and cerium was also conducted [P053, U047].

10.1.5 Water Treatment

Waste processing at Rocky Flats has included both liquid and solid process wastes. Liquid waste treatment operations have had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building 771. Radionuclides were removed by precipitation, and the resulting slurry filtered. The solids removed from filters were combined with cement or other solidifying agents. The aqueous waste from this first stage goes through a second precipitation [P053]. These processes used sodium hydroxide, ferric sulfate, magnesium sulfate, and calcium chloride [P109]. See Section 23.0, Solidified Aqueous Sludge Building 774, for a detailed description of these processes.

Around 1965, an evaporator was installed in Building 774 to treat liquids from the second stage treatment and from the solar ponds. The concentrate from the evaporator was introduced into a steam-heated double-drum drier, which produced a salt waste. The Building 774 evaporator was taken out in 1979 [P053]. Beginning in 1985, the liquids from the Building 774 second stage treatment and the solar ponds were transferred to the Building 374 evaporator where a similar salt waste was produced [P052, P053].

In Building 374, liquids were concentrated by evaporation into a salt brine. The salt brine was introduced into a spray dryer producing small salt particles suspended in the air stream. The salt-laden air passed through a baghouse filter followed by HEPA filtration [P106]. Over time, a visible buildup of salt would form on the HEPA filters [P016].

Building 774 also processed organic liquid wastes. Plutonium-contaminated organic liquids were generated from plutonium machining [P053]. The spent organic liquid was filtered and then mixed with a solidifying agent. The process was later changed to a one step process in which the organic liquid was mixed with Envirostone (gypsum cement) and allowed to set up. The air from the process passed through a HEPA filtration system prior to being released [P109]. Filters from this process may have been contaminated with sludges containing oil and halogenated solvents [P052]. See Section 25.0, Solidified Organic Waste for a detailed description of these processes.

Treatment of solid transuranic wastes was conducted in Buildings 771 and 776. Building 771 processed wastes containing plutonium above the EDL while Building 776 processed wastes below the EDL.

Operations in Building 771 processed wastes including Raschig rings, HEPA filters, and sludges from the filter plenum and from process piping [P061]. HEPA filters (IDC 490) removed from filter plenums were double bagged and placed in cardboard containers for assay [P001]. Glovebox and plenum filters (IDCs 335 and 490) contaminated with plutonium above the EDL were processed in Building 771. Prior to disassembly, the filters were manually shaken to remove loose particulate. The particulate was sent for recovery. Filter frames were usually below the EDL and were disposed of as combustible or metal waste. Filter media were then repackaged as IDC 338 [P024, P061]. HEPA filters (IDC 490) below the EDL were transferred to Building 776, removed from the cardboard container, and crushed in a press [P001, P016].

Size reduction in Building 776 removed materials from drums and sorted them in an airlock vault [P067]. Ful-Flo incinerator filters (IDC 328), absolute drybox filters (IDC 335), and insulation and filter media (IDC 338) were initially packed into drums by each waste-generating area and then assayed for plutonium content. Beginning in approximately 1975, wastes contaminated with plutonium below the EDL were transported to size reduction in Building 776 [C103, P001, P124]. Dry Portland cement was added to the waste as a precautionary measure to absorb moisture, neutralize any residual nitric acid that may be present, and reduce the potential for drum pressurization. Prior to 1979, the waste was usually emptied from the original packaging (bottles, cans, or plastic bags) into a mortar box, mixed with dry Portland cement, and repackaged in a 15-gallon plastic bag. Since then, waste received at size reduction in cans or bottles was removed and repackaged in a 15-gallon polyethylene bag. A small quantity of Portland cement was added to each bag and the bag was shaken to disperse the cement. Waste received at size reduction in plastic bags was processed by cutting open the bag, pouring in a small quantity of Portland cement, and shaking the bag [P024]. After the waste was processed, it was assigned IDC 376 [P001, P024].

Advanced size reduction operations in Building 776 disassembled or cut plutonium-contaminated gloveboxes and miscellaneous large equipment into sizes that could be packaged in approved containers. Glovebox HEPA filters in this area required periodic change-out [P110].

The fluidized-bed incinerator in Building 776 received low-level plutonium-contaminated combustible solid and liquid wastes [P052, P067]. Building 771 also housed an incinerator for processing combustible wastes [P061, U047]. Process flue gas from the Building 776 incinerator passed through cyclone separators, a sintered metal filter bank, and a HEPA filter bank, before being exhausted into the HEPA filter plenum of the building ventilation system [P067]. Off-gases from the Building 771 incinerator passed through a caustic scrubber and the incinerator filter plenum before being combined with other glovebox exhaust gases in the main filter plenum [P061, U047]. The caustic scrubber solution (potassium hydroxide) passed through Ful-Flo filters to remove particulate matter [P052, P061]. See Section 14.0, Incinerator Waste, for a detailed description of the incineration processes.

10.1.6 Maintenance

Routine and non-routine maintenance at Rocky Flats includes utilities, filter testing and change-out, strip-out activities, and other general maintenance and cleanup activities.

Utility systems include HVAC systems, fume scrubbers, and process vacuum systems. The HVAC systems contain air supply units for filtering incoming air and plenums for filtering exhaust air. KW detergent was used periodically to wipe down filter frames. Scrubbers housed in Buildings 371, 559, 771,

and 779 used potassium or sodium hydroxide to neutralize acid fumes from various process off-gas streams and glovebox exhaust streams. Process vacuum systems provided an absolute pressure at a vacuum header which serves as a means to transfer fluids on demand by valving arrangements [P061, P067].

In-place testing of the plenum HEPA filters was initiated in response to a filter change, when there was visible damage to the filter or supporting framework, when plenum monitoring indicated there may be a problem, and when the routine testing schedule for that particular bank of filters dictated [P053]. Dioctylphthalate was used for testing filter efficiency, and KW detergent was used for wiping down filter frames [C105].

The Building 776 fire in 1969 resulted in the removal of filters in the area and a high volume of filter waste was generated through 1972 because the plenums were rebuilt. To protect against a similar fire, several building filtering systems were upgraded which resulted in an increase in filter waste in 1973 and 1974 [P053, P090, U056].

Other incidents generating filters included strip-out activities associated with a control valve release in Building 707 that occurred in 1974, which allowed radioactive particulates to escape from an exhaust stack on the roof and into Module K. From April 9, 1973 through April 25, 1973, tritium-contaminated plutonium was processed in Building 779, causing a tritium release to the atmosphere and elevated tritium levels in surface waters, process wastes, equipment, gloveboxes, and exhaust plenums [P053].

10.2 Waste Packaging

Ful-Flo incinerator filters (IDC 328) were bagged out of the glovebox in one or two polyethylene bags [P001, P015]. The bagged filters may also be contained in an RPC (clamshell) [P015]. Each bag or clamshell was placed in a 55-gallon drum [P001].

Each absolute drybox filter (IDC 335) removed from a glovebox was double contained in plastic bags and sealed with tape. Oil-Dri® was added to any bags containing damp filters [P001, P016, P024]. Each bag containing a filter was assayed for plutonium content before placement in a 55-gallon drum [P024].

HEPA filters (IDC 490) removed from filter plenums were double bagged and placed in cardboard cartons. The cardboard cartons were transferred to the drum counter for assay and then sent to Building 776 where the filter was removed from the carton for size reduction. The crushed filter was then placed into a waste box or a 55-gallon drum. The cardboard cartons used for transporting the filters were cut flat and may have been placed into the container as well [P001, P016]. Drums of IDC 490 consist primarily of glovebox filters (rather than plenum filters) which were single or double bagged before being placed into the drum [P024].

Filter media (IDC 338) was packaged by placing the media into a 1-gallon polyethylene bottle or in a polyethylene bag and double bagged out of the glovebox. Each bottle or bag was placed in a 55-gallon drum [P001].

Insulation (IDC 360) was single- or double-bagged in PVC or polyethylene [P015, P024]. Each bag was sealed with tape and placed in a lined 55-gallon drum. Waste such as pipe insulation waste may have been wrapped with tape and placed directly into the drum. Wet insulation may have been dried in a clothes dryer prior to packaging [P024].

Processed insulation and filter media (IDC 376) consists of Ful-Flo incinerator filters, drybox filters, filter media, and insulation combined with dry Portland cement. IDCs 328, 335, and 338 were packaged as described above. After adding the cement, the bags of filters were placed in a 55-gallon drum for shipment [P016].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners [P008, P012, P016, P064]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

During the 3,100 m^3 Project it was determined that for IDCs 335, 376, and 490 wastes several combinations of drum bags, poly bags, and O-ring bags may have been used to package the wastes. Any combination of these plastic bags, provided that four layers of containment were not exceeded, did not impact acceptability of the drums. Drums that exceeded the TRUPACT-allowed containment layers were flagged *Treatment* [P225].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024]. During RTR examinations of containers of filters and insulation waste, quantities of absorbent were identified that varied significantly from expected quantities, and some drums contained no absorbent. In addition, Oil-Dri® and vermiculite may have been used in some drums outside the expected time periods, or other absorbent materials may have been used [P225].

Operations added Portland cement to IDCs 328, 335, and 338 wastes to absorb moisture, neutralize any residual nitric acid that might have been present, and reduce the potential for drum pressurization. These processed wastes were assigned IDC 376. While cement was an expected waste material of IDC 376, cement was not identified in some drums during RTR examination performed during the 3,100 m^3 Project [P225].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. Visual examination of filters and insulation containers identified a variety of items including lead tape, nails, wood frames, rubber gaskets, and D-cell batteries [U011, U015, U028]. A PCB label was found during VE in one drum of IDC 376 (Section 10.3 includes further discussion regarding this label) [C214]. Acceptable knowledge confirmation activities have also identified numerous items in a small percentage of the filters waste containers, including small quantities of liquid and miscellaneous metal and plastic items [P225].

10.3 Waste Characterization

Filters and insulation are characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. This section provides a hazardous waste determination based on RCRA and the WIPP CH-WAP requirements for filters and insulation as well as radionuclide contaminants and potential complexing agents contained in

the waste in compliance with the WIPP CH-WAC. The wastes contain at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and are therefore heterogeneous waste [P141].

IDCs 335, 376 and 490 wastes were characterized together under the CBFO approved WSP, INW211.001, and corresponding containers were shipped to the WIPP facility by the 3,100 m^3 Project [P216, P225]. IDCs 328, 338 and 360 wastes were not included in the WSP.

During VE at INEEL, a PCB label was found in one drum (IDC 376) [C214]. Research determined that the label had originally been placed on insulation to identify that the underlying tank, which the insulation was surrounding, held a PCB contaminated waste. The insulation itself was not PCB contaminated. The IDC 376 drum (and other drums containing similar strip-out material) would not be prohibited from disposal at WIPP [C214].

10.3.1 Hazardous Waste Determination

The wastes may exhibit the characteristic of toxicity for barium, chromium, lead, mercury, silver, and chloroform. The wastes were mixed with halogenated and nonhalogenated solvents and electroplating wastes, and are therefore F-listed hazardous wastes. There is no historical evidence that filters and insulation wastes exhibit any other characteristic of hazardous waste [C107]. The EPA HWNs assigned for the filters and insulation waste group are presented by IDC in Table 10-8 [U092]. The HWNs assigned to the wastes (IDCs 335, 376 and 490) characterized during the 3,100 m^3 Project in WSP INW211.001 were based on both AK and confirmatory data and are included in the discussion presented in the following sections [P216, P225].

10.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The INEEL materials do not exhibit the characteristic of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23). The origin of the characteristic HWN for ignitability for some filters and insulation IDCs as identified in baseline AK is provided in Table 10-9. The HWN may be applicable to waste for which a specific source and time period were identified but are not necessarily applicable to the entire waste stream or IDC. The HWN is not applicable to wastes generated from areas other than those listed in the table or from those specific areas during a different period of time.

Table 10-8. Filters and Insulation Waste Characterization.

IDC	Title	EPA HWNs
328	Filters, Ful-Flo from Building 771 Incinerator	D005, D007, D008, D009[a], D011, F001, F002, F003, and F005
335	Absolute Drybox Filters	D005, D007, D008, D009[a], D011, D022, F001, F002, F005, F006, F007, and F009
338	Insulation and Filter Media	D005, D007, D008, D009[a], D011, F001, and F002
360	Insulation	D005, D007, D008, D009[a], D011, F001, and F002
376	Processed Insulation and Filter Media	D005, D007, D008, D009[a], D011, D022, F001, F002, F005, F006, F007, and F009
490	HEPA Filters	D005, D007, D008, D009[a], D011, D022, F001, F002, F005, F006, F007, and F009

a. April 24, 2001, the D009 HWN was added as part of Rev. 1 to INW211.001 Filters WSP.

Table 10-9. Buildings of Origin for Characteristic Hazardous Waste Numbers.

IDC	EPA HWNs	Building
335	D001	Building 374 generated after 1984
338	D001	Building 374 generated after 1984
490	D001	Building 374 generated after 1984

Ignitability: Filters and insulation assigned IDCs 328, 360, and 376 do not meet the definition of ignitability as defined in 40 CFR 261.21. D001 was originally identified for filters (IDCs 335 and 490) and associated filter media (IDC 338) used in conjunction with the Building 374 saltcrete generation, which began in 1985 [P153], because these materials may have visible nitrate salt contamination [P016]. It was originally thought that this contamination could pose a risk of spontaneous combustion [P052], however, any potential for self-ignition due to nitrate salt formation would have occurred within a relatively short time-frame (e.g., prior to shipment to INEEL from Rocky Flats). There has been no apparent chemical reaction over the past 20 or more years [U097].

The materials in this waste group are not liquid, and packaging procedures prohibited the addition of liquids to the containers [P016]. In addition, absorbents were added to wastes having the potential of generating free liquids (i.e., filters used in acid glovebox lines) [P012, P015, P016, P024, U011, U015]. Free liquids were identified in drums of Ful-Flo filters; however, the liquids were determined to be aqueous and not ignitable [P015]. The waste materials are not compressed gases, nor does the waste contain compressed gases [P012, P015, P016, P024, U011, U015]. Filter and insulation wastes (IDCs 328, 360, and 376) are not DOT oxidizers as defined in 49 CFR 173, and are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P024]. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials in this waste group are not liquid, and packaging procedures prohibited the addition of liquids to the containers [P016]. In addition, absorbents were added to wastes having the potential of generating free liquids [P012, P015, P024, U011, U015]. Further, none of the drums that were shipped to WIPP contained free liquids in excess of acceptable levels as defined in the CH-WAP (i.e., less than or equal to 1 inch of liquid in internal containers and less than or equal to 0.55 gal [2082 ml] total volume in a drum). Because none of the drums shipped to WIPP contained 20% by volume, aqueous waste (20% by volume is required in order to measure pH per the prescribed method in 40 CFR 261.22), the corrosive characteristic did not apply. Although in 1983 small quantities of free liquids were identified in two drums of Ful-Flo filters (IDC 328), nonrepresentative waste samples (i.e., free liquids only) indicated that the pH was not greater than 12 [P015, U060]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain sulfides, and although IDCs 335, 376, and 490 may be contaminated with trace amounts of cyanide (derived from the treatment of electroplating wastes), the materials are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P015, P024, U011]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for barium, chromium, lead, mercury, silver, and chloroform.

Filters from the Building 771 incinerator plenum are contaminated with lead and barium [P016]. RTR and VE have identified drums of filters containing lead items such as lead tape [U011]. In addition, as reported in 1986, emission spectroscopy data (Table 10-10) from plenum HEPA filter samples indicate the presence of several metals [U020]. Visual examination (Section 10.2) of filters and insulation containers also identified D-cell batteries, which may contain mercury.

Table 10-10. Emission Spectroscopy Results for HEPA Filters [U020].

Compound	Total Concentration (ppm)
Barium	> 5,000
Chromium	5 to 500
Lead	> 5,000
Silver	5 to 500

Filters and insulation (IDCs 328, 335, 338, 360, 376, and 490) may exhibit the characteristic of toxicity for barium, chromium, lead, mercury, and silver. Therefore, the materials in this waste group are assigned EPA Hazardous Waste Numbers D005, D007, D008, D009, and D011 (Table 10-11), since a representative sample of this waste cannot be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating filters and insulation. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene were used for cleaning and degreasing. Benzene was used in laboratory analysis. These compounds were typically used as solvents, and are specifically addressed in the treatment standards for listed hazardous waste [P080]. The wastes are regulated as listed hazardous waste and not characteristic waste for these compounds. The filters and insulation wastes are characterized as listed hazardous wastes due to spent solvent contamination (Section 10.3.1.2), the toxicity codes for these compounds have not been applied.

Chloroform was used in laboratory operations, and glovebox filters from these operations may have been exposed to chloroform vapors [P053, P067]. Even though only trace quantities of chloroform are expected on the filters, the exact concentration is unknown. Results from headspace gas sampling at the INEEL for IDCs 335, 376, and 490 containers indicated the presence of chloroform with a calculated UCL_{90} well below the PRQL (Table 10-12). As a conservative measure, IDCs 335, 376, and 490 wastes were assigned EPA HWN D022.

10.3.1.2 Listed Hazardous Waste. The materials in this waste group are listed hazardous wastes because they were mixed with wastes listed in 40 CFR 261, Subpart D as hazardous waste from nonspecific sources (40 CFR 261.31). The materials are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The origins of the listed HWNs assigned to filters and insulation are provided in Table 10-11. The table includes only the hazardous waste numbers that are applicable to waste for which a specific source and time period were identified. Wastes

generated from areas other than those listed in the table, or from those specific areas but during a different period of time, are not assigned the hazardous waste numbers.

Table 10-11. Buildings of Origin for Listed Hazardous Waste Numbers.

IDC	EPA HWNs	Building
328	F001, F002, F003, and F005	Building 771 Incinerator
335	F001 and F002	Building 774
	F001, F002, F005, F006, F007, and F009	Building 374 generated after 1984
338	F001 and F002	Building 774
360	F001 and F002	Building 774
376	F001 and F002	Building 774
	F001, F002, F005, F006, F007, and F009	Building 374 generated after 1984
490	F001, F002, F005, F006, F007, and F009	Building 374 generated after 1984

Combustible wastes fed to the plutonium recovery incinerator in Building 771 may have been contaminated with F001-, F002-, F003-, and F005-listed spent solvents (Section 14.0). Ful-Flo filters (IDC 328) were used to filter particulate matter from the caustic solution used in the off-gas system of the incinerator. The Ful-Flo filters were derived from the treatment of a hazardous waste and were assigned EPA HWNs F001, F002, F003, and F005 [P052].

The Colorado Department of Public Health and Environment has stated that filters (except Ful-Flo) with no visible contamination can be excluded from characterization as a listed hazardous waste [C102]. Based on this guidance, only filters used in conjunction with liquid waste treatment operations in Buildings 374 and 774 are characterized as listed hazardous wastes.

Waste oils and F001- and F002-listed spent solvents generated from machining and degreasing of plutonium metal were immobilized in Building 774. Absolute drybox filters would become contaminated with sludge containing oil and halogenated solvents from the organic liquid immobilization process. These filters (IDC 335) and the related filter media (IDCs 338, 360, and 376) from Building 774 were derived from the treatment of a hazardous waste and are assigned EPA HWNs F001 and F002 [C102, P052].

Liquid waste treatment operations in Building 374 treated aqueous wastes from numerous areas and processes that could have contained some F001-, F002-, or F005-listed spent solvents. Recent headspace gas sampling at INEEL of the filters and insulation wastes (IDCs 335, 376, and 490) characterized under the CBFO approved WSP, INW211.001, indicated the presence of 1,1,1-trichloroethane, benzene, carbon tetrachloride, chloroform, methylene chloride, toluene, and trichloroethylene, although only the calculated UCL_{90} for 1,1,1-trichlorethane was above the PRQL (Table 10-12) [P216, P225]. IDCs 335, 376, and 490 wastes were derived from the treatment of hazardous waste, and are assigned EPA HWNs F001, F002, and F005 [C102, P052, P216, P225].

The aqueous waste transferred to Building 374 for treatment may have contained small amounts of acetone, methanol, and xylene (nonhalogenated solvents listed solely for the characteristic of ignitability). However, these F-listed solvents were not mixed before being discharged into the process waste line. Solvents were also diluted with water and washed into the process waste line at the point of generation. Therefore, the ignitability characteristic was removed at the time of dilution and discharge. Although the headspace gas sampling performed at INEEL indicated the presence of acetone, butanol, ethyl benzene,

and xylene, none of the calculated UCL_{90}s were greater than the respective PRQLs (Table 10-12). Also, because the F003-listed waste was rendered nonignitable prior to subsequent discharge and aggregation within the liquid waste stream destined for sludge generation, this waste qualifies for the exemption in 40 CFR 261.3(a)(2)(iii) for nonhazardous wastewaters. This waste was not assigned the F003 EPA HWN [P052, P216, P225].

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating filters and insulation. Therefore, the filter and insulation waste group is not F004-listed hazardous waste.

Headspace analysis performed on samples of filters and insulation obtained at INEEL (reported in 1995) and Rocky Flats (results queried in 1996) confirmed the presence of F-listed solvents. Headspace analysis results are not available for IDC 360. The detected F-listed compounds reported in these early results in which the UCL_{90} was above the PRQL are as follows [P033, U030]:

- 1,1,1-trichloroethane
- benzene (IDC 376 only)
- tetrachloroethylene (IDC 335 only)
- toluene (IDC 490 only)
- trichloroethylene (IDCs 335, 338, and 490 only).

F-listed solvents also detected in headspace samples of filters and insulation obtained at Rocky Flats in 1996 in which the UCL_{90} was above the PRQL are as follows [U030]:

- toluene (IDCs 335 and 376).

After 1984, aqueous waste treatment operations in Building 374 treated spent stripping, cleaning, and plating solutions from Building 444 electroplating operations [P052]. The Building 444 electroplating operations utilized cyanide [P067], and therefore the Building 374 wastewater treatment operations received F007 and F009 wastes, and generated an F006 wastewater treatment sludge. Filters used in conjunction with the generation of salt waste in Building 374, which utilized a spray dryer, may have visible nitrate salt contamination. Filters (IDCs 335, 376 and 490) were derived from the treatment of a hazardous waste, and therefore are assigned EPA Hazardous Waste Numbers F006, F007, and F009 [C102, P052, P216, P225].

The inventory of filter and insulation (IDCs 338 and 360) wastes was generated in 1973 [U092]. Because the process in Building 374 that utilized a spray dryer to generate the salt waste was not in operation until mid-1985, these filter and insulation wastes would not be contaminated with nitrate salts [P052]. Therefore, IDCs 338 and 360 generated prior to 1985 were not assigned EPA Hazardous Waste Numbers F005, F006, F007, or F009 [C102].

The materials in this waste group are not hazardous waste from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous wastes.

Table 10-12. Statistical Evaluation of all HSG Results for the Filter and Insulation Waste Steam (INW211.001, IDCs 335, 376 and 490) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	618	453	41.4	644	16,000	80.3	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	619	1	0.162	1.42	31.0	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	621	148	79.5	847	12,000	169	10	F002[e]
1,1-Dichloroethane	616	181	1.32	9.93	130	2.27	10	N/A
1,1-Dichloroethylene	616	79	0.544	5.53	120	1.35	10	N/A
1,2,4-Trimethylbenzene	617	67	0.198	1.77	39.0	0.478	10	N/A
1,2-Dichloroethane	616	312	0.255	0.539	9.80	0.294	10	N/A
1,3,5-Trimethylbenzene	619	43	0.184	1.60	35.0	0.502	10	N/A
Acetone	622	591	26.6	72.8	960	30.5	100	N/A
Benzene	617	464	1.29	5.58	92.0	1.62	10	F005[d]
Bromoform	617	2	0.057	0.160	2.05	0.404	10	N/A
Butanol	619	381	1.12	2.83	32.0	1.31	100	N/A
Carbon tetrachloride	618	276	101	2373	59,000	284	10	F001[c]
Chlorobenzene	616	62	0.121	0.704	17.0	0.237	10	N/A
Chloroform	616	421	0.872	6.69	160	1.29	10	D022[d]
Cis-1,2-dichloroethylene	616	5	0.099	0.215	3.20	0.246	10	N/A
Cyclohexane	616	190	0.249	0.406	3.25	0.287	10	N/A
Ethyl benzene	617	98	0.221	1.18	25.0	0.375	10	N/A
Ethyl ether	615	3	0.138	0.308	3.65	0.474	10	N/A
Methanol	624	50	16.5	35.5	410	23.1	100	N/A
Methyl chloride	83	47	6.30	12.5	79.0	8.66	10	N/A[f]
Methyl ethyl ketone	622	514	4.54	7.41	60.0	4.96	100	N/A
Methyl isobutyl ketone	622	258	25.7	460	9,900	62.5	100	N/A
Methylene chloride	617	421	11.3	161	3,600	21.4	10	F002[e]
Tetrachloroethylene	617	32	0.149	0.693	8.08	0.310	10	F001/F002[d]
Toluene	619	597	19.7	214	4,600	31.0	10	F005[c]
Trans-1,2-dichloroethylene	393	2	0.116	0.280	3.55	0.725	10	N/A
Trichloroethylene	617	189	3.60	25.4	380	5.98	10	F001/F002[d]
m&p-Xylene	616	177	0.460	3.07	60.0	0.758	10	N/A
o-Xylene	619	79	0.235	1.51	31.5	0.455	10	N/A

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. HWN assigned based on confirmatory HSG results.

f. Methyl chloride, a tentatively identified compound detected in greater than 25% of HSG sample, was added as a target analyte. This compound does not carry an EPA HWN.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

10.3.2 Radionuclides

The radioisotopes potentially contained in the waste, as well as the chemical form of radionuclide contaminants and radioassay interferences, are identified in the following sections. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0. Wastes from some of the processes described below may not be contained in the inventory based on the assigned prefixes. However, as explained in Section 10.3.2.6, it is assumed that repackaged drums could contain waste generated from any process.

Radioassay interferences may include polypropylene from Ful-Flo filters, cadmium or chromium from HEPA filter frames, aluminum foil used as a spacer between the folds of the filter media, and Nomex, which is a aromatic polyamide fiber used in HEPA filters at 5 to 7 weight percent [P035, P052].

10.3.2.1 Plutonium Production. Radionuclide contamination in waste from Building 707 primarily consisted of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers [C171, C174, C184, C185, P053, P164, P167].

Building 777 performed disassembly of site-return parts and fabrication operations including machining, briquetting, assembly, and production support processes (container prefixes 0004, 0023, and 0024) [C184, P052, U059, P079]. Wastes from fabrication operations were contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations were contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053].

Buildings 707 and 777 handled actinides in metal or oxide form only [P060, P079]. The actinide metals will likely have partially or completely oxidized because of the reaction with dry air, and some could possibly have formed a hydroxide layer from reaction with moist air. Radioassay interferences may include beryllium from Part V metal fabrication in Building 707, and calcium fluoride which was sprayed onto graphite molds in Building 707 prior to casting [C184, P060]. Other interfering waste contaminants included aluminum, beryllium, and stainless steel (chromium), which were machined in Building 777 [P079].

10.3.2.2 Plutonium Recovery and Purification. Waste from recovery operations in Building 371 contains weapons-grade plutonium primarily from electrorefining [C184, P067]. A limited amount of the waste could also have been generated from aqueous recovery operations that only ran for a short time in 1982. Aqueous recovery operations were designed for recovering and purifying weapons-grade plutonium [C184, P164].

The feed materials to the recovery and purification processes (container prefixes 0001 and 0002) in Building 771 were impure plutonium residues that were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated will be contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Filters containing recoverable amounts of plutonium were processed in Building 771 by manually shaking the filter to remove loose particulates that were sent through recovery [P024, P061]. Radionuclides from aqueous recovery operations vary widely in chemical form depending

on the specific process the waste originated, and because the majority of the aqueous processes were performed within one large MBA (container prefixes 0001 and 0002), the specific process could not be determined. The different actinide forms were plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Wastes from the americium recovery glovebox lines (container prefix 0006) in Building 771, used for extraction of americium from site-return plutonium, will contain a significant amount of americium-241 [C184, P053, P164, U059]. The americium was in a chloride, hydroxide, nitrate, oxalate, and oxide chemical form during different steps of the process. Prior to 1975, ammonium thiocyanate was also used [P053].

The Oralloy leach process (container prefix 0074) in Building 771 chemically separated plutonium surface contamination from enriched uranium hemishells using nitric acid. The chemical form of the radionuclides will therefore be plutonium nitrate and uranyl nitrate [C184, P061, P163, U059].

Site-return metal and other non-specification plutonium were processed by pyrochemical operations in Building 776 (container prefix 0003) to produce plutonium for use in the foundry [C184, P053, U059]. The molten salt extraction process removed americium-241 from site-return and other non-specification plutonium. Electrorefining was used to purify plutonium metal that did not meet foundry specifications. Since metal was the feed and product to the MSE and electrorefining processes, wastes generated from these processes will be contaminated with actinide metals which now will probably have formed an oxide or hydroxide layer from reaction with dry and moist air. Direct oxide reduction was developed to convert plutonium dioxide to plutonium metal [P163, P175]. MSE residue salts, which contain actinide chlorides, were the feed to the salt scrub process. Metal was the product of this process as well, so the radionuclide contaminants could be in a metal, oxide, and/or hydroxide form. Radioassay interferences may include chloride salts (i.e., sodium, potassium, magnesium, calcium, and zinc) [P163].

Assay results for a drum of IDC 335 (IDRF000302881) from pyrochemical operations indicate a significant amount of uranium-235 [P115]. Although not confirmed, it was thought that the uranium from MSE and electrorefining salts may have concentrated in the filter [P175].

Hydride operations in Building 779 (container prefix 0055) recovered plutonium from various substrates by reacting plutonium metal with gaseous hydrogen in an argon-inerted glovebox [P052, U059, P062, P163]. Hydriding produced plutonium metal for use in the foundry or non-specification feed to pyrochemical operations, in addition to plutonium oxides sent for aqueous recovery [C184, P062]. The hydriding process formed plutonium hydride which was converted to plutonium dioxide by oxidizing the material in an air atmosphere [P163].

10.3.2.3 Laboratory

The analytical laboratory in Building 371 (container prefix 0071) provided analytical support for process control and performed analyses on feed materials and residues from recovery operations in Building 371 [P053, U059, P081]. The laboratory also analyzed samples from various operations at the site, but primarily from Building 374 [P081]. The Building 371 chemical standards laboratory prepared standards for various users and inspected standards that were used throughout plant site [P053]. Wastes from these laboratories will be contaminated with weapons-grade plutonium and enriched and depleted uranium.

The Building 559 analytical laboratory (container prefix 0029) performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, U059, U073]. The primary mission of this laboratory was analysis of site-return and feed materials, in addition to recovery, purification, and foundry products [P053].

The Building 771 analytical laboratory (container prefix 0037) received samples from recovery operations in the building as well as from the foundry [P067, U059]. The samples included plutonium metal turnings, plutonium oxide, acidic plutonium solutions, and various process residues [P061]. In addition, the analytical laboratory analyzed samples from R&D laboratories in Buildings 771 and 779 (Section 10.3.2.4) [P067, P061]. The chemical standards laboratory (container prefix 0038) prepared uranium, plutonium, and americium nitrates used as control standards for the Buildings 371, 559, and 771 analytical laboratories [P067, P061]. The laboratory also produced nondestructive assay standards used at drum counters and fluoride standards for chemical operations [P061].

The metallography laboratory (container prefix 0021) in Building 777 prepared and examined metallographic specimens in support of R&D operations (plutonium metallography, nuclear and non-nuclear joining, quality engineering, and product physical chemistry) and, therefore, may contain any of the radionuclides used during R&D activities (Section 10.3.2.4) [C184, U059, P079]. The Building 777 tritium surveillance laboratory analyzed solid, liquid, and gas samples from throughout the plant site for tritium content [U078].

Because the laboratories supported all phases of weapons production, the chemical form of the radionuclide contaminants and radioassay interferences will vary widely depending on the type of sample analyzed.

10.3.2.4 Research and Development

Projects using transuranic radionuclides were done in Buildings 771, 776, 777, 779, and 881. Most of the documentation pertaining to R&D activities does not specify locations in which the work was performed, and unless otherwise noted, it was assumed that any of the radioisotopes could have been handled in the R&D areas of any of these buildings. In addition to weapons-grade plutonium, americium-241, and enriched and depleted uranium, the following radioisotopes were processed during R&D activities [C134, C137, C185, P053, P164, P167, P189, P190, P194, P195, P198, P200, U064].

- americium-240
- curium-244
- neptunium-237
- plutonium-238, -240, -241, and -242
- low NGS plutonium (≈3% Pu-240)
- power grade plutonium (up to 20% Pu-240 and 1% Pu-241)
- thorium-228
- uranium-233, -235, -236, and –238.

A summary of the projects and time periods that these and other radionuclides were used is presented in Section 3.0.

In Building 771, special recovery anion exchange (container prefix 0045) separated plutonium from other materials that were not suitable for the regular recovery processes [C154, P052, P061]. Chemical technology (container prefix 0042) conducted aqueous R&D activities while plutonium metallurgy operations (container prefix 0078) performed alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C184, U059, P061]. These processes may have used numerous radioisotopes.

A pilot-scale fluidized-bed incinerator (container prefix 0075) was developed in Building 776 to treat low-level waste [C184, U059]. The waste fed to the incinerator was contaminated with low levels of plutonium [P024].

The coatings laboratory (container prefix 0016) in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium [P052, U059, P079]. This research and development facility supported production processes [P052, P079]. The special weapons area (container prefix 0066) in Building 777 was a research and development facility that assembled war reserve and other specially fabricated parts [U059, P079]. The process was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

Pyrochemical technology (container prefixes 0010 and 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations [P067, U059, P062]. These processes included direct oxide reduction, molten salt extraction, electrorefining, salt scrub for MSE, salt scrub for electrorefining, pyrochemical salt recycle, anode alloy, and pyroredox [C182, P062]. Most of the materials used in Building 779 were the same as those in the weapons-production areas and, therefore, will be contaminated primarily with weapons-grade plutonium and enriched uranium [P053]. However, other R&D activities in the building may have used a variety of other radionuclides [C171, C184].

10.3.2.5 Liquid Waste Treatment. Aqueous waste treatment operations in Buildings 374 and 774 received wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. Other radionuclides may also be found in the waste streams from R&D, analytical, and special order work [P164]. Radionuclide contaminants are removed from the aqueous wastes by precipitation using sodium hydroxide and, therefore, will be primarily in the form of hydroxides [P163]. Radioassay interferences may include magnesium sulfate and calcium chloride reagents used in the process [P106, P163].

Building 774 also processed organic liquid wastes. Organic wastes are comprised of a variety of oils and solvents. Most of the oils were from spent lathe coolant used in the plutonium machining area and lubricating oils used in machines throughout the plant [P164]. The majority of the transuranic organic liquids were oils and solvents from plutonium machining and degreasing operations in Buildings 707 and 777 and, therefore, will be contaminated with actinide metals and oxides [P052]. A more detailed discussion of the wastes treated in these buildings is provided in Sections 22.0 through 25.0.

10.3.2.6 Size Reduction/Repackaging/Solid Waste Treatment. The SRV in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging

was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, U077]. Size reduction included cutting up gloveboxes or ducting, and crushing HEPA filters. Solid waste treatment activities included washing leaded gloves and scrap metal with hot water in a ball-mill washer to recover plutonium [C053, P067, P164].

10.3.2.7 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1 [P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235, and -238 activities. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, uranium-235, and uranium-238, were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P225].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 10-13. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 10-13. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
328	771	0002	Aqueous Recovery	12/8/82 - 2/1/83	WG Pu
328	776	0041	Waste Processing/Final Packaging	4/23/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
335	any	0036	Note a	1/8/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
335	771	0002	Aqueous Recovery	9/8/82	WG Pu
335	771	0037	Analytical Laboratory	1/23/73 - 2/14/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
335	776	0003	Pyrochemical Operations	3/23/83 - 7/8/87	WG Pu, EU, ^{241}Am
335	776	0019	Size Reduction	8/26/85 - 8/26/85	WG Pu, EU, ^{241}Am, DU, ^{233}U

Table 10-13. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
338	any	0090	Note a	4/17/73	Unknown - Note b
338	771	0002	Aqueous Recovery	1/26/73 - 4/26/73	WG Pu, EU[c], DU[c], ^{233}U[c]
376	371	0092	Aqueous Recovery	4/28/83 - 7/18/84	WG Pu, ^{241}Am
376	707	0012	Foundry and Casting Operations	12/19/81	WG Pu
376	771	0002	Aqueous Recovery	5/21/82 - 10/22/85	WG Pu
376	776	0019	Size Reduction	12/8/81 - 1/9/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
376	776	0040	Waste Processing/Final Packaging	4/9/84 - 7/16/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
376	776	0041	Waste Processing/Final Packaging	4/23/80 - 9/15/88	WG Pu, EU, ^{241}Am, DU, ^{233}U
490	771	0001	Aqueous Recovery	1/12/73	WG Pu
490	776	0019	Size Reduction	8/26/85 - 3/22/88	WG Pu, EU, ^{241}Am, DU, ^{233}U

a. Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompassed all RF buildings and processes that generated filters and insulation transuranic wastes. The characterization brackets the filters and insulation wastes generated in these time periods and identified by these IDCs and container prefixes.

b. Prefix 0090 was assigned to the Valve Vaults (liquid waste transfer system) wastes. The Valve Vault system did not exist at the time this waste was generated. These containers were assumed to contain TRU contaminated filters based on assignment of IDC. At the end of the 3,100 m^3 Project, no 0090 containers had been processed, neither waste nor radionuclide content were verified.

c. Isotopes added by confirmatory radioassay.

WG = weapons grade DU = depleted uranium ED = enriched uranium

10.3.2.8 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for filter and insulation media wastes are summarized in Tables 10-14 and 10-15. The overall yield for filter and insulation media radioassay data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 10-14 and Table 10-15 for those IDCs (335, 376 and 490) included in the WSP (INW211.001).

The radionuclide and related radioassay information for the Ful-Flo Filters waste (IDC 328) is presented in Table 10-16. As indicated in the table, only one drum was assayed. IDC 328 was not included in the INW211.001 waste stream and no drums were shipped to the WIPP facility. The data for the individual radioassay systems information are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 10-14. Overall Radioassay Yield for Filter and Insulation Media Waste Stream (INW211.001) (IDCs 335, 376, and 490) [P322].

Total number of:	Number	Percentage of Total
Distinct containers	1,869	
"*WIPPOK*" containers	1,507	81%
"*Treatment*" containers	68	4%
"Deficient / Permanently Rejected" containers	294	16%

Table 10-15. Radionuclide and Related Quantities for Filter and Insulation Media (INW211.001) (IDCs 335, 376, and 490)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	3.493E+00	4.968E+00	-4.614E-03	2.891E+01	1866
TRU Activity (Ci)	3.500E+00	4.978E+00	-4.617E-03	2.897E+01	1866
TRU Activity Concentration (nCi/g)	1.154E+05	2.088E+05	-1.338E+02	4.955E+06	1866
Thermal Power (W)	1.099E-01	1.566E-01	-1.515E-04	9.119E-01	1867
Thermal Power Density (W/ft^3)	1.496E-02	2.130E-02	-2.061E-05	1.241E-01	1867
Plutonium Fissile Gram Equivalent (g)	3.950E+01	5.554E+01	-3.816E-02	3.266E+02	1866
Americium-241 (g)	1.707E-01	2.531E-01	-9.639E-04	5.158E+00	1332
Plutonium-238 (g)	4.785E-03	6.304E-03	-4.237E-06	3.626E-02	1704
Plutonium-239 (g)	4.276E+01	5.637E+01	-3.795E-02	3.248E+02	1704
Plutonium-240 (g)	2.594E+00	3.421E+00	-2.308E-03	1.975E+01	1704
Plutonium-241 (g)	7.864E-02	1.037E-01	-6.980E-05	5.974E-01	1704
Plutonium-242 (g)	1.881E-02	2.562E-02	-1.735E-05	1.485E-01	1777
Uranium-233 (g)	6.943E-01	1.669E+00	2.969E-03	4.813E+00	8
Uranium-234 (g)	2.318E-03	5.386E-03	-5.556E-06	3.379E-02	165
Uranium-235 (g)	2.320E+00	5.163E+00	-5.169E-03	3.122E+01	161
Uranium-238 (g)	8.728E+01	1.859E+02	3.976E-02	7.444E+02	25

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry

b. The standard deviation is the statistical variation of the population for which measurements were available.

c. The negative low values were from the "Deficient / Permanently Rejected" category. These assays were outside the systems capabilities. Since this report merely summarized the data stored in the Transuranic Reporting, Inventory, and Processing System (TRIPS) the values were left in for completeness.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

Table 10-16. Radionuclide and Related Quantities for Ful-Flo Filter, IDC 328[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	3.842E+00	N/A	3.842E+00	3.842E+00	1
TRU Activity (Ci)	3.853E+00	N/A	3.853E+00	3.853E+00	1
TRU Activity Concentration (nCi/g)	8.857E+04	N/A	8.857E+04	8.857E+04	1
Thermal Power (W)	1.210E-01	N/A	1.210E-01	1.210E-01	1
Thermal Power Density (W/ft^3)	1.646E-02	N/A	1.646E-02	1.646E-02	1
Plutonium Fissile Gram Equivalent (g)	4.341E+01	N/A	4.341E+01	4.341E+01	1
Americium-241 (g)	1.216E-01	N/A	1.216E-01	1.216E-01	1

Table 10-16. (continued).

Quantity	Average	Standard	Range		Events
Plutonium-238 (g)	6.844E-03	N/A	6.844E-03	6.844E-03	1
Plutonium-239 (g)	4.286E+01	N/A	4.286E+01	4.286E+01	1
Plutonium-240 (g)	2.678E+00	N/A	2.678E+00	2.678E+00	1
Plutonium-241 (g)	6.388E-02	N/A	6.388E-02	6.388E-02	1
Plutonium-242 (g)	1.141E-02	N/A	1.141E-02	1.141E-02	1
Uranium-233 (g)	ND	ND	ND	ND	0
Uranium-234 (g)	3.614E-04	N/A	3.614E-04	3.614E-04	1
Uranium-235 (g)	3.361E-01	N/A	3.361E-01	3.361E-01	1
Uranium-238 (g)	ND	ND	ND	ND	0

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. N/A – Not Applicable. The standard deviation is not applicable for a single measurement.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

10.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA (ethylenediaminetetraacetic acid) is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant, including wiping down filter frames. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, P079, U043]. Oxalic acid was also used for americium recovery [P113]. Filters and insulation may contain trace quantities of these complexing agents.

10.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For filter and insulation media wastes, IDCs 335, 376, and 490, the yield of successful RTR examinations was approximately 96% [P323]. Conversely, approximately 4% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: absence of prohibited items could not be verified; presence of excess free liquids; unverifiable IDC; layers of confinement exceeded for the assigned shipping category; presence of sealed inner containers greater than 4 liters; did not meet the criteria for protection against sharp objects; presence of pressurized containers; and presence of explosives [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

11. GLASS

This waste group consists of glass materials generated by the production, recovery, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations. The waste was generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012, P083]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 11-1 [U092]. This waste was characterized under a CBFO approved WSP, INW243.001, for containers of waste shipped to the WIPP facility [P215, P224].

Table 11-1. Glass Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
440	Glass [P012] Glass (except Raschig Rings) [P014]	November 1972–December 1986

Item Description Code 440, Glass (except Raschig Rings): This waste consists of glass generated by plutonium production, recovery, treatment, laboratory, and maintenance operations in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012, P083]. The waste consists of items such as bottles, vials, light bulbs, labware, glovebox windows, and process equipment. The materials may be glass, ceramic, leaded glass, or quartz [P001, P012, P015, P024, P052]. The waste may also contain limited amounts of metal, plastic, rubber, and combustibles [P015, P024].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the glass waste (IDC 440) are listed in Table 11-2 [P224]. Typical waste material parameters, including typical packaging materials for the waste as identified for the 3,100 m^3 Project, are presented in Table 11-3 [P224].

Table 11-2. Items Identified by RTR for Glass Waste (IDC 440) During the 3,100 m^3 Project [P224].

Item	Comment
Items containing Lead	Miscellaneous lead-containing items, such as lead tape, lead sheeting, leaded rubber aprons, leaded rubber gloves, leaded glass, lead slab, lead drum liner, and other lead-containing waste items not identified above.
Inorganic Liquid	Free liquid was detected in several drums and assigned to other inorganic materials by RTR. Containers with liquids exceeding the WAC were not shipped to WIPP. Compliance with the WAC free liquids criteria was confirmed using RTR and VE.
Miscellaneous Metal Items	Miscellaneous metal items identified during RTR included screwdrivers, Volrath cans, nuts and bolts, and other non-specific metal items not specifically identified.
Miscellaneous Cellulosics	Miscellaneous cellulosics identified included cardboard, filters, wood, and other cellulosics not specifically identified.
Clamshell container	RTR identified a clamshell container, a sealed container greater than 4 liters. Drum containing WAP-prohibited items were flagged *Treatment*.
Light Ballast	A light ballast was identified during RTR examination as Iron-Based Metals/Alloys. Any container identified with light ballasts was flagged in the TRIPS and not shipped to WIPP.

Table 11-2. (continued).

Item	Comment
Mercury	Mercury was identified during RTR examination. According to AK, mercury may be present in the glass waste stream due to the potential presence of fluorescent bulbs.
Pressurized Containers	Pressurized containers were identified during RTR. Pressurized containers are prohibited items. Containers with items prohibited by the WIPP WAP were not shipped to WIPP.
Fiberglass	Fiberglass was identified during VE. (Fiberglass material, itself, is not a material that is inherently hazardous).
Sealed container with >1 inch liquid	Liquids were identified during RTR examination. The liquid was greater than one inch, so the drums were considered to contain excess free liquid and did not meet WIPP WAC. The drums were dispositioned as *Treatment*.

Table 11-3. Typical Waste Material Parameters for Glass Waste (IDC 440) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Glass, vermiculite, Oil-Dri®
Plastics (Waste Materials)	Small poly bags, poly bottles

11.1 Waste Generation

Glass was generated by production, recovery, purification, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations at the site. Process flow diagrams for glass waste generating processes are provided in archived WSRIC information [P060, P061, P062, P070, P077, P078, P079, P081, P082].

11.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the construction of Building 707 in 1972. Building 707 was constructed after the 1969 fire in Building 776 which shut down foundry and machining operations in that building [P053].

The foundry in Building 707 cast molten plutonium into classified components, subassemblies, and assemblies. Other parts were manufactured by rolling, forming, and machining plutonium ingots also cast in the foundry. Components were assembled using a number of welding and joining techniques in Buildings 707, 777, and 779. Production support operations in Buildings 707 and 777 included a variety of inspection, calibration, measurement, weighing, leak testing, and cleaning activities to assure that the parts met stringent specifications. Rejected plutonium parts, scraps, and turnings were returned to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to Building 771 to be recovered [P052, P053]. Glass waste generated by production operations consisted primarily of items such as bottles and sample vials [P083].

Halogenated solvents were used in production operations to clean and degrease plutonium parts and metal. In addition, the solvents were used with cutting oils to cool plutonium parts during machining. Carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloroethylene, and methylene chloride were the primary solvents historically used during plutonium production. Tetrachloroethylene was replaced by 1,1,1-trichloroethane for degreasing during the 1973 time frame. Several nonhalogenated solvents were also used for cleaning and degreasing, primarily during efforts to reduce use of halogenated solvents [P023, P053]. These solvents included isopropyl alcohol, ethanol, and acetone [P052, P053, P067]. Building 777 housed the carbon tetrachloride and 1,1,1-trichloroethane systems that collected and filtered solvents generated during production operations. In addition to parts cleaning and degreasing, solvents were also used to clean plutonium operation glovebox lines [P053].

11.1.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Building 771 housed operations that recovered plutonium from waste materials and other sources [P053]. Plutonium purification was performed primarily in Buildings 371, 771, 776, and 779 [P083].

Recovery operations in Building 771 used acid to dissolve solid materials containing plutonium. The resulting solutions were processed by a series of ion exchange, precipitation, calcination, fluorination, and reduction operations to produce purified plutonium metal to be recycled back into production operations. Potassium hydroxide, potassium fluoride, hydrogen peroxide, and nitric, hydrochloric, and hydrofluoric acids were the primary reagents used for plutonium recovery operations [P053, P061, P067, P083, U047].

Plutonium metal from returned parts and metal from other DOE facilities was purified at Rocky Flats. Plutonium-241 decays to americium-241, which decreases the effectiveness of the plutonium parts. Plutonium parts were disassembled in Building 777 [P053, P113]. Beginning in 1967, the MSE process in Building 776 recovered americium from plutonium metal using sodium chloride, potassium chloride, and magnesium chloride [P053]. Americium was separated from the MSE residue salts using potassium hydroxide precipitation followed by an ammonium thiocyanate anion exchange process. In 1975, the process changed to cation exchange followed by anion exchange (no thiocyanate) and then precipitation using oxalic acid [P113, U047]. The process changed again the following year to the salt scrub process which used a magnesium/zinc or a magnesium/aluminum extractant [U047]. The purified plutonium metal from MSE was either sent to the foundry in Building 707 or sent to the electrorefining process in Building 371 or Building 776 if the metal contained other impurities [P053, U047].

Spray leaching (Building 771) and hydride leaching (Building 779) also used acids to remove plutonium surface contamination from uranium metal and other metals or beryllium contamination from plutonium metal. These processes used nitric, hydrochloric, sulfuric, and sulfamic acids [P053, P061, P062].

Glass waste generated by recovery operations included items such as bottles, condensers, ion exchange columns, vessels, and vessel liners [P083].

11.1.3 Laboratory

Buildings 371, 559, and 771 housed the main analytical laboratories at the site. The laboratories' primary function was to provide analytical support to production activities in addition to supporting

recovery, purification, and liquid waste treatment operations. Each of the laboratories used numerous acids, bases, solvents, and other chemical reagents.

Building 371 had an analytical laboratory and a chemical standards laboratory. The chemical standards laboratory prepared standards for various users and inspects standards that have been used in the field. The analytical laboratory analyzed samples from various operations on site. The types of analyses performed included [P081]:

- Total alpha activity
- Isotopic analysis
- X-Ray emission
- X-Ray diffraction
- Plutonium, uranium, and americium content
- Corrosivity
- Ignitability

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process. The types of analyses performed included [P067]:

- Emission spectroscopy
- Atomic absorption
- Infrared analysis
- Gallium analysis
- Plutonium assay
- Carbon analysis
- Uranium analysis
- Raschig ring analysis
- Tritium analyses
- Nonroutine chemical analysis
- Anion/cation solution analysis
- Isotopic analysis
- Thermal analysis
- Gas analysis
- Spark source mass spectroscopy
- X-ray analysis

Building 771 housed analytical and chemical standards laboratories. The chemical standards laboratory prepared control sample standards for the analytical laboratories in Buildings 371, 559, and 771 [P061]. The analytical laboratory provided analyses in support of plutonium operations. The types of analyses performed included [P061, P067]:

- X-Ray fluorescence
- Alpha/gamma scintillation
- Atomic absorption
- Laser fluorimetry
- Spectrophotometry
- Calorimetry
- Gamma spectroscopy
- Titrations

The laboratories used a variety of reagents and solvents including:

Acids/Bases

- boric [P067]
- hydrochloric [P061, P067, P081]
- hydrofluoric [P061, P067, P081]
- nitric [P061, P067, P081]
- perchloric [P067]
- phosphoric [P067]
- sodium hydroxide [P061, P067, P083]
- sulfamic [P067]
- sulfuric [P067, P083]
- tartaric [P067]

Reagents

- ammonium hydroxide [P083]
- ammonium molybdate [P067]
- ceric ammonium nitrate [P067]
- ceric sulfate [P083]
- ferrous sulfamate [P067]
- ferric chloride [P067]
- potassium bromide [P083]
- potassium chloride [P067]
- sodium fluoride [P067]
- total ionic strength adjusting buffer (contains diaminocyclohexane tetraacetic acid) [P061]
- trioctyl phosphene oxide [P061, P081]

Organic Solvents

- acetone [P083]
- benzene [P053]
- carbon disulfide [P083]
- carbon tetrachloride [P053, P067, P083]
- chloroform [P053, P067, P083]
- cyclohexane [P061]
- ethanol [P083]
- isooctane [P083]
- isopropanol [P083]
- methanol [P083]
- methylene chloride [P053, P083]
- petroleum ether [P083]
- toluene [P083]
- tributyl phosphate [P083]
- 1,1,1-trichloroethane [P083]
- trichloroethene [P083]
- 1,1,2-trichloro-1,2,2-triflouroethane [P067, P083]
- xylene [P083]

Laboratory operations generated a majority of the glass waste group. Laboratory operations generated items such as reagent bottles, vials, burettes, pipettes, ceramics, syringes, stirrers, watch glasses, funnels, beakers, flasks, sample cells, ampules, plasma torches, and other glass laboratory equipment and instruments [P083].

11.1.4 Research and Development

Research and Development included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed much of the R&D operations at the plant. Other areas at the plant supporting R&D included Buildings 559, 771, 776, 777, and 881 [P053].

The purpose of Building 779 was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials, which might be used in plutonium operations. Other activities in Building 779 included developing improvements to the manufacturing process and finding new ways to recover plutonium and associated actinides. Another function was to develop a better understanding of the aging and shelf life limitations of Rocky Flats products. Most of the materials used and wastes generated in this facility were the same as those in the production and recovery buildings, as much of the work conducted involved improvement of existing processes [P053]. However, processing of neptunium, curium, and cerium was also conducted [P053, U047].

The plant conducted special order work for other facilities in the DOE complex, the DOD, or other federal departments or agencies. One example is the introduction of radionuclide tracers into pits destined for off-site test shots. This work took place in the 1960s and well into the 1970s. Materials such as americium-240, plutonium-238, neptunium, curium, and cerium were blended in with the regular component materials for the purpose of studying performance of the different weapon components based on post-test distribution of the rare tracers. These tracer materials were kept separate from the regular production material streams, and special recovery operations in Building 771 specialized in recovering these more exotic materials [C072, P053].

From approximately 1959 to the mid-1970s, Rocky Flats was involved in "Project Plowshare." The mission of the program was to develop technology for using nuclear explosives for peaceful applications such as excavation and uncovering of deep mineral deposits. Materials used in the manufacturing of these components were the same as those used in the production buildings [P053].

Research and Development activities may have generated any of the glass items generated by similar production, recovery, and purification operations at the site.

11.1.5 Waste Treatment

Waste processing at Rocky Flats has included both liquid and solid process wastes. Liquid waste treatment operations have had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building 771. Radionuclides were removed by precipitation, and the resulting slurry filtered. The solids removed from filters were combined with cement or other solidifying agents. The aqueous waste from this first stage goes through a second precipitation [P053]. These processes use sodium hydroxide, ferric sulfate, magnesium sulfate, and calcium chloride [P109]. See Section 23.0, Solidified Aqueous Sludge Building 774, for a detailed description of these processes.

Around 1965, an evaporator was installed in Building 774 to treat liquids from the second stage treatment and from the solar ponds. The concentrate from the evaporator was introduced into a steam-heated double-drum drier, which produced a salt waste. The Building 774 evaporator was taken out in 1979, and the liquids from the second stage treatment and solar ponds have since been transferred to Building 374 for additional treatment [P053].

Building 774 also processed organic liquid wastes. Plutonium-contaminated organic liquids were generated from plutonium machining [P053]. The spent organic liquid was filtered and then mixed with a solidifying agent. The process was later changed to a one step process in which the organic liquid was mixed with Envirostone (gypsum cement) and allowed to set up [P109]. See Section 25.0, Solidified Organic Waste for a detailed description of these processes.

Treatment of solid transuranic wastes was conducted in Buildings 771 and 776. Building 771 processed wastes containing plutonium above the EDL while Building 776 processed wastes below the EDL.

Operations in Building 771 processed wastes including Raschig rings, HEPA filters, and sludges from the filter plenum and from process piping. Filters were disassembled to remove plutonium-contaminated dust. Process piping removed from service was cut up and cleaned of built-up sludge. Sludge from the process piping and from the filter plenum was dissolved in nitric acid to recover plutonium. Until 1984, plutonium was recovered from Raschig rings by nitric acid leaching [P061].

Size reduction in Building 776 removed materials from drums and sorted them in an airlock vault. Materials such as light metals, filters, glass, combustibles, and Raschig rings were then put into containers with like materials. Light metals and leaded gloves were washed in a ball mill [P067].

Advanced size reduction operations in Building 776 disassembled or cut plutonium-contaminated gloveboxes and miscellaneous large equipment into sizes that could be packaged in approved containers [P067, P110].

The fluidized-bed incinerator in Building 776 received low-level plutonium-contaminated combustible solid and liquid wastes [P052, P067]. Building 771 also housed an incinerator for processing combustible wastes [P067, U047]. See Section 14.0, Incinerator Waste, for a detailed description of the incineration processes.

Glass waste generated by waste treatment operations consisted primarily of items such as bottles and other broken containers [P083].

11.1.6 Routine Maintenance

Routine maintenance at Rocky Flats included utilities; change out of oils, coolants, filters, and Raschig rings; and other general maintenance activities.

Utility systems include HVAC systems, fume scrubbers, and process vacuum systems. The HVAC systems contain air supply units for filtering incoming air and plenums for filtering exhaust air. KW detergent was used for periodic maintenance inside and outside the plenums. Scrubbers housed in Buildings 371, 559, 771, and 779 used potassium or sodium hydroxide to neutralize acid fumes from various process off-gas streams and glovebox exhaust streams. Process vacuum systems provide an absolute pressure at a vacuum header which serves as a means to transfer fluids on demand by valving arrangements [P061, P067].

Oils, coolants, filters, and Raschig rings were used in numerous processes and required periodic change out. Other general maintenance activities included repair or replacement of gloveboxes, tanks, valves, pumps, and pipes [P108, P061, P067, P109].

Glass waste generated by maintenance activities included leaded glass glovebox windows, scrubber vessels, inspection ports from fume scrubber towers, and fluorescent and incandescent light bulbs.

11.1.7 Non-Routine Operations

Non-routine operations include spill clean up, strip-out operations, and activities associated with fires and other incidents.

Occasionally, spills of various materials occur due to leaks in tanks and piping or from material releases from gloveboxes. Tanks or pipes may have contained acids, bases, or solvents used during normal process operations. A paint stripper containing methylene chloride was often used for decontamination [P053, P067].

Another non-routine activity was the strip-out of glovebox lines, process piping, valves, and associated systems. Strip-out activities were performed when a glovebox line was scheduled to be replaced or during renovation. Solvents such as trichloroethylene or 1,1,1-trichloroethane may have been used during this type of operation for decontamination [P067, P108].

Other non-routine activities, such as fires and other incidents, included:

- The 1969 fire which spread through combustible materials in several hundred inter-connected gloveboxes in Building 776/777 [P053];

- The 1974 control valve release in Building 707 which allowed radioactive particulates to escape from an exhaust stack on the roof and into Module K [P053]; and

- The tritium release in which tritium-contaminated plutonium was processed from April 9, 1973 through April 25, 1973 in Building 779 causing a tritium release to the atmosphere, as well as elevated tritium levels in surface waters, process wastes, equipment, gloveboxes, and exhaust plenums [P053].

11.2 Waste Packaging

Glass was either loaded directly into a lined 55-gallon drum or double-bagged out of the glovebox line. To increase loading, many glass items were broken prior to packaging. Light bulbs may have been crushed prior to disposal. The waste may also have been collected in metal cans, polyethylene bottles, or Fibre-Paks prior to placement in a lined 55-gallon drum [P012, P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or one or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners for puncture protection [P008, P012, P016, P063, P064]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) were placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024]. During RTR examinations of containers of glass waste, quantities of absorbent were identified that varied significantly from expected quantities, and some drums contained no absorbent. In addition, Oil-Dri® and vermiculite may have been used in some drums outside the expected time periods [P224].

During the 3,100 m^3 Project, it was determined during RTR examinations that there were varying combinations of inner bags and liners in glass waste containers. Several combinations of drum bags, poly bags, and O-ring bags may have been used to package the waste. Some drums may not contain a rigid liner. Any combination of plastic packaging, provided that 6 layers of containment were not exceeded, did not impact acceptability of the drum. Drums that exceeded the TRUPACT allowed containment layers were flagged for treatment in TRIPS.

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. VE of containers of glass waste identified plastic bottles, lead tape, rubber gaskets, and Raschig rings [P009, P015, P024]. Acceptable knowledge confirmation activities have also identified numerous items in a small percentage of the glass waste containers, including small quantities of liquid, pressurized containers, lead items (e.g., rubber gloves and aprons, tape, and sheeting), metal items (e.g., light ballasts, hand tools, and cans), and cellulosic items (e.g., cardboard, filters, and wood) [P224].

11.3 Waste Characterization

Glass was characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. This section provides a hazardous waste determination based on RCRA and the WIPP WAP requirements for glass as well as radionuclide contaminants and potential complexing agents contained in the waste in compliance with the WIPP WAC. This waste contains at least 50% by volume materials that meet the CH-WAP criteria for classification as debris, and is therefore a heterogeneous waste [P141].

Fluorescent light ballasts have been identified in containers of glass waste by RTR and VE. The ballasts are assumed to contain greater than 50 ppm PCBs. All containers were screened for light ballasts. Any container identified with light ballasts was not shipped to WIPP [C198, P224].

11.3.1 Hazardous Waste Determination

Some of the glass waste is not regulated as hazardous wastes as defined in 40 CFR 261.7 (empty container). Glass waste may exhibit the characteristic of toxicity for barium, lead, mercury, and chloroform. The waste was mixed with halogenated and nonhalogenated solvents, and is therefore an F-listed hazardous waste. There is no evidence that glass exhibits any other characteristic of a hazardous waste [C091, C094]. EPA HWNs applicable to some or all of the glass waste group are presented by IDC in Table 11-4.

Table 11-4. Historical Glass Waste Characterization.

IDC	Title	EPA HWNs
440	Glass (except Raschig Rings)	D005, D008, D009, D022, F001, F002, and F005

11.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C, as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22) or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and absorbents were added to wastes having the potential of generating free liquids (i.e., glass vials containing liquid) [P012, P015, P024]. Small vials containing residual liquids were identified in a few drums of glass waste in 1991 [U005]. Headspace gas analysis

also indicated the presence of cyclohexane (an ignitable liquid) at a UCL_{90} greater than the PRQL [P215, U005]. Acetone, methanol, ethanol, isopropanol, isooctane, petroleum ether, and xylene were identified in acceptable knowledge as having been used as organic solvents in some laboratory operations [P038]. However, this glass material waste stream is a solid debris waste stream and does not exhibit the characteristic of ignitability as defined in 40 CFR 261.21. The materials are not compressed gases, nor does the waste contain compressed gases [P012, P014, P015, P022, P024]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P024]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not a liquid, and absorbents were added to wastes having the potential of generating free liquids (i.e., glass vials containing liquid) [P012, P015, P024]. Free liquids were identified in a few drums of glass waste; however, headspace gas analysis of those drums indicates that the liquids contain cyclohexane and 1,1,1-trichloroethane, which are not corrosive liquids [U005]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P013, P015, P021, 022, P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for barium, lead, mercury, and chloroform.

VE of the glass waste revealed leaded glovebox windows and other lead items, as well as fluorescent bulbs [P015]. Barium and lead are components of leaded glass, and fluorescent bulbs contain mercury. Prior to 1989, leaded glass and fluorescent bulbs were not sorted from other glass waste. Glass waste may exhibit the characteristic of toxicity for these metals. Therefore, the materials in this waste group are assigned EPA HWNs D005, D008, and D009 since a representative sample of this waste cannot be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating glass. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene were used for cleaning and degreasing. Benzene and chloroform were used in laboratory operations (Section 11.1.3). Glass may have contacted these compounds during process operations. This waste group is already characterized as F001, F002, and F005 (Section 11.3.1.2), and therefore the toxicity codes for carbon tetrachloride, tetrachloroethylene, trichloroethylene, and benzene do not apply. Chloroform was used in laboratory operations and identified by AK. Recent headspace gas sampling by INEEL identified the presence of chloroform in 19 of 21 samples, although the calculated UCL_{90} is below the PRQL [P215]. The EPA HWN D022 (chloroform) was conservatively applied to this waste stream.

11.3.1.2 Listed Hazardous Waste. The material in this waste is a listed hazardous waste as defined in 40 CFR 261, Subpart D, hazardous waste from non-specific sources (40 CFR 261.31). The material is not, or was not mixed with, hazardous wastes from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were identified in the AK record as used in production, laboratory, and maintenance operations that generated this waste. Benzene, carbon disulfide, and toluene were used in laboratory operations. During process operations, glass may have been contaminated with these compounds. Headspace gas analysis performed on samples of glass obtained at INEEL for the 3,100 m^3 Project confirmed the presence of organic solvents (Table 11-5). The detected compounds in which the UCL_{90} is above (or near) the PRQL are 1,1,1-trichloroethane, trichloroethylene, and toluene [P033, P215]. This waste was assigned EPA HWNs, F001, F002, and F005.

Acetone, methanol and xylene (non-chlorinated solvents) also were used in the laboratory, and glass may have been contaminated with these compounds. Although the presence of these compounds is indicated by confirmatory headspace gas data (Table 11-5) for all HSG samples collected during the 3,100 m^3 Project, the UCL_{90}s are all below the corresponding PRQLs [P215]. The F003 code was not assigned for these solvents because these constituents, which are listed solely due to the characteristic of ignitability, were commingled with solid waste at the point of generation. Therefore this waste does not exhibit the characteristic of ignitability.

Raschig rings were identified in one drum of glass waste. Raschig rings removed from tanks that contained organic solvents are characterized as F-listed waste. The drum of glass waste in question was generated in Building 371 where Raschig ring tanks did not contain solvents, and headspace gas analysis of this drum did not identify the presence of any organic compounds. It has been RFP waste management practice to sort Raschig rings from other glass waste since before 1970 [C089, C090, P015]. Therefore, this waste group was not assigned F-listed HWNs based on the presence of Raschig rings.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating glass. Therefore, this waste group is not an F004-listed hazardous waste. The material in this waste group is not a hazardous waste from specific sources since it was not generated from any of the processes listed in 40 CFR 261.32. The material in this waste group is therefore not K-listed hazardous waste. The materials in this waste are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste are therefore not P- or U-listed hazardous waste.

Table 11-5. Statistical Evaluation of all HSG Results From the Glass Waste Stream (INW243.001, IDC 440) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	227	198	66.1	121	790	77.1	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	227	0	0.335	0.516	3.20	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	227	23	1.43	15.4	230	5.67	10	F002[d]
1,1-Dichloroethane	226	26	0.532	2.06	29.0	1.06	10	N/A
1,1-Dichloroethylene	226	35	0.983	4.52	65.0	1.98	10	N/A
1,2,4-Trimethylbenzene	227	19	0.384	0.532	3.00	0.547	10	N/A
1,2-Dichloroethane	227	70	0.687	1.52	11.0	0.921	10	N/A
1,3,5-Trimethylbenzene	227	17	0.343	0.496	3.35	0.504	10	N/A
Acetone	227	206	12.7	15.9	180	14.1	100	N/A
Benzene	227	116	0.647	1.39	19.0	0.814	10	F005[d]
Bromoform	227	0	0.215	0.291	1.75	b	10	N/A
Butanol	227	81	1.27	1.59	11.0	1.50	100	N/A
Carbon tetrachloride	227	82	2.94	17.9	183	5.50	10	F001[d]
Chlorobenzene	227	2	0.327	0.504	3.15	1.43	10	N/A
Chloroform	227	107	6.38	44.2	610	11.9	10	D022[c]
Cis-1,2-dichloroethylene	227	1	0.387	0.652	4.40	b	10	N/A
Cyclohexane	227	163	143	327	2,600	176	10	N/A
Ethyl benzene	227	48	0.582	1.27	13.0	0.819	10	N/A
Ethyl ether	224	0	0.520	0.715	4.10	b	10	N/A
Methanol	228	18	7.15	12.3	150	11.0	100	N/A
Methyl chloride	34	20	5.51	6.47	27.0	7.43	10	N/A[e]
Methyl ethyl ketone	227	126	2.57	3.77	39.0	3.00	100	N/A
Methyl isobutyl ketone	227	40	0.415	0.620	4.25	0.543	100	N/A
Methylene chloride	225	101	3.66	16.8	170	5.81	10	F002[d]
Tetrachloroethylene	227	10	0.407	1.73	24.0	1.16	10	F001/F002[d]
Toluene	227	220	11.5	13.8	120	12.7	10	F005[c]
Trans-1,2-dichloroethylene	55	0	0.675	0.983	4.30	b	10	N/A
Trichloroethylene	226	130	10.6	33.8	430	14.4	10	F001/F002[c]
m&p-Xylene	224	59	1.11	3.56	41.0	1.72	10	N/A
o-Xylene	227	40	0.548	0.949	9.20	0.744	10	N/A

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. Methyl chloride, a tentatively identified compound detected in greater than 25% of HSG sample, was added as a target analyte. This compound does not carry an EPA HWN.

11.3.2 Radionuclides

The radioisotopes potentially contained in the waste, as well as the chemical form of radionuclide contaminants and radioassay interferences are identified in this section. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0. Wastes from some of the processes described below may not be contained in the inventory based on the assigned prefixes. However, as explained in Section 11.3.2.6, it is assumed that repackaged drums could contain waste generated from any process.

11.3.2.1 Plutonium Production. Radionuclide contamination in waste from Building 707 will primarily consist of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers [C171, C174, C184, C185, P053, P164, P167].

Building 777 performed disassembly of site-return parts and fabrication operations including machining, briquetting, assembly, and production support processes (container prefixes 0004, 0023, and 0024) [C184, P052, U059, P079]. Wastes from fabrication operations will be contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations will be contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053].

Buildings 707 and 777 handled actinides in metal or oxide form only [P060, P079]. The actinide metals will likely have partially or completely oxidized because of the reaction with dry air, and some could possibly have formed a hydroxide layer from reaction with moist air. Radioassay interferences may include beryllium from Part V metal fabrication in Building 707, and calcium fluoride which was sprayed onto graphite molds in Building 707 prior to casting [C184, P060]. Other interfering waste contaminants include aluminum, beryllium, and stainless steel (chromium) which were machined in Building 777 [P079].

11.3.2.2 Plutonium Recovery and Purification. Waste from recovery operations in Building 371 will contain weapons-grade plutonium primarily from electrorefining [C184, P067]. A limited amount of the waste could also have been generated from aqueous recovery operations which only ran for a short time in 1982. Aqueous recovery operations were designed for recovering and purifying weapons-grade plutonium [C184, P164].

The feed materials to the recovery and purification processes (container prefixes 0001 and 0002) in Building 771 were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated will be contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Radionuclides from aqueous recovery operations will vary widely in chemical form depending on the specific process the waste originated, and because the majority of the aqueous processes were performed within one large MBA (container prefixes 0001 and 0002), the specific process can not be determined. The different actinide forms are plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Wastes from the americium recovery glovebox lines (container prefix 0006) in Building 771, used for extraction of americium from site-return plutonium, will contain a significant amount of americium-241 [C184, P053, P164, U059]. The americium was in a chloride, hydroxide, nitrate, oxalate,

and oxide chemical form during different steps of the process. Prior to 1975, ammonium thiocyanate was also used [P053].

The Oralloy leach process (container prefix 0074) in Building 771 chemically separated plutonium surface contamination from enriched uranium hemishells using nitric acid. The chemical form of the radionuclides will therefore be plutonium nitrate and uranyl nitrate [C184, P061, P163, U059].

Site-return metal and other non-specification plutonium were processed by pyrochemical operations in Building 776 (container prefix 0003) to produce plutonium for use in the foundry [C184, P053, U059]. The molten salt extraction process removed americium-241 from site-return and other non-specification plutonium. Electrorefining was used to purify plutonium metal that did not meet foundry specifications. Since metal was the feed and product to the MSE and electrorefining processes, wastes generated from these processes will be contaminated with actinide metals which now will probably have formed an oxide or hydroxide layer from reaction with dry and moist air. Direct oxide reduction was developed to convert plutonium dioxide to plutonium metal [P163, P175]. MSE residue salts, which contain actinide chlorides, were the feed to the salt scrub process. Metal was the product of this process as well, so the radionuclide contaminants could be in a metal, oxide, and/or hydroxide form. Radioassay interferences may include chloride salts (i.e., sodium, potassium, magnesium, calcium, and zinc) [P163].

Hydride operations in Building 779 (container prefix 0055) recovered plutonium from various substrates by reacting plutonium metal with gaseous hydrogen in an argon-inerted glovebox [P052, U059, P062, P163]. Hydriding produced plutonium metal for use in the foundry or non-specification feed to pyrochemical operations, in addition to plutonium oxides sent for aqueous recovery [C184, P062]. The hydriding process formed plutonium hydride which was converted to plutonium dioxide by oxidizing the material in an air atmosphere [P163].

11.3.2.3 Laboratory. The analytical laboratory in Building 371 (container prefix 0071) provided analytical support for process control and performed analyses on feed materials and residues from recovery operations in Building 371 [P053, U059, P081]. The laboratory also analyzed samples from various operations at the site, but primarily from Building 374 [P081]. The Building 371 chemical standards laboratory prepared standards for various users and inspected standards that were used throughout the plant site [P053]. Wastes from these laboratories will be contaminated with weapons-grade plutonium and enriched and depleted uranium.

The Building 559 analytical laboratory (container prefix 0029) performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, U059, U073]. The primary mission of this laboratory was analysis of site-return and feed materials, in addition to recovery, purification, and foundry products [P053].

The Building 771 analytical laboratory (container prefix 0037) received samples from recovery operations in the building as well as from the foundry [P067, U059]. The samples included plutonium metal turnings, plutonium oxide, acidic plutonium solutions, and various process residues [P061]. In addition, the analytical laboratory analyzed samples from R&D laboratories in Buildings 771 and 779 (Section 11.3.2.4) [P067, P061]. The chemical standards laboratory (container prefix 0038) prepared uranium, plutonium, and americium nitrates used as control standards for the Buildings 371, 559, and 771 analytical laboratories [P067, P061]. The laboratory also produced nondestructive assay standards used at drum counters and fluoride standards for chemical operations [P061].

The metallography laboratory (container prefix 0021) in Building 777 prepared and examined metallographic specimens in support of R&D operations (plutonium metallography, nuclear and

non-nuclear joining, quality engineering, and product physical chemistry) and, therefore, may contain any of the radionuclides used during R&D activities (see Section 11.3.2.4) [C184, U059, P079]. The Building 777 tritium surveillance laboratory analyzed solid, liquid, and gas samples from throughout the plant site for tritium content [U078].

Because the laboratories supported all phases of weapons production, the chemical form of the radionuclide contaminants and radioassay interferences will vary widely depending on the type of sample analyzed.

11.3.2.4 Research and Development. Projects using transuranic radionuclides were conducted in Buildings 771, 776, 777, 779, and 881. Most of the documentation pertaining to R&D activities does not specify locations in which the work was performed, and unless otherwise noted, it will be assumed that any of the radioisotopes could have been handled in the R&D areas of any of these buildings. In addition to weapons-grade plutonium, americium-241, and enriched and depleted uranium, the following radioisotopes were processed during R&D activities [C134, C137, C185, P053, P164, P167, P189, P190, P194, P195, P198, P200, U064]:

- americium-240
- curium-244
- neptunium-237
- plutonium-238, -240, -241, and -242
- low NGS plutonium (≈3% Pu-240)
- power grade plutonium (up to 20% Pu-240 and 1% Pu-241)
- thorium-228
- uranium-233, -235, -236, and -238.

A summary of the projects and time periods that these and other radionuclides were used is presented in Section 3.0.

In Building 771, special recovery anion exchange (container prefix 0045) separated plutonium from other materials that were not suitable for the regular recovery processes [C154, P052, P061]. Chemical technology (container prefix 0042) conducted aqueous R&D activities while plutonium metallurgy operations (container prefix 0078) performed alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C184, U059, P061]. These processes may have used numerous radioisotopes.

A pilot-scale fluidized-bed incinerator (container prefix 0075) was developed in Building 776 to treat low-level waste [C184, U059]. The waste fed to the incinerator was contaminated with low levels of plutonium [P024].

The coatings laboratory (container prefix 0016) in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium [P052, U059, P079]. This research and development facility supported production processes [P052, P079]. The special weapons area (container prefix 0066) in Building 777 was a research and development

facility where war reserve and other specially fabricated parts were assembled [U059, P079]. The process was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

Pyrochemical technology (container prefixes 0010 and 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations [P067, U059, P062]. These processes included direct oxide reduction, molten salt extraction, electrorefining, salt scrub for MSE, salt scrub for electrorefining, pyrochemical salt recycle, anode alloy, and pyroredox [C182, P062]. Most of the materials used in Building 779 were the same as those in the weapons-production areas and, therefore, will be contaminated primarily with weapons-grade plutonium and enriched uranium [P053]. However, other R&D activities in the building may have used a variety of other radionuclides [C171, C184].

11.3.2.5 Liquid Waste Treatment. Aqueous waste treatment operations in Buildings 374 and 774 received wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. Other radionuclides may also be found in the waste streams from R&D, analytical, and special order work [P164]. Radionuclide contaminants are removed from the aqueous wastes by precipitation using sodium hydroxide and, therefore, will be primarily in the form of hydroxides [P163]. Radioassay interferences may include magnesium sulfate and calcium chloride reagents used in the process [P106, P163].

Building 774 also processed organic liquid wastes. Organic wastes are composed of a variety of oils and solvents. Most of the oils were from spent lathe coolant used in the plutonium machining area and lubricating oils used in machines throughout the plant [P164]. The majority of the transuranic organic liquids were oils and solvents from plutonium machining and degreasing operations in Buildings 707 and 777 and, therefore, will be contaminated with actinide metals and oxides [P052]. A more detailed discussion of organic liquid wastes treated in these buildings is provided in Section 25.0.

11.3.2.6 Size Reduction/Repackaging/Solid Waste Treatment. Repack operations (container prefix 0076) in Building 371 involved the repackaging of residues for off-site shipment to other DOE facilities and the repackaging of wastes and residues for on-site storage [P081, U059]. Residues and wastes repacked for off-site shipment included plutonium oxides, incinerator ash, molten salt, electrorefining salt, cell scrape out, and anode heels. Wastes and residues were received from either the stacker/retriever (container prefix 0043) in Building 371 or from one of several 10- and 55-gallon drum storage areas within Building 371 [P081, U059].

Solid waste treatment, repackaging, and size reduction operations were conducted in the SRV in Building 776. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, U077]. Size reduction included cutting up gloveboxes or ducting, and crushing HEPA filters. Solid waste treatment activities included washing leaded gloves and scrap metal with hot water in a ball-mill washer to recover plutonium [C053, P067, P164].

11.3.2.7 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL based most alpha-emitting isotope activities on NDA

measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241, plutonium-238, plutonium-239, plutonium-240, plutonium-241, uranium-233, uranium-235, and uranium-238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of uranium-242 used its mass fraction in weapons grade Pu, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, uranium-235, and uranium-238 were based on the individual gamma spectrometric measurements. The uranium-238 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P224].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 11-6. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 11-6. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
440	any	0089	Note a	11/17/72	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
440	any	0036	Any building in this table	2/9/73 - 4/10/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
440	371	0039	Building 371 Operations	7/18/84 - 11/9/84	WG Pu, EU, ^{241}Am, DU
440	371	0071	Analytical/Standards Laboratory	1/18/83 - 2/6/85	WG Pu, EU, ^{241}Am, DU
440	371	0073	Aqueous Recovery	9/14/82 - 4/3/84	WG Pu, ^{241}Am
440	371	0076	Note a	1/16/73 - 3/26/81	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
440	371	0076	Repackaging Residues	1/22/82 - 6/3/83	WG Pu, EU, ^{241}Am, DU
440	371	0092	Aqueous Recovery	9/14/82 - 11/14/84	WG Pu, ^{241}Am
440	559	0029	Analytical Laboratory	12/12/80 - 2/6/85	WG Pu, EU, ^{241}Am, DU, ^{233}U[d]
440	707	0012	Foundry and Casting Operations	6/10/83 - 11/14/84	WG Pu
440	707	0028	Note a	6/10/80 - 12/22/82	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
440	771	0002	Aqueous Recovery	4/24/81 - 11/3/84	WG Pu, EU[d]
440	771	0006	Aqueous Recovery (Americium)	9/15/80 - 9/8/82	WG Pu, ^{241}Am
440	771	0037	Analytical Laboratory	4/10/73 - 12/21/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	771	0037	Analytical Laboratory	1/10/83 - 6/4/84	WG Pu, EU, ^{241}Am, DU

Table 11-6. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
440	771	0042	Chemical Technology	3/16/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	771	0042	Chemical Technology	8/15/83 - 6/7/84	WG Pu, EU, ^{241}Am, DU
440	771	0074	Oralloy Leach	8/22/83	EU, WG Pu
440	771/881	0045	Note c	9/8/82 - 9/8/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	776	0003	Pyrochemical Operations	8/19/85 - 12/15/86	WG Pu, ^{241}Am
440	776	0019	Size Reduction	7/24/81 - 3/14/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	776	0025	Drum Repack	11/11/80 - 3/14/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	776	0041	Waste Processing/Final Packaging	1/10/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	776	0075	Waste Processing Development	6/23/81	WG Pu
440	777	0023	Metal Fabrication-Machining	1/12/81 - 11/5/83	WG Pu, EU
440	779	0054	Research and Development	10/22/80 - 8/3/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
440	779	0054	Research and Development	5/23/83 - 11/3/84	WG Pu, EU, ^{241}Am, DU
440	865	0056	Material Tech.-General Metallurgy	4/3/84	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]

a. Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompasses all RF buildings and processes that generated glass transuranic wastes. The characterization brackets the glass wastes generated in these time periods and identified by these IDCs and container prefixes.

b. Because the historical information for these prefixes did not definitively identify radionuclides for these container prefixes, all TRU radionuclides (WG Pu, EU, ^{241}Am, DU, and ^{233}U) were listed for these prefixes as a conservative measure.

c. Prefix 0045 appears to have been assigned to MBAs in both Buildings 771 and 881 at different times. Prefix 0045 was used for Special Recovery Anion Exchange in Building 771 and Construction Management in Building 881.

d. Isotopes added by confirmatory radioassay.

WG = weapons grade EU = enriched uranium DU = depleted uranium

11.3.2.8 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN system coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for glass wastes are summarized in Tables 11-7 and 11-8. The overall yield for glass waste stream data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 11-7 and Table 11-8, respectively. The data for the individual radioassay systems information are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project [P322]."

Table 11-7. Overall Radioassay Yield for Glass Waste Stream [P322].

Total number of:	Number	Percentage of Total
Distinct containers	426	
"*WIPPOK*" containers	374	88%
"Treatment" containers	3	1%
"Deficient / Permanently Rejected" containers	49	12%

Table 11-8. Radionuclide and Related Quantities for Glass Waste[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	6.459E-01	1.358E+00	7.899E-05	1.407E+01	399
TRU Activity (Ci)	6.449E-01	1.357E+00	7.554E-05	1.409E+01	399
TRU Activity Concentration (nCi/g)	1.533E+04	3.127E+04	6.056E-01	2.931E+05	399
Thermal Power (W)	2.036E-02	4.310E-02	6.593E-07	4.487E-01	400
Thermal Power Density (W/ft^3)	2.771E-03	5.864E-03	8.977E-08	6.104E-02	400
Plutonium Fissile Gram Equivalent (g)	7.021E+00	1.385E+01	9.770E-04	1.263E+02	400
Americium-241 (g)	3.701E-02	1.378E-01	2.510E-04	1.657E+00	380
Plutonium-238 (g)	8.507E-04	1.661E-03	1.085E-07	1.406E-02	399
Plutonium-239 (g)	6.602E+00	1.316E+01	9.716E-04	1.256E+02	399
Plutonium-240 (g)	4.062E-01	8.078E-01	5.909E-05	7.609E+00	399
Plutonium-241 (g)	1.105E-02	2.255E-02	1.787E-06	2.310E-01	399
Plutonium-242 (g)	2.450E-03	5.277E-03	4.442E-07	5.776E-02	399
Uranium-233 (g)	7.833E+00	1.345E+01	5.993E-02	2.337E+01	3
Uranium-234 (g)	6.903E-04	2.874E-03	3.265E-06	3.462E-02	215
Uranium-235 (g)	6.385E-01	2.679E+00	5.483E-03	3.221E+01	214
Uranium-238 (g)	5.725E+01	8.992E+01	6.354E-01	2.614E+02	8

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

11.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a group of chelating compound. Chelating compounds are often found as constituents in commercial cleaning compounds. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, U043]. Oxalic acid was also used for americium recovery [P113]. Glass may contain trace quantities of these complexing agents.

11.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For glass wastes, the yield of successful RTR examinations was

approximately 92% [P323]. Conversely, approximately 8% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: unverifiable IDC; absence of prohibited items could not be verified; presence of excess free liquids; did not meet the criteria for protection against sharp objects; presence of sealed inner containers greater than 4 liters; PCBs present; and presence of pressurized containers [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

12. GRAPHITE

This waste group consists of graphite generated by production, recovery, laboratory, size reduction, and research and development activities associated with plutonium operations. Graphite wastes include broken molds, furnace liners and spacers, graphite pieces ranging from chunks to pieces, and some laboratory equipment [P052, U032]. The waste was generated in Buildings 371, 559, 707, 771, 776, and 779 [P012]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 12-1 [U092].

Graphite wastes were characterized under two CBFO approved WSPs; INW276.003 for nonhazardous TRU graphite waste (IDC 300) and INW276.004 for hazardous TRU graphite wastes (IDCs 300, 301, 303 and 312) [P205, P211, P212, P221]. In addition, two other WSPFs (INW276.001 and INW276.002) were submitted to CBFO for the nonhazardous waste [C005, P205, P289]. Graphite scarfings (IDC 310) waste was not included in the WSP because it was identified as a homogeneous solid (waste matrix code S3110) and not a debris waste as were the other IDCs in this waste group. The majority of the IDC 310 waste was in the form of fines.

Table 12-1. Graphite Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
300	Graphite Molds [P012] (Bldg. 707 casting operations only)	January 1973 – June 1988 (Bldg. 707 casting operations only)
300	Graphite Molds [P012]	December 1972 – August 1986
301	Classified Graphite Shapes [P032] Graphite Cores [P014]	September 1982 – February 1985
303	Scarfed Graphite Chunks [P012]	March 1985-April 1988
310	Graphite Scarfings [P024] Graphite, Pulverized or Fines [P014] Graphite Scarfings and Fines [P032]	December 1983 – October 1985
312	Coarse Graphite [P012]	January 1984 – June 1984

***Item Description Code 300, Graphite Molds*:** This waste consists of graphite generated in Buildings 371, 559, 707, 771, and 776. Graphite items include molds from plutonium casting operations, spacers and liners used in high-temperature furnaces and ovens, electrodes, and pieces and chunks generated during mold cleaning [P012, P067]. Although the waste is primarily molds from plutonium casting operations in Building 707, limited amounts of graphite molds were periodically generated by various research and development projects [P016, P024, P052]. IDC 300 may also include graphite electrodes from Building 559 laboratory operations [P067]. Graphite contaminated with plutonium above the EDL was sent for recovery in Buildings 371 or 771. Some surgical gloves may also be included in the waste [P024].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the graphite molds waste (IDC 300) are listed in Table 12-2 [P221]. Typical waste material parameters, including typical packaging materials for the waste as identified for the 3,100 m^3 Project are presented in Table 12-3 [P221].

Table 12-2. Items Identified by RTR for Graphite Molds Waste (IDC 300) During the 3,100 m^3 Project [P221].

Item[a]	Comment
Thermocouple	PSD86-061 [P021].
Blotter paper	The drums with blotter paper were later re-examined and it was determined that the items originally described as blotter paper were part of the cardboard liner.
Bungee cords	Items described as "bungee cords" at ANL-W are the elastic bands that held the bag-out end to the glovebox portal.
Lead-containing items	This was identified through RTR. The presence of the lead was not confirmed through VE.
Outlet Cover	A drum contained what might have been an outlet cover.
Surgeons Gloves	Surgeon's gloves were identified in 4 drums during VE at ANL-W.
Miscellaneous plastic items	Typical plastic items included spacers, poly inserts, tygon or other plastic hosing or tubing, and chair wheels.
Miscellaneous metal items	Metal items were negligible or very minor in weight and volume contributions. These items included hooks, clips, razor blade, knife, bolts, small metal cap, and metal locking band.
Plastic packaging as waste (including O-ring bags, drum bags, glovebox liner, etc.)	RTR identified drums that contain O-ring bags as a waste item. Based on several VE, it is likely that the O-ring bags are just the bag-out ends, not the entire bag. RTR conservatively assumed that the entire bag is present when the horsetail as a waste item was identified.
Miscellaneous cellulosics	RTR identified a pair of coveralls, paint brush, a cardboard roll end, an empty spool of tape, and a wooden handled brush with "hair" bristles.
Glass	RTR identified glass assigned to the other inorganic materials waste material parameter. The item comprises less than 20% of the waste, so there is no impact to the IDC.
Inorganic Liquid	One pint of free liquid was detected and assigned to other inorganic materials by RTR. The quantity of free liquid did not exceed 1 vol.% of the drum. No volatiles were detected above the PRQL. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to the WIPP.

Table 12-3. Typical Waste Material Parameters for Graphite Molds Waste (IDC 300) During the 3,100 m^3 Project [P221].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags, inner container bags, possible poly bottles
Other Inorganic Materials	Graphite molds, vermiculite, Oil-Dri®
Cellulosics	Cardboard liner, Fibre-Pak
Iron Metals/Alloys	1-gallon "paint cans" used as inner containers
Rubber	Elastic bands from bag-out ends

Item Description Code 301, Graphite Cores: This waste consists of graphite cores generated in Buildings 371, 559, and 707 [P024, U092, U059]. Graphite cores were part of a classified shaped mold generated primarily by plutonium casting operations in Building 707 [P024, P052, P060]. During the casting of plutonium, classified shapes were sorted from unclassified shapes. Graphite cores contaminated with plutonium above the EDL were sent for plutonium recovery [P024]. Prior to 1984, graphite cores were destroyed in Building 776 to render the material unclassified [P052]. The pieces of graphite that remained after declassification were assigned IDC 310 or 312. The graphite from Building 559 may be graphite electrodes which have been misidentified as IDC 301 [C074]. Classified waste should not have been shipped to the INEEL, and can be verified by RTR [C074, C077]. There were no miscellaneous items identified during RTR examination performed for the 3,100 m^3 Project.

Typical waste material parameters, including typical packaging materials for the waste as identified for the 3,100 m^3 Project, are presented in Table 12-4 [P221].

Table 12-4. Typical Waste Material Parameters for Graphite Cores Waste (IDC 301) During the 3,100 m^3 Project [P221].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags, inner container bags, possible poly bottles
Other Inorganic Materials	Graphite molds, vermiculite, Oil-Dri®
Cellulosics	Cardboard liner, Fibre-Pak
Iron Metals/Alloys	1-gallon "paint cans" used as inner containers

***Item Description Code 303, Scarfed Graphite Chunks*:** This waste consists of pieces of broken graphite mold generated from the mechanical cleaning (scarfing) of graphite molds and cores. Scarfing of the mold surface removed most of the mold coating (calcium fluoride) and plutonium contamination [P052].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the scarfed graphite chunks waste (IDC 303) are listed in Table 12-5 [P221]. Typical waste material parameters, including typical packaging materials for the waste as identified for the 3,100 m^3 Project are presented in Table 12-6 [P221].

***Item Description Code 310, Graphite Scarfing and Fines*:** This waste consists of graphite scarfings and fines generated from the mechanical cleaning (scarfing) of graphite molds. The small pieces and fines are coated with calcium fluoride and plutonium [P052]. The fines were removed from larger chunks by screening [P060].

***Item Description Code 312, Coarse Graphite*:** This waste consists of odd sized and shaped chunks of graphite generated from the mechanical cleaning (scarfing) of graphite molds [P038, P052]. The graphite is coated with calcium fluoride and plutonium [P038].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the coarse graphite waste (IDC 312) are listed in Table 12-7 [P221]. Typical waste material parameters, including typical packaging materials for the waste as identified for the 3,100 m^3 Project are presented in Table 12-8 [P221].

Table 12-5. Items Identified by RTR for Scarfed Graphite Chunks Waste (IDC 303) During the 3,100 m^3 Project [P221].

Item[a]	Comment
Miscellaneous plastic items	RTR identified a 90-mil liner lid, elastic sleeving and a single poly bag (.25 lb) as plastic waste material.
Miscellaneous metal items	Metal items include two metal hooks (approximately 1 pound) and a locking ring. These items were assigned to the iron-based metals/alloys waste material parameter category.

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to WIPP.

Table 12-6. Typical Waste Material Parameters for Scarfed Graphite Chunks Waste (IDC 303) During the 3,100 m^3 Project [P221].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags
Other Inorganic Materials	Graphite, vermiculite, Oil-Dri®
Cellulosics	Cardboard liner, Fibre-Pak

Table 12-7. Items Identified by RTR for Coarse Graphite Waste (IDC 312) During the 3,100 m^3 Project [P221].

Item[a]	Comment
Miscellaneous plastic items	RTR indicated that a drum contained 27 poly bottles as plastic waste material.
Lead-containing items	One drum contained a small lead piece that was estimated to weigh approximately 2 pounds.

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to WIPP.

Table 12-8. Typical Waste Material Parameters for Coarse Graphite Waste (IDC 312) During the 3,100 m^3 Project [P221].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags
Other Inorganic Materials	Graphite, vermiculite, Oil-Dri®
Cellulosics	Cardboard liner, Fibre-Pak
Plastics (waste materials)	1 gallon polyethylene bottles

12.1 Waste Generation

Graphite molds and cores were generated primarily by plutonium production operations. Graphite materials were also generated from research and development activities and laboratory operations. Graphite wastes contaminated with plutonium above the EDL were processed by recovery operations. Size reduction operations declassified materials, and performed waste repackaging or inspection activities. Figure 12-1 shows a general graphite generation flow diagram. Graphite waste generation by building is shown in Figure 12-2. Detailed process flow diagrams for graphite waste generating processes are provided in archived WSRIC information [P060, P061, P078, P079, P081].

12.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the construction of Building 707 in 1972 [P053].

The foundry in Building 707 cast molten plutonium into classified components, subassemblies, and assemblies. Molds were cut from solid blocks, logs, or slabs of graphite which had high mechanical strength. The working surfaces of the mold were coated with calcium fluoride [P016]. Molten plutonium metal was cast in graphite molds as the initial step in weapons parts production. Plutonium metal was melted within a tantalum crucible and poured into the graphite mold. The castings were removed and allowed to cool, and the molds and castings were separated. If a mold was going to be reused, it was mechanically cleaned to remove the adhered plutonium, which generated graphite scarfings. Once a mold had been used three times or was no longer usable, it was discarded as IDC 300 or 301 [P059, P060].

12.1.2 Research and Development

Research and Development included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed much of the R&D operations at the plant. Other areas at the plant supporting R&D included Buildings 559, 771, 776, 777, and 881 [P053].

Graphite molds were generated from R&D operations in Buildings 771 and 779 [P061, P062, U032]. Plutonium metallurgy in Building 771 cast plutonium alloys in furnaces using graphite crucibles. Solvents were not used in this process [P061]. Experimental casting in Building 779 tested metal compatibilities with various substrates. Plutonium and nonnuclear metals were heated in a furnace and cast into graphite molds. Freon was used to clean the castings [P062]. These operations simulated casting operations in Building 707 [P061, P062].

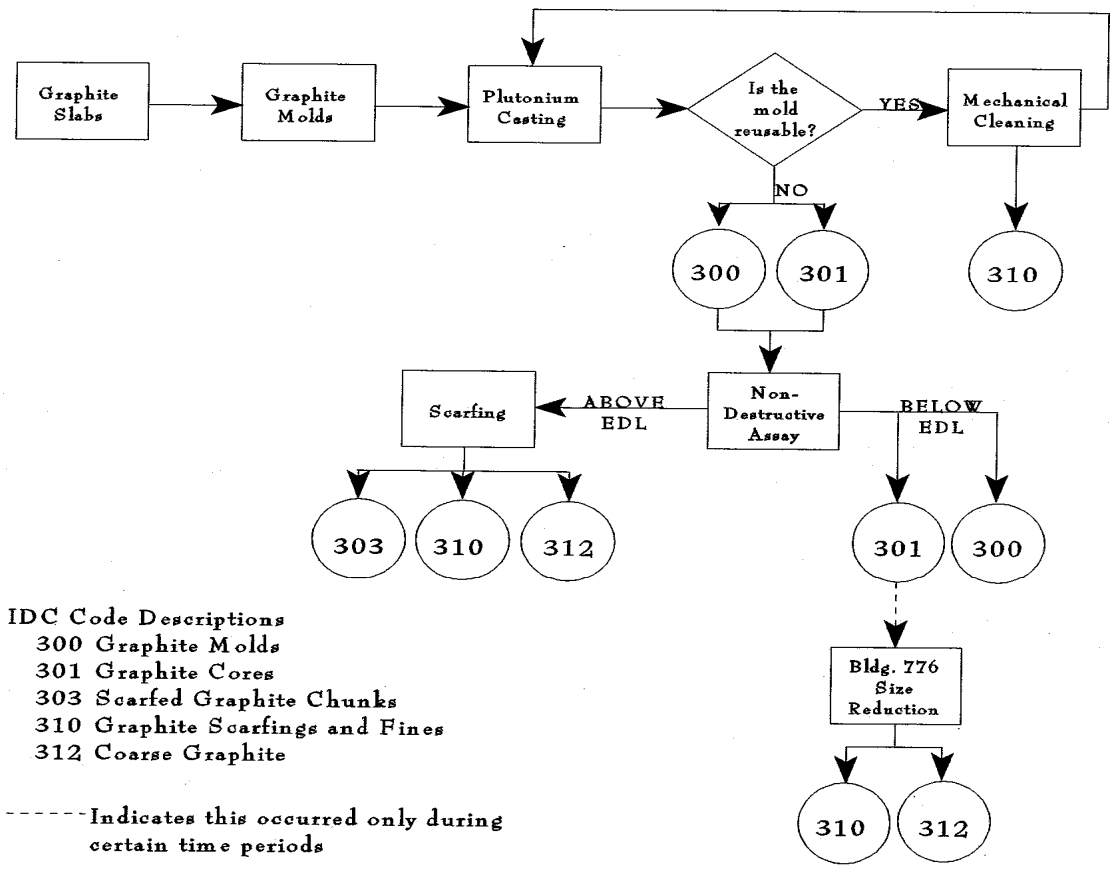

Figure 12-1. Graphite Waste Generation Flow Diagram.

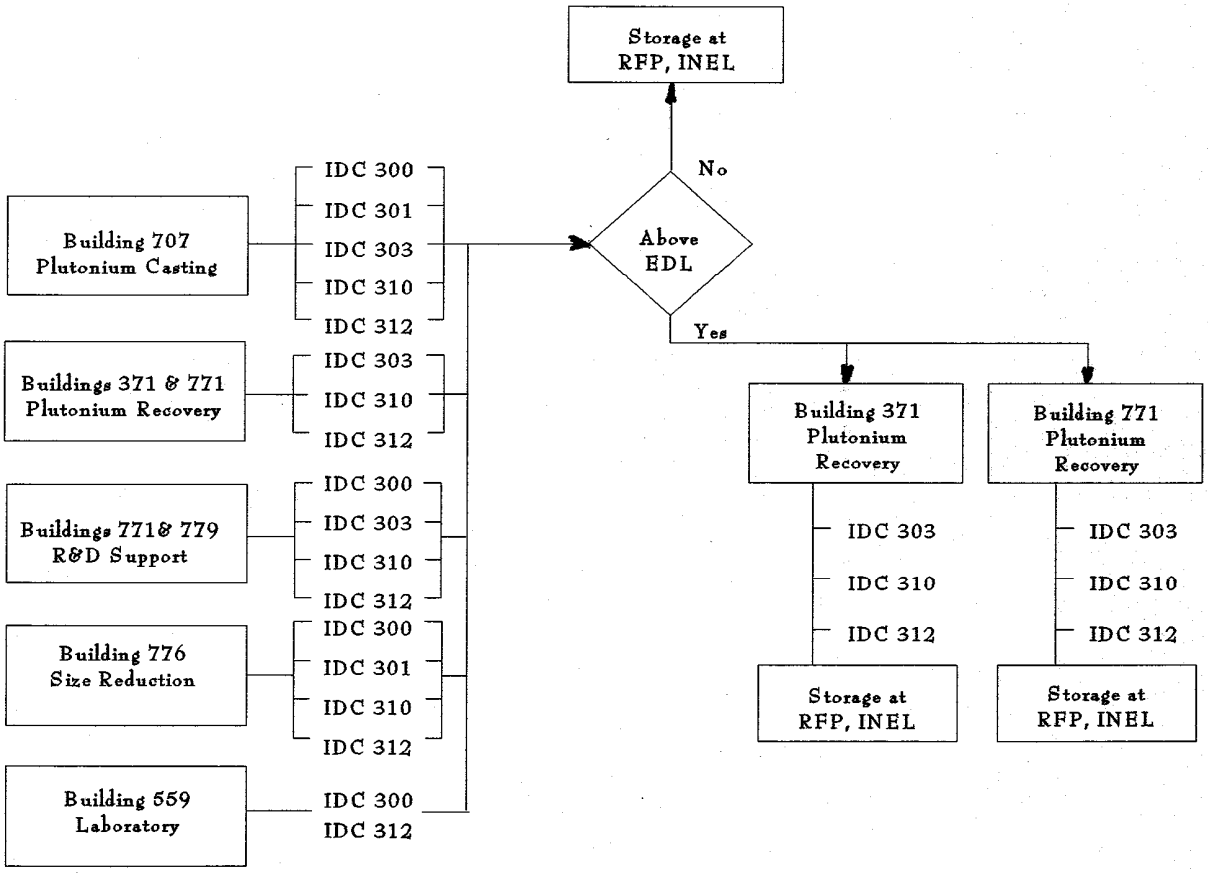

Figure 12-2. Graphite Waste Generation By Building.

12.1.3 Laboratory

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process [P067].

Emission spectroscopy was used for the determination of rare earth metals and impurities in various metal samples. The samples were leached in hydrochloric acid and dried in an oven to a low density oxide. The oxide was mixed with sodium fluoride and packed into a graphite electrode that was fired with an arc. The electrodes were removed from the spectrometer when their integrity was lost. Graphite electrodes were assigned IDC 300 [P067].

The Building 559 analytical laboratory also generated one drum (RF002900629) of graphite cores (IDC 301) in 1983. There were no operations in Building 559 that generate or process IDC 301, and it is suspected that this drum may contain graphite electrodes from emission spectroscopy analysis. There are no classification issues with graphite electrodes [C067].

12.1.4 Size Reduction

Prior to 1984, graphite cores were destroyed in Building 776 to render them unclassified [P052]. The graphite cores were broken into pieces no larger than one inch [C066].

After being assayed, drums containing plutonium below the EDL were sent to Building 776 for repackaging or inspection. A drum would have to be repackaged if the plutonium content was too high (>200 grams) or if the net weight of the drum exceeded 200 pounds [P024]. The declassified graphite cores were also repackaged [P001]. After repackaging, drums were identified as being generated from Building 776. Therefore, Building 776 could be identified as the generation building for any of the graphite wastes.

12.1.5 Plutonium Recovery

Graphite molds containing plutonium above the EDL were cleaned by a mechanical scraping or "scarfing" to remove the plutonium metal which had adhered to the surface of the mold. This process also removed the calcium fluoride coating. Scarfing operations have occurred in Buildings 371, 707, 771, and 777. The process of scarfing generated IDCs 300, 301, 303, 310, and 312. Scarfed graphite chunks (IDC 303) were generated from the pieces of the mold remaining after the plutonium-contaminated surface had been scarfed. These pieces of graphite are typically one inch in diameter or larger. IDC 303 was created in early 1985 [C005]. Prior to this, scarfed graphite chunks were assigned IDC 300 or 301 [C177]. The material which was mechanically removed from the mold was identified as IDC 310 or 312 depending on size. Graphite scarfing and fines (IDC 310) consisted of granular and fine graphite particles, and coarse graphite (IDC 312) consisted of pieces which were less than one inch in diameter but were larger than the fines. The graphite scarfings and fines were separated from the coarse graphite using a sifting screen [C061, P035, P059, P097, P104].

12.2 Waste Packaging

Graphite (IDCs 300 and 301) was placed directly into a lined 55-gallon drum or bagged out of the glovebox line in two polyvinyl chloride (PVC) or polyethylene bags. Graphite pieces and chunks (IDCs 303 and 312) were typically placed in Fibre-Paks which were bagged out of the line [P012, P024]. Graphite chunks (IDC 312) may have also been collected in 1/2- or 1-gallon polyethylene bottles [P015, P022]. Graphite scarfings (IDC 310) were collected in 1-gallon polyethylene bottles before being bagged out of the glovebox line [P024]. After removal from the glovebox, the waste was placed in a lined 55-gallon drum [P012, P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A PVC O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners for puncture protection [P008, P012, P016, P063, P064]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

During the 3,100 m^3 Project it was determined that for IDCs 300, 301, 303, and 312 wastes several combinations of drum bags, poly bags, and O-ring bags may have been used to package the wastes. Any combination of these plastic bags, provided that four layers of containment were not exceeded, did not

impact acceptability of the drums. Drums that exceeded the TRUPACT allowed containment layers were flagged for treatment in TRIPS [P221].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) were placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3–12 pounds according to the amount of waste contained in each drum [P024]. During RTR examinations of containers of graphite waste, quantities of absorbent were identified that varied significantly from expected quantities, and some drums contained no absorbent. In addition, Oil-Dri® and vermiculite may have been used in some drums outside the expected time periods, or other absorbent materials may have been used [P221].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. However, based on interviews with cognizant operators, the graphite containers should contain almost exclusively mold material [U089]. VE of three graphite mold (IDC 300) containers identified paper clips, bungee cords, and blotter paper [U011]. Acceptable knowledge confirmation activities determined that the bungee cords are actually elastic bands, and the blotter paper was, in fact, just part of the cardboard liner packaging [P205, P221]. One drum of graphite cores (IDC 301) contained a few metal bolts and some aluminum shavings [P015]. Acceptable knowledge confirmation activities have also identified numerous other items in a small percentage of the graphite waste containers, including small quantities of liquid, lead items, an outlet cover, wire, coveralls, a brush, surgical gloves, and other miscellaneous metal and plastic items [P205, P221].

12.3 Waste Characterization

Graphite wastes were characterized based on knowledge of the material, and of the processes generating the wastes, RTR review of the wastes, VE, and headspace gas analyses results. This section provides a hazardous waste determination based on Resource Conservation and Recovery Act (RCRA) and the WIPP WAP requirements for graphite as well as radionuclide contaminants and potential complexing agents contained in the waste in compliance with the WIPP WAC. Graphite wastes (IDCs 300, 301, 303, and 312) contain an estimated 80% or more (by volume), inorganic nonmetal debris that meet the CH-WAP criteria for classification as debris, and are classified as heterogeneous wastes [C204, P141]. Graphite scarfings (IDC 310) waste was identified by a waste matrix code for a homogeneous solid waste (S3110) and not a debris waste as was the other IDCs in this waste group and was not included in either of the WSPs (INW276.003 and INW276.004) developed by the 3,100 m^3 Project [P205, P211].

Graphite wastes were characterized under two CBFO approved WSPs; INW276.003 for nonhazardous TRU graphite waste (IDC 300) and INW276.004 for hazardous TRU graphite wastes (IDCs 300, 301, 303 and 312) [P205, P211, P212, P221]. IDC 300 waste generated during casting operations (container prefix 0012) in Building 707 is identified as the nonhazardous graphite waste.

12.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The waste may exhibit the characteristic of toxicity for lead, 1,1-dichloroethylene, and trichloroethylene. The waste may also have been mixed with halogenated solvents, and is an F-listed hazardous waste. There is no evidence that graphite exhibits any other characteristic of a hazardous waste. EPA HWNs applicable to some or all of the graphite waste group are presented by IDC in Table 12-9.

Table 12-9. Graphite Waste Characterization.

IDC	Title	EPA HWNs
300	Graphite Molds (Bldg. 707 casting operations only—Container prefix 0012 only)	None
300	Graphite Molds	D008, D029, D040, F001, F002, F005[a]
301	Graphite Cores	D008, D029, D040, F001, F002, F005[a]
303	Scarfed Graphite Chunks	D008, D029, D040, F001, F002, F005[a]
310	Graphite Scarfings and Fines	D008, D029, D040, F001, F002, F005[a]
312	Coarse Graphite	D008, D029, D040, F001, F002, F005[a]

a. September 26, 2000, the F005 HWN was added as part of Revision 1 of the INW276.004 Graphite WSP. INW276.004, Revision 0, was signed in August 2000.

12.3.1.1 Characteristic Waste. The materials in graphite waste containers identified as hazardous or mixed TRU wastes may exhibit the characteristic of toxicity as defined in 40 CFR 261, Subpart C (40 CFR 261.24). The materials do not exhibit the characteristic of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid wastes, and no free liquids have been identified in the waste [P015, P016, P017, P021, P022, U011]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [C064]. The materials are not compressed gases, nor do the drums contain compressed gases [P015, P016, P017, P021, P022, U011]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, and no free liquids have been identified in the waste [P015, P016, P017, P021, P022, U011]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P015, P016, P017, P021, P022, U011]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in graphite waste containers identified as hazardous or mixed TRU wastes meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. The waste in these containers may exhibit the characteristic of toxicity for lead, 1,1-dichloroethylene, and trichloroethylene.

Toxicity characteristic metals were not used in the process which generated graphite waste [P016, P035, P052, P060, P061, P062]. Graphite bars or rods from Building 774 silver recovery were identified

as IDC 312 and may contain cadmium and silver. The IDC 312 waste was a nonline-generated low-level waste stream [P109, U032]. Analysis of a single sample of this waste stream indicated cadmium and silver below regulatory levels [C060, P052]. Another reference also indicated that some of the graphite wastes exhibit the characteristic of toxicity for cadmium, and that the source of cadmium was from salt residues. However, there is no information as to what process generated the cadmium contaminated graphite waste [P049]. The majority of the available references indicate that graphite waste is nonhazardous, and the most likely source of any cadmium containing salt contamination is the silver recovery process in Building 774. An assessment of plutonium metal impurities concluded that the waste will not exhibit the characteristic of toxicity solely due to the plutonium [U086]. Toxicity characteristic leaching procedure (TCLP) metals analysis of IDC 300 supports the nonhazardous characterization [P205]. However, RTR and VE have identified containers of graphite with lead items [P221, P212]. Therefore, EPA HWN D008 is applicable to graphite waste drums containing lead and was assigned to the wastes characterized under the WSPF (INW276.004) as a conservative measure.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating graphite. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride was used for cleaning plutonium parts in the Building 707 production area. However, carbon tetrachloride was used only to clean the gloveboxes and furnaces in the casting area [U087, U088, U089, U090]. The graphite molds from the process may contain trace quantities of this compound because cleaning was performed in the glovebox line [P060, P062]. The carbon tetrachloride was not used to clean the molds, and the waste does not retain toxicity characteristic levels of this compound [U085]. There is no documentation indicating the presence or use of any other toxicity characteristic organics in the areas or processes generating graphite. In addition to the above information, analysis of 27 samples of graphite fines and chunks (IDCs 310 and 312) generated between 1979 and 1989 verified that graphite wastes do not exhibit the characteristic of toxicity for metal or organic compounds [U085]. TCLP analysis of IDC 300 for volatile and semi-volatile organic compounds also supports the nonhazardous characterization [P205]. However, headspace gas analyses results indicated 1,1-dichloroethylene and trichloroethylene, with calculated UCL_{90}s greater than their corresponding PRQLs. The source of these organics has not been determined [P212]. EPA HWNs D029 and D040 were assigned to the graphite waste stream (IDCs 300, 301, 303, and 312) characterized under the WSPF (INW276.004) as a conservative measure [P205, P211, P212, P221].

12.3.1.2 Listed Hazardous Waste. The materials in the graphite waste containers identified as hazardous or mixed TRU waste are were assigned listed hazardous waste numbers because the waste may have been mixed with wastes listed in 40 CFR 261, Subpart D from non-specific sources (40 CFR 261.31). There was no definitive AK information for graphite wastes that indicated whether the wastes were or were not in contact with spent solutions. Without a definitive statement from the generator, the INEEL assigned the listed codes, F001 and F002, based on headspace gas data. Headspace gas summary data generated for the two waste streams, INW276.003 nonhazardous graphite waste, and INW276.004 hazardous graphite wastes, during the 3,100 m^3 Project are presented in Table 12-10 and Table 12-11, respectively.

The materials in this waste group are not, or were not mixed with hazardous waste from specific sources (40 CFR 261.32), or as discarded commercial chemical products, off-specification species, container residues, or spill residues (40 CFR 261.33).

Carbon tetrachloride, 1,1,1-trichloroethane, and freon (1,1,2-trichloro-1,2,2-trifluoroethane) were used for cleaning gloveboxes, equipment, and plutonium metal. The graphite molds may contain trace quantities of these compounds because cleaning was performed in the glovebox line [P060, P062, U087].

However, none of these solvents were used in conjunction with casting operations and did not come into direct contact with the molds. Therefore, graphite molds (IDC 300) from casting operations in Building 707 are not F001- or F002-listed wastes, as characterized in WSP INW276.003 [U087, U090, P205, P211, P221].

Results from headspace analyses of samples of graphite (IDCs 300, 303, and 312) obtained at INEEL indicated the presence of 1,1,1-trichlorethane and methylene chloride in coarse graphite (IDC 312) [P033]. The calculated UCL_{90}s for 1,1,1-trichloroethane, methylene chloride, and trichloroethylene from other graphite headspace gas sampling results were greater than their respective PRQLs [P212].

There is definitive documentation indicating how these solvents were used in Building 707 graphite casting operations [U087, U088, U089, U090]. However, solvent use in other operations generating graphite waste (i.e., scarfing, R&D, and laboratory) is not conclusive. Graphite waste from operations other than Building 707 casting is assigned EPA HWNs F001 and F002.

There is no documentation indicating the use of any F003- or F004-listed solvents in the areas or processes generating graphite [U087, U088, U089, U090]. Therefore, this waste group is not an F003- or F004-listed waste.

Also as reported in 1995, headspace analysis performed on samples of graphite (IDCs 300, 303, and 312) obtained at INEEL indicated the presence of toluene in coarse graphite (IDC 312) [P033]. Other INEEL graphite headspace gas sampling results identified toluene in samples, although the UCL_{90} was less than the PRQL. The source of the toluene is unknown [P212]. Graphite waste was conservatively assigned EPA HWN F005.

The materials in this waste group are not hazardous wastes from specific sources because they were not generated from any of the processes listed in 40 CFR 261.3. The material in this waste group is therefore not a K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

Table 12-10. Statistical Evaluation of Headspace Gas Results for the Nonhazardous Graphite Waste Stream (INW276.003, IDC 300, prefix 0012) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	479	352	20.0	104	2,000	27.1	10	N/A[c]
1,1,2,2-Tetrachloroethane	478	4	0.071	0.207	4.30	0.240	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	479	20	0.076	0.551	11.0	0.240	10	N/A
1,1-Dichloroethane	479	13	0.061	0.356	6.00	0.195	10	N/A
1,1-Dichloroethylene	470	8	0.075	0.324	6.70	0.237	10	N/A
1,2,4-Trimethylbenzene	478	24	0.071	0.222	4.30	0.131	10	N/A
1,2-Dichloroethane	478	16	0.055	0.123	2.10	0.096	10	N/A
1,3,5-Trimethylbenzene	479	24	0.063	0.263	4.60	0.134	10	N/A

Table 12-10. (continued).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
Acetone	479	459	7.98	10.5	91.0	8.60	100	N/A
Benzene	479	96	0.085	0.274	4.95	0.121	10	N/A
Bromoform	470	0	0.046	0.131	2.70	b	10	N/A
Butanol	479	64	0.249	1.04	16.0	0.418	100	N/A
Carbon tetrachloride	478	88	0.132	0.587	10.0	0.213	10	N/A
Chlorobenzene	479	2	0.055	0.247	4.35	0.593	10	N/A
Chloroform	478	332	0.210	0.503	9.80	0.246	10	N/A
Cis-1,2-dichloroethylene	471	0	0.054	0.256	4.85	b	10	N/A
Cyclohexane	478	19	0.049	0.083	1.45	0.074	10	N/A
Ethyl benzene	478	19	0.071	0.172	2.60	0.124	10	N/A
Ethyl ether	470	0	0.091	0.200	3.95	b	10	N/A
Methanol	479	4	4.16	6.57	87.0	9.55	100	N/A
Methyl chloride	25	18	1.27	1.63	5.80	1.78	10	N/A
Methyl ethyl ketone	471	211	0.309	0.862	12.5	0.386	100	N/A
Methyl isobutyl ketone	479	1	0.099	0.535	11.0	b	100	N/A
Methylene chloride	479	182	0.821	6.28	120	1.42	10	N/A
Tetrachloroethylene	478	4	0.047	0.123	1.90	0.147	10	N/A
Toluene	478	75	0.156	0.847	17.0	0.283	10	N/A
Trans-1,2-dichloroethylene	23	0	0.050	0.054	0.280	b	10	N/A
Trichloroethylene	478	105	0.168	1.14	23.0	0.311	10	N/A
m&p-Xylene	470	26	0.071	0.183	2.45	0.118	10	N/A
o-Xylene	471	25	0.070	0.269	4.60	0.141	10	N/A

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90}cannot be calculated.

c. Although incidental solvent contamination of the graphite molds could have been possible (e.g., residual solvent contamination within the glovebox), such contamination does not meet the regulatory definition of listed hazardous waste. It was also documented in AK that the polyethylene liner lids were glued in place with Raycohesive (tradename). Trichloroethane is a constituent of this adhesive and as such was not used for its solvent properties during waste generation. Therefore a nonhazardous determination was made for the IDC 300 graphite molds generated in the foundry and casting operations of Building 707 [P211, P222].

Table 12-11. Statistical Evaluation of Headspace Gas Results for the Hazardous Graphite Waste Stream (INW276.004, IDCs 300, 301, 303, 312) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	114	95	20.1	48.8	330	26.5	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	114	0	0.096	0.213	1.73	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	114	3	0.054	0.110	0.900	0.173	10	N/A
1,1-Dichloroethane	114	14	0.093	0.201	1.80	0.166	10	N/A
1,1-Dichloroethylene	112	13	1.19	9.13	96.0	4.62	10	D029[d]
1,2,4-Trimethylbenzene	114	14	0.191	0.617	4.50	0.414	10	N/A
1,2-Dichloroethane	114	20	0.095	0.140	0.85	0.136	10	N/A
1,3,5-Trimethylbenzene	114	10	0.104	0.275	1.90	0.224	10	N/A
Acetone	114	109	12.0	16.9	160	14.1	100	N/A
Benzene	114	45	0.294	1.26	13.0	0.539	10	N/A
Bromoform	112	0	0.064	0.135	1.08	b	10	N/A
Butanol	114	42	0.486	1.49	11.0	0.785	100	N/A
Carbon tetrachloride	114	24	0.087	0.179	1.40	0.135	10	N/A
Chlorobenzene	114	1	0.068	0.152	1.26	b	10	N/A
Chloroform	114	80	0.311	0.725	5.20	0.416	10	N/A
Cis-1,2-dichloroethylene	112	0	0.062	0.128	1.05	b	10	N/A
Cyclohexane	114	13	0.067	0.103	0.650	0.106	10	N/A
Ethyl benzene	114	12	0.196	0.651	4.70	0.452	10	N/A
Ethyl ether	112	0	0.125	0.230	1.58	b	10	N/A
Methanol	114	1	4.24	3.32	26.0	b	100	N/A
Methyl chloride	14	12	1.69	1.48	5.30	2.27	10	N/A
Methyl ethyl ketone	112	90	1.38	2.49	23.0	1.72	100	N/A
Methyl isobutyl ketone	114	4	0.110	0.214	1.58	0.285	100	N/A
Methylene chloride	114	57	1.11	3.89	32.6	1.78	10	F001/F002[d]
Tetrachloroethylene	114	8	0.200	1.23	13.0	0.815	10	N/A
Toluene	114	85	1.12	2.28	13.0	1.43	10	F005[d]
Trans-1,2-dichloroethylene	13	0	0.068	0.072	0.245	b	10	N/A
Trichloroethylene	114	33	5.11	30.7	290	12.1	10	F001/F002/D040[c]
m&p-Xylene	112	12	0.381	1.94	15.0	1.14	10	N/A
o-Xylene	112	10	0.172	0.663	5.00	0.462	10	N/A

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on HSG data.

d. HWN assigned based on HSG data submitted with the original WSPF or subsequent lot characterization summaries.

12.3.2 Radionuclides

The radioisotopes potentially contained in the waste are identified in the following sections. In addition, the matrix and other physical parameters that could affect radioassay results are summarized in Table 12-12.

Radionuclide contamination in graphite waste from Building 707 will primarily consist of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers. Graphite molds used in plutonium production operations were also used for casting these plutonium alloys; however, processing of plutonium alloys was limited compared to plutonium [C171, C174, C184, C185, P053, P164, P167].

Graphite waste from recovery operations in Buildings 371 and 771 was generated from scarfing operations. This graphite originated in Building 707 and, therefore, will contain primarily weapons-grade plutonium but could possibly contain the plutonium alloys. Graphite from R&D activities in Building 771 (container prefixes 0042 and 0078) will contain weapons-grade plutonium and could contain a variety of other radionuclides including neptunium-237, uranium-233, and plutonium-242 [C185, U059].

Graphite from Building 559 consists of electrodes from emission spectroscopy analysis. This process analyzed weapons-grade plutonium and enriched uranium metal and oxide samples from Building 707 [U073].

The SRV in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked graphite containers have the potential to contain contaminated materials from any of the processes which generated graphite waste [P067, U077].

U-235 was detected in two drums of IDC 300 from Building 707 and 6 drums of IDC 303 from Building 371 [P115]. Uranium was not cast in Building 707, however, on one occasion in the mid-1980s, metal chips from machining of plutonium and enriched uranium in Building 777 were mistakenly briquetted in Building 707 [C184].

Table 12-12. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	Plutonium metal and oxide will be present in the graphite waste [P035]. In general, visible pieces of plutonium metal were removed from graphite molds prior to packaging [P104]. However, small pieces of plutonium metal were identified in drums of graphite (IDC 300) [P015]. Review of RTR images of IDC 300 have shown that drums contain either scarfed graphite or unscarfed graphite. Source particle size in this waste with range from finely divided in the scarfed graphite and impregnated on the surface of the molds to metal fines and shavings dispersed in the waste [P154].
Hydrogen Content	The primary sources for hydrogen in graphite waste include fiberboard, polyvinyl chloride, and polyethylene liners, bags, and bottles (Section 12.2).

Table 12-12. (continued).

Parameter	Results of Evaluation
	In addition, trace concentrations of hydrocarbons have been detected in the headspace of graphite containers [P033]. Moisture absorption should not be an issue because neither graphite nor calcium fluoride (mold coating) are hygroscopic [C181].
Other Interfering Waste Contaminants	The graphite material itself is a moderating material and can bias radioassay. Other contaminants include calcium fluoride mold coating, and magnesium metal or oxide (plutonium impurity) [P035].
Physical Matrix Parameters	If present in IDCs 300 or 301, the calcium and magnesium metal or oxide will be located on the inside mold surface; otherwise, the material is homogeneous [P035]. Based on two samples of IDC 310, the particle size distribution of the graphite fines was less than 0.7% and 0.5% dispersible fines. The material in both containers sampled was essentially 100% fines [C186].

12.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix.

Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1[P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 uses its mass fraction in weapons grade Pu, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, uranium-235, and uranium-238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P221].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 12-13. The user of this document can use this table to determine the building or area of generation for containers in the INEEL inventory identified by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 12-13. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
300	371	0011	Note a	4/28/83–5/23/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
300	371	0032	Aqueous Recovery	1/17/83–10/29/85	WG Pu, EU[b], ^{241}Am, DU[b]
300	371	0039	Note a	2/1/83	WG Pu, EU, ^{241}Am, DU
300	371	0073	Aqueous Recovery	9/7/82–9/7/82	WG Pu
300	559	0029	Analytical Laboratory	6/12/81–9/13/82	WG Pu, EU
300	707	0012	Foundry and Casting Operations	1/4/73–6/8/88	WG Pu
300	707	0028	Building 707 operations	6/25/82	WG Pu, EU[b], ^{241}Am, DU[b], ^{233}U
300	771	0001	Aqueous Recovery	12/12/72–1/8/73	WG Pu
300	771	0002	Aqueous Recovery	9/7/82	WG Pu, ^{233}U[b]
300	771	0042	Chemical Technology	8/14/85	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
300	771	0078	Plutonium Metallurgy Development	5/22/81–5/7/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
300	771	0078	Plutonium Metallurgy Development	3/24/83–6/24/86	WG Pu, EU, ^{241}Am, DU
300	776	0019	Size Reduction	8/29/83–10/18/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
300	776	0025	Drum Repack	9/13/82–8/7/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
300	776	0026	Size Reduction	8/26/80–9/13/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
300	776	0040	Waste Processing/Final Packaging	12/1/84	WG Pu, EU, ^{241}Am, DU, ^{233}U
300	776	0041	Waste Processing/Final Packaging	9/20/82–1/10/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
301	371	0011	Note a	4/4/73–4/18/73	WG Pu, EU, ^{241}Am, DU
301	371	0073	Aqueous Recovery	9/10/82	WG Pu
301	559	0029	Analytical Laboratory	6/23/83	WG Pu
301	707	0012	Foundry and Casting Operations	2/13/85	WG Pu, EU[b], ^{233}U[b]
303	371	0032	Aqueous Recovery	3/26/85–4/11/88	WG Pu, EU[b], ^{233}U[b]
303	776	0025	Drum Repack	8/6/86–8/7/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
310	371	0032	Aqueous Recovery	12/14/83	WG Pu
310	707	0012	Foundry and Casting Operations	10/24/85	WG Pu
312	371	0032	Aqueous Recovery	1/24/84–2/21/84	WG Pu, EU[b], ^{233}U[b]
312	776	0025	Drum Repack	6/7/84–6/7/84	WG Pu, EU, ^{241}Am, DU, ^{233}U

a. Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompasses all RF buildings and processes that generated graphite transuranic wastes. The characterization brackets the graphite wastes generated in these time periods and identified by these IDCs and container prefixes.

b. Isotopes added by confirmatory radioassay.

WG = weapons grade EU = enriched uranium DU = depleted uranium

12.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for IDC 335, IDC 376 and IDC 490 graphite wastes are summarized in Tables 12-14 and 12-15. The overall yield for the graphite wastes radioassay data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 12-14 and Table 12-15, respectively.

Radioassay data also was collected by the 3,100 m^3 Project for graphite scarfings waste (IDC 310). Only two graphite scarfings waste containers (IDC 310) were analyzed during the life of the 3,100 m^3 Project, and the overall yield for IDC 310 radioassay data was not compiled. The radionuclide and related radioassay data were derived from the PAN/Gamma system and are presented in Table 12-16. The data for the individual radioassay systems information are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 12-14. Overall Radioassay Yield for Graphite Waste Streams (INW276.003 and INW276.004) (IDCs 300, 301, 303, and 312) [P322].

Total number of:	Number	Percentage of Total
Distinct containers	1,342	
"*WIPPOK*" containers	1,212	90%
"Treatment" containers	0	0%
"Deficient / Permanently Rejected" containers	130	10%

Table 12-15. Radionuclide and Related Quantities for Graphite Waste Streams (INW 276.003 and INW276.004) (IDCs 300, 301, 303, and 312)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	2.213E+00	2.356E+00	7.200E-05	2.515E+01	1342
TRU Activity (Ci)	2.218E+00	2.362E+00	7.300E-05	2.522E+01	1342
TRU Activity Concentration (nCi/g)	3.117E+04	3.498E+04	1.109E+00	4.468E+05	1342
Thermal Power (W)	6.965E-02	7.418E-02	2.000E-06	7.902E-01	1342
Thermal Power Density (W/ft^3)	9.491E-03	1.009E-02	1.000E-06	1.075E-01	1340
Plutonium Fissile Gram Equivalent (g)	2.497E+01	2.649E+01	8.550E-04	2.935E+02	1342
Americium-241 (g)	6.702E-02	7.835E-02	1.000E-06	7.425E-01	1342
Plutonium-238 (g)	3.918E-03	4.122E-03	1.739E-07	4.665E-02	1338
Plutonium-239 (g)	2.483E+01	2.634E+01	8.510E-04	2.921E+02	1342
Plutonium-240 (g)	1.550E+00	1.642E+00	5.300E-05	1.825E+01	1342
Plutonium-241 (g)	3.734E-02	4.018E-02	1.000E-06	4.354E-01	1342
Plutonium-242 (g)	6.817E-03	7.630E-03	2.898E-07	8.491E-02	1339

Table 12-15. (continued)

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Uranium-233 (g)	2.754E-01	2.871E-01	1.093E-02	9.257E-01	21
Uranium-234 (g)	6.479E-04	1.482E-03	7.419E-06	9.231E-03	39
Uranium-235 (g)	5.899E-01	1.364E+00	2.660E-02	8.587E+00	40
Uranium-238 (g)	2.234E+00	N/A	2.234E+00	2.234E+00	1

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available. N/A – Not Applicable. The standard deviation is not applicable for a single measurement.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

Table 12-16. Radionuclide and Related Quantities for Graphite Scarfings Waste (IDC 310)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	8.761E+00	1.905E+00	7.413E+00	1.011E+01	2
TRU Activity (Ci)	8.785E+00	1.911E+00	7.434E+00	1.014E+01	2
TRU Activity Concentration (nCi/g)	2.025E+05	1.244E+05	1.145E+05	2.904E+05	2
Thermal Power (W)	2.758E-01	5.968E-02	2.336E-01	3.180E-01	2
Thermal Power Density (W/ft^3)	3.752E-02	8.120E-03	3.178E-02	4.327E-02	2
Plutonium Fissile Gram Equivalent (g)	1.008E+02	2.072E+01	8.611E+01	1.154E+02	2
Americium-241 (g)	2.607E-01	1.603E-02	2.493E-01	2.720E-01	2
Plutonium-238 (g)	1.572E-02	3.702E-03	1.310E-02	1.834E-02	2
Plutonium-239 (g)	9.847E+01	2.318E+01	8.207E+01	1.149E+02	2
Plutonium-240 (g)	6.153E+00	1.449E+00	5.128E+00	7.177E+00	2
Plutonium-241 (g)	1.467E-01	3.455E-02	1.223E-01	1.712E-01	2
Plutonium-242 (g)	2.620E-02	6.170E-03	2.184E-02	3.057E-02	2
Uranium-233 (g)	ND	ND	ND	ND	0
Uranium-234 (g)	3.918E-03	N/A	3.918E-03	3.918E-03	1
Uranium-235 (g)	3.645E+00	N/A	3.645E+00	3.645E+00	1
Uranium-238 (g)	ND	ND	ND	ND	0

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available. The standard deviation is not applicable when only a single measurement is available. (N/A = Not Applicable).

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

12.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. There is no documentation indicating the presence or use of complexing agents in the processes generating graphite.

12.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the nonhazardous graphite waste, the yield of successful RTR examinations was approximately 99.6% [P323]. Conversely, approximately 0.4% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition are: 50% presence of excess free liquids and 50% layers of containment exceeded.

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the hazardous graphite waste, the yield of successful RTR examinations was approximately 99% [P323]. Conversely, approximately 1% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP [P323]. The reasons for the *Treatment* disposition, in decreasing order of occurrence, were: layers of containment exceeded and presence of sealed inner containers greater than 4 liters [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

13. GRIT

This waste group consists primarily of iron fines, iron pellets, and aluminum oxide used in grit blasting operations in Building 707 and 771. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 13-1 [U092].

Table 13-1. Grit Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
372	Grit [P024]	November 1982– January 1984

Item Description Code 372, Grit: This waste consists primarily of aluminum oxide and pin-head-size iron fines and pellets used in grit blasting operations. Grit blasting media such as walnut shells, glass beads, and ceramic beads may also be included [C120, P024, P035].

13.1 Waste Generation

The grit blasting process in Building 707 affixed serial numbers and part type identification to plutonium parts. Each part was mounted in a holding fixture along with a stencil indicating the serial number and part type. The part and stencil were placed in the grit blaster which etched the part through the stencil with aluminum oxide grit. Grit was recycled in the grit blaster and was infrequently replaced [P035, P060].

Grit was also generated by plutonium recovery operations in Building 771 [P001, P024, P049]. Pin-head-size iron fines or pellets, walnut shells, glass beads, or ceramic beads were used to grit blast various metal wastes such as molds contaminated with plutonium above the EDL [C120, P024].

Process flow diagrams for grit waste generating processes are provided in archived WSRIC information [P060].

13.2 Waste Packaging

Grit from plutonium recovery operations was packaged in one-gallon polyethylene bottles and double-bagged out of the glovebox in polyvinyl chloride and polyethylene bags. Each bag was sealed with tape before placement in a prepared 55-gallon drum [P024].

Information on the exact packaging configuration of grit from Building 707 was not identified. However, standard glovebox bag-out operations (double-bagged in plastic) were most likely used when packaging this waste.

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. Use of 90-mil rigid polyethylene liners began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P024, P063, P064]. A fiberboard liner and discs may also have been used between the waste and the drum liners [P008, P064]. When a drum was full, the drum liners were twisted and taped closed, the rigid liner lid was sealed on the rigid liner, and the drum lid and gasket were installed and secured with a lock-chime [P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when

vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner [P024].

13.3 Waste Characterization

Grit waste is characterized based on knowledge of the material and knowledge of the processes generating the waste. This section provides a RCRA hazardous waste determination for grit as well as radionuclide contaminants and potential complexing agents contained in the waste. This waste contains an estimated 80% or more (by volume), inorganic nonmetal debris that meet the CH-WAP criteria for classification as debris, and are classified as heterogeneous wastes [C204].

13.3.1 Hazardous Waste Determination

The material in this waste group does not qualify for any of the exclusions outlined in 40 CFR 260 or 261. Grit waste may exhibit the characteristic of toxicity for chromium. The waste was not mixed with a listed waste. EPA HWNs applicable to the grit waste group are presented by IDC in Table 13-2.

Table 13-2. Grit Waste Characterization.

IDC	Title	EPA HWNs
372	Grit	D007

13.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials in this waste group do not exhibit a characteristic of hazardous waste as an ignitable waste (40 CFR 261.21), a corrosive waste (40 CFR 261.22), or a reactive waste (40 CFR 261.23).

Ignitability: The material in this waste group does not meet the definition of ignitability as defined in 40 CFR 261.21. The material is not a liquid, and no free liquids have been identified in this waste [P024]. The grit waste may contain iron fines, but are not divided finely enough to cause fire through friction, absorption of moisture, or spontaneous chemical change [P024]. The material is not a compressed gas, and compressed gases have not been identified in this waste [P024]. The material is not a DOT oxidizer as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The material in this waste group does not meet the definition of corrosivity as defined in 40 CFR 261.22. The material is not a liquid, and no corrosive liquids have been identified in this waste [P024]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and

organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for chromium.

Building 771 grit blasted various metals to recovery plutonium from the surface of the metal. Although the specific metals are not identified, it is assumed the metals included stainless steel. The spent grit material may contain chromium from stainless-steel. Therefore, EPA HWN D007 is conservatively applied to this waste group [C205].

Toxicity characteristic organics, pesticides, and herbicides were not used in the process that generated this waste. Therefore, this waste group does not exhibit the characteristic of toxicity for these compounds (D012-D043).

13.3.1.2 Listed Hazardous Waste. The material in this waste group is not, or was not mixed with, a waste listed in 40 CFR 261, Subpart D as a hazardous waste from non-specific sources (40 CFR 261.31), as a hazardous waste from specific sources (40 CFR 261.32), or as a discarded commercial chemical product, an off-specification species, a container residue, or a spill residue thereof (40 CFR 261.33).

1,1,1-trichloroethane was used in the grit blasting process in Building 707 for parts cleaning. However, parts cleaning was performed following grit blasting, and the grit will not be contaminated with the solvent. No other solvents were identified with grit blasting operations [C120, P060]. The material in this waste group is therefore not a listed hazardous waste.

The material in this waste group is not a hazardous waste from specific sources since it was not generated from any of the processes listed in 40 CFR 261.32. The material in this waste group is therefore not a K-listed hazardous waste.

The material in this waste group is not a discarded commercial chemical product, an off-specification species, or a container residue (40 CFR 261.33). It is uncertain if the waste was generated from cleanup of a commercial chemical product spill. However, it is highly unlikely that the cleanup of a commercial chemical product would result in the generation of TRU waste. Therefore, the material in this waste group is not a P- or U-listed hazardous waste.

13.3.2 Radionuclides

Grit waste from Building 707 was generated from etching of plutonium parts and, therefore, radionuclide contamination will consist of weapons-grade plutonium. Grit from Building 771 was generated from recovery of plutonium from various metal surfaces. Information on physical form and other waste matrix parameters that may influence radioassay measurements or interpretation are listed in Table 13-3.

Table 13-3. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	Based on the process generating grit waste, the plutonium will most likely be in an oxide form. No information on plutonium particle size or distribution was identified.
Hydrogen Content	The primary source of hydrogen is from plastic packaging material (see Section 13.2). Walnut shells, which were used for grit blasting, are an organic material.

Table 13-3. (continued).

Parameter	Results of Evaluation
Other Interfering Waste Contaminants	The majority of the grit waste is thought to be aluminum oxide.
Physical Matrix Parameters	The form of the material may range from fines to irregular particles.

13.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. The compilation of radionuclides of concern and package dates by container prefix is presented in Table 13-4. The user of this document can use this table to determine the building or area of generation for containers in the INEEL inventory identified by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 13-4. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
372	707	0012	Foundry and Casting Operations	1/24/84	WG Pu
372	771	0001	Aqueous Recovery	11/15/82 -2/15/83	WG Pu

WG = weapons grade

13.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the grit waste stream are summarized in Table 13-5. Only two (2) grit waste containers were subjected to radioassay and the overall yield was not calculated. The radionuclide and related radioassay information is presented in Table 13-5. The data for the individual radioassay systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

13.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. There is no documentation indicating the presence or use of complexing agents in the processes generating grit.

Table 13-5. Radionuclide and Related Quantities for Grit (IDC 372)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	1.872E+01	2.648E+01	-3.009E-04	3.745E+01	2
TRU Activity (Ci)	1.877E+01	2.655E+01	-3.017E-04	3.755E+01	2
TRU Activity Concentration (nCi/g)	3.569E+05	5.047E+05	-1.934E+00	7.138E+05	2
Thermal Power (W)	5.917E-01	8.368E-01	-9.444E-06	1.183E+00	2
Thermal Power Density (W/ft^3)	8.050E-02	1.139E-01	-1.285E-06	1.610E-01	2
Plutonium Fissile Gram Equivalent (g)	1.993E+02	2.819E+02	-3.558E-03	3.987E+02	2
Americium-241 (g)	8.561E-01	1.211E+00	-5.278E-06	1.712E+00	2
Plutonium-238 (g)	3.153E-02	4.458E-02	-5.655E-07	6.305E-02	2
Plutonium-239 (g)	1.974E+02	2.792E+02	-3.541E-03	3.949E+02	2
Plutonium-240 (g)	1.234E+01	1.745E+01	-2.213E-04	2.467E+01	2
Plutonium-241 (g)	2.942E-01	4.161E-01	-5.278E-06	5.885E-01	2
Plutonium-242 (g)	5.254E-02	7.431E-02	-9.424E-07	1.051E-01	2
Uranium-233 (g)	1.908E+00	N/A	1.908E+00	1.908E+00	1
Uranium-234 (g)	ND	ND	ND	ND	0
Uranium-235 (g)	ND	ND	ND	ND	0
Uranium-238 (g)	ND	ND	ND	ND	0

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation was the statistical variation of the population for which measurements were available. N/A = Not Applicable. The standard deviation is not applicable for a single measurement.

c. The negative low values are from the "Deficient / Permanently Rejected" category. These assays are outside the systems capabilities. Since this report is merely summarizing the data stored in TRIPS the values were left in for completeness.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

13.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the grit waste stream, 13 containers were subjected to RTR over the life of the 3,100 m^3 Project. This waste was not characterized for shipment to WIPP and a WSP was not developed. The yield of successful RTR examinations was 0.0% [P323]. Conversely, 100% of the containers were dispositioned as *Treatment*. The reason for the *Treatment* disposition was the layers of confinement were exceeded for the assigned shipping category [P323].

VE indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

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14. INCINERATOR WASTE

This waste group includes sludge, fire brick, coarse fire brick, ash, ash heel, soot, and cemented inorganic process solids generated by the low-specific activity (LSA) and high-specific activity (HSA) incinerators in Building 371, the plutonium recovery incinerator in Building 771, and the fluidized-bed incinerator (FBI) in Building 776. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 14-1 [U092].

Some of the incinerator wastes described in this section were characterized under two CBFO approved WSPs for containers shipped to the WIPP facility. The WSPs were INW161.001 for fire brick waste (IDCs 371 and 377) and INW222.001 for the two incinerator sludge wastes (IDCs 292 and 807) [P306, P286, P287, P288].

Table 14-1. Incinerator Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
292	Cemented Sludge [P014] Incinerator Sludge [P001]	May 1980 – February 1987 [P286]
371	Fire Brick [P001]	December 1972 – May 1987
377	Coarse Fire Brick [P008]	March 1985 – June 1987
420	Pulverized Incinerator Ash [P008]	December 1983
421	Ash Heel [P001]	N/A[b]
422	Soot [P001]	March 1982 – February 1986
423	Soot Heel	N/A[b]
425	Fluidized Bed Ash [P014]	July 1981
807[a]	Cemented Incinerator Sludge [P067]	October 23, 1985 – March 21, 1987
818	Cemented Ash [P012]	October 1986
820	Cemented Soot [P012]	April 1986 – October 1986

a. After March 18, 1987, IDC 807 was assigned to Solidified Bypass Sludge from Liquid Waste Treatment in Building 374 (Section 22). Cemented Incinerator Sludge continued to be packaged under IDC 807 until July 1987 (Table 14-18). The overlap of dates of generation was discovered during the 3,100 m^3 Project.

b. Containers of IDC 421 and IDC 423 waste do not exist in the INEEL accessible storage inventory.

Item Description Code 292, Incinerator Sludge: This waste consists of sludge generated from the scrubber in the plutonium recovery incinerator in Building 771 [P014]. The sludge consists of fly-ash and diatomite filter media [P016, P067]. The sludge's consistency may range from a damp mass with a consistency of paste, to a mass that has been dried to some extent and may contain fines [P035, P052]. Portland cement was used as an absorbent for liquids in the sludge [P024].

Items that have been identified in IDC 292 containers during INEEL 3,100 m^3 Project RTR examinations are listed in Table 14-2 [P286]. Typical waste material parameters for IDC 292 sludge identified during RTR examination for the 3,100 m^3 Project, including packaging materials are listed in Table 14-3 [P286].

Table 14-2. Items Identified During RTR Examination of IDC 292 Containers from the 3,100 m^3 Project [P286].

Item[a]	Comment
Inorganic liquid	RTR examination indicated the presence of excess free liquid. Containers containing prohibited items, such as excess liquids, were not certifiable for shipment. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE [P286].
Clamshell	RTR examination indicated clamshells as plastic waste [P286].
90-mil rigid liner	Because the liner did not have a lid, the liner was categorized as waste rather than packaging material [P286].
Incinerator filters	The RTR examination identified two incinerator filters (2 lbs) as waste material. It is likely that incinerator filters are contaminated with the same constituents expected to be present in incinerator sludge [P286].

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to WIPP.

Table 14-3. Typical Waste Material Parameters for IDC 292 Sludge for the 3,100 m^3 Project [P286].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Plastics	Inner container bags, 2- or 4-liter Nalgene bottles used as inner containers
Cellulosics	Cardboard liner, fiberboard liner and discs, tape
Other Inorganic Materials	Portland cement, Oil-Dri®, vermiculite[a]
Other Metals	Lead liner
Inorganic Matrix	Incinerator sludge consisting of fly-ash, diatomite filter media, and Portland cement

a. Portland cement may not be distinguishable from the inorganic matrix, since the cement will be located inside the inner containers.

Item Description Code 371, Fire Brick: This waste consists of fire brick which is an insulating material made of high-density refractory clay (primarily an alumina ceramic material) that was used to line plutonium processing furnaces and incinerators [P001, P016, P032, P035]. Drums of IDC 371 generated from 1971-1973 may contain pieces of construction bricks, cinder blocks, and fire brick from the plutonium recovery incinerator and from cleanup of the 1969 fire. The waste consists primarily of incinerator fire brick from the plutonium recovery incinerator, and may include fire brick from the LSA and HSA incinerators [P024, P037, P052].

Items that have been identified in IDC 371 containers during INEEL 3,100 m^3 Project RTR examinations are listed in Table 14-4 [P306]. Typical waste material parameters for IDC 371 waste identified during RTR examinations for the 3,100 m^3 Project, including packaging materials are listed in Table 14-5 [P306].

Table 14-4. Items Identified During RTR Examination of IDC 371 Containers from the 3,100 m^3 Project [P306].

Item[a]	Comment
Miscellaneous Rubber Items	Rubber hose was identified during RTR examination. Rubber material, itself, is not a material that is inherently assigned an HWN(s).
Filters	Filter media (aluminum and cellulosic) was identified during RTR examination.
Inorganic Liquid	Residual liquid was identified during RTR examination. Containers with liquids above the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using RTR and VE.

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to WIPP.

Table 14-5. Typical Waste Material Parameters for IDC 371 Waste for the 3,100 m^3 Project [P306].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gal drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Plastics (waste materials)	Poly bags
Cellulosics	Fibre-Paks; fiberboard liner and discs
Other Inorganic Materials	Fire brick, construction bricks, cinder blocks, Oil-Dri®, vermiculite

Item Description Code 377, Fire brick, Coarse: This waste consists of coarse fire brick which is fire brick larger than one-quarter inch in diameter and smaller than one-inch in diameter [P032]. IDC 377 may also include cinder block and construction brick pieces of the same size [P024].

Table 14-6 lists the typical waste material parameters for IDC 377 waste identified during RTR examinations for the 3,100 m^3 Project, including packaging materials [P306].

Table 14-6. Typical Waste Material Parameters for IDC 377 Waste for the 3,100 m^3 Project [P306].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gal drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Plastics (waste materials)	Poly bags
Cellulosics	Fibre-Paks; fiberboard liner and discs
Other Inorganic Materials	Fire brick, construction bricks, cinder blocks, Oil-Dri®, vermiculite

Item Description Code 420, Pulverized Incinerator Ash: This waste consists of ash from the plutonium recovery incinerator, and is a mixture of coarse, granular, fine, and very fine particulate. The ash was jaw crushed and ball milled prior to removal from the glovebox [P014]. The pulverized ash was assigned IDC 420. Drums of pulverized incinerator ash may contain some miscellaneous tramp metal, bits of unburned feed materials, and carbon from the incomplete oxidation of some feed materials [P035,

P052, U013]. Ash from the LSA and HSA incinerators may also be included in IDC 420 [P052]. Although not associated with an incinerator, IDC 420 may also include fire ash from the 1969 fire [P058].

Item Description Code 421, Ash Heel: This waste consists of those insoluble materials from the nitric acid dissolution of plutonium-containing materials in the first step of aqueous recovery processing [P014, P024, P035, P043, P052]. The heel is a very fine (less than 100 mesh) particulate and fairly homogenous due to the mixing action of the dissolution system. In general the heel will contain the same constituents as the source ash; the relative concentrations will change depending on the solubility of the constituents [P035].

***Item Description Code 422, Soot*:** This waste consists of soot which is the airborne fly ash material that accumulated in the off-gas system of the plutonium recovery, LSA, and HSA incinerators [P014, P024, P052, U013]. Soot will contain most of the same constituents as the ash from which it was derived; however, the relative amounts of silica, carbon and minor components (the alumina, calcium, iron, and sodium oxides) will vary widely in the mixture. Soot generally contained a higher concentration of carbon and fine particulate than IDC 420 due to incomplete oxidation of some feed materials [P016, P035, P052].

Item Description Code 425, Fluidized Bed Ash: This waste consists of fluidized bed ash which is a fine powder generated by the FBI. The ash is made up of approximately 10% NaCl, 10% Na_2CO_3, 6% carbon, 30% Cr_2O_3 (oxidation catalyst) on Al_2O_3, and 40% fly ash (SiO_2, Fe_2O_3, Al_2O_3) [P014, P052].

Item Description Code 807, Cemented Incinerator Sludge: This waste consists of incinerator sludge (IDC 292) immobilized into a solid monolith with Portland cement. After March 18, 1987, IDC 807 also was assigned to Solidified Bypass Sludge from the Liquid Waste Treatment in Building 374 (Section 22). The overlap of dates of generation was discovered during the 3,100 m^3 Project. It was determined that one cemented incinerator container (1DRF001102663) was generated (July 9, 1987) outside the generation period shown in Table 14-1 [P043, P063, P067, P098].

Items that have been identified in IDC 807 incinerator sludge containers during INEEL 3,100 m^3 Project RTR examination are listed in Table 14-7 [P286]. Typical waste material parameters for IDC 807 incinerator sludge identified during RTR examination for the 3,100 m^3 Project, including packaging materials are listed in Table 14-8 [P286].

Table 14-7. Items Identified During RTR of IDC 807 Containers from the 3,100 m^3 Project [P286].

Item[a]	Comment
Inorganic liquid	Residual liquids were detected during RTR examination. Any containers with liquids above the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to WIPP.

Table 14-8. Typical Waste Material Parameters for IDC 807 Sludge for the 3,100 m^3 Project [P286].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Plastics	Poly bags
Cellulosics	Cardboard liner, fiberboard liner and discs
Other Inorganic Materials	Oil-Dri®, vermiculite[a]

Table 14-8. (continued).

Potential Waste Material Parameter	Description
Inorganic Matrix	Incinerator sludge mixture, Portland cement, and water

a. Absorbents may not be distinguishable from the inorganic matrix.

Item Description Code 818, Cemented Ash: This waste consists of incinerator ash (IDC 420) immobilized into a solid monolith with Portland cement. The waste may contain miscellaneous tramp metal, bits of unburned feed material, and carbon from the incomplete oxidation of feed material [P016, P098]. There were 7 IDC 818 drums examined by RTR for the 3,100 m^3 Project. All of the drums were compliant candidates from an RTR perspective for shipment to WIPP with no dispositions as *Treatment*, i.e., no prohibited conditions or items were present in the seven drums examined.

Item Description Code 820, Cemented Soot: This waste consists of soot (IDC 422) immobilized into a solid monolith with Portland cement [P016, P098]. There were 27 IDC 820 drums examined by RTR for the 3,100 m^3 Project. All of the drums were compliant candidates from an RTR perspective for shipment to WIPP with no dispositions as *Treatment*, i.e., no prohibited conditions or items were present in the 25 drums examined.

14.1 Waste Generation

TRU incinerator wastes were generated by the plutonium recovery incinerator in Building 771, the Fluidized-Bed Incinerator (FBI) in Building 776, and test runs by the LSA and HSA incinerators in Building 371. Process flow diagrams for incinerator waste generating processes are provided in archived WSRIC information [P061].

14.1.1 Low-Specific Activity and High-Specific Activity Incinerators

The LSA and HSA incinerators in Building 371 were developed as volume-reduction incinerators. The startup operation test program used nonhazardous materials during test runs. The test revealed design concerns, and the incinerators never became operational. Fire brick (IDCs 371 and 377), ash (IDC 420), and soot (IDC 422) wastes were generated during incinerator stripout operations [P016, P052].

14.1.2 Plutonium Recovery Incinerator

The plutonium recovery incinerator in Building 771 was constructed for two main purposes. The first was to reduce the volume of solid combustible wastes to reduce storage costs. The second was to generate an ash from which actinides, primarily plutonium and americium, could be recovered [U047]. The incineration system was comprised of a multi-chamber, refractory-lined firebox; caustic scrubber system; dedicated vacuum system; heat exchangers; various tanks, pipes, and valves; and a filter plenum [P061].

Combustible wastes (primarily IDCs 330, 331, 336, and 337) were received from production processes in Buildings 371, 707, 771, 776, 777, and 779 [P016, P052]. Combustibles fed to the incinerator included paper, polyvinyl chloride and polystyrene bags, polypropylene and Ful-Flo filters, surgical gloves, polyvinyl chloride maintenance tents, and various types of sludge. The radioactively contaminated materials entered the glovebox from the drum hoist and bag-in area and were hand-sorted to segregate the combustibles. Noncombustibles, such as metal or glass wastes, were removed from the glovebox [P052, P061].

The incinerator was comprised of three chambers; a firebox where combustibles were initially introduced into the system, a main burner chamber where ashes that fell through the firebox grate

continued to burn, and an afterburner section [U047]. Material was fed into the incinerator and was reduced by a 12-to-1 ratio, by weight. Incinerator ash was pulverized in the ball mill before being bagged out of the glovebox into drums. The pulverized ash was discarded as solid waste (IDC 420) if the plutonium was below the EDL or was sent for recovery if it contained plutonium above the EDL [P061].

Two air-to-gas heat exchangers drew in room air to help cool the incinerator off-gas before it passed through a caustic scrubber, and a venturi which increased the scrubbing efficiency of the potassium hydroxide (KOH) caustic scrubber solution. After the off-gas passed through the scrubber, it was filtered through the incinerator filter plenum. Cooling air from the heat exchangers was filtered through the incinerator filter plenum and then through the main filter plenum where the gases were combined with other glovebox exhaust gases [P061].

The KOH solution from the scrubber was processed through the drum filter where particulate matter (fly ash) was entrained on diatomite filter media [P067]. Sludge, which consisted of fly ash and diatomite filter media, was discarded as solid waste (IDC 292) if the plutonium was below the EDL or was sent for recovery if the plutonium was above the EDL [P016, P061, U013].

Fire brick (IDCs 371 and 377), which lined plutonium processing furnaces and incinerators, was generated during maintenance operations. After the fire brick was removed, it was subjected to a mechanical scarfing process to remove plutonium-bearing surface layers [P016, P037, P117]. Soot (IDC 422) was generated during routine filter change operations and when the off-gas system was disassembled and cleaned [P016, P052]. The plutonium recovery incineration process is presented in Figure 14-1 [P052].

The low-level dissolution process was intended for high impurity/low plutonium content residues. The dissolution systems operated in the following way: ash was introduced into a glovebox system, fed by screw conveyor with calcium fluoride to the first dissolver pot, and allowed to cascade by gravity through a series air lifted dissolver pots before overflowing into a pan type nutsche filter. Aluminum nitrate was added to the last dissolver to complex any remaining fluoride and prevent corrosion of down stream equipment. The undissolved material collected in the pan filter was periodically scraped from the filter, dried on a hot plate, and assayed for plutonium content. This material was labeled IDC 421, ash heel [P024, P035, P052, P163].

Beginning in 1985, incinerator sludge, ash, and soot wastes (IDCs 292, 420, and 422) were immobilized into a solid monolith with Portland cement and water [C050, P016]. Portland cement and water were mixed, and incinerator sludge was gradually added to the mixture. The sludge, cement, and water mixture was poured into a 1-gallon polyethylene container mold and allowed to cure. The mold was removed from the solidified “puck” which was placed in a 55-gallon drum. Several “pucks” were placed in a drum. The same procedure was followed for cementation of incinerator ash and soot [P016, P043, P098]. The cemented sludge, ash, and soot drums were assigned IDCs 807, 818, and 820, respectively [P016, P043].

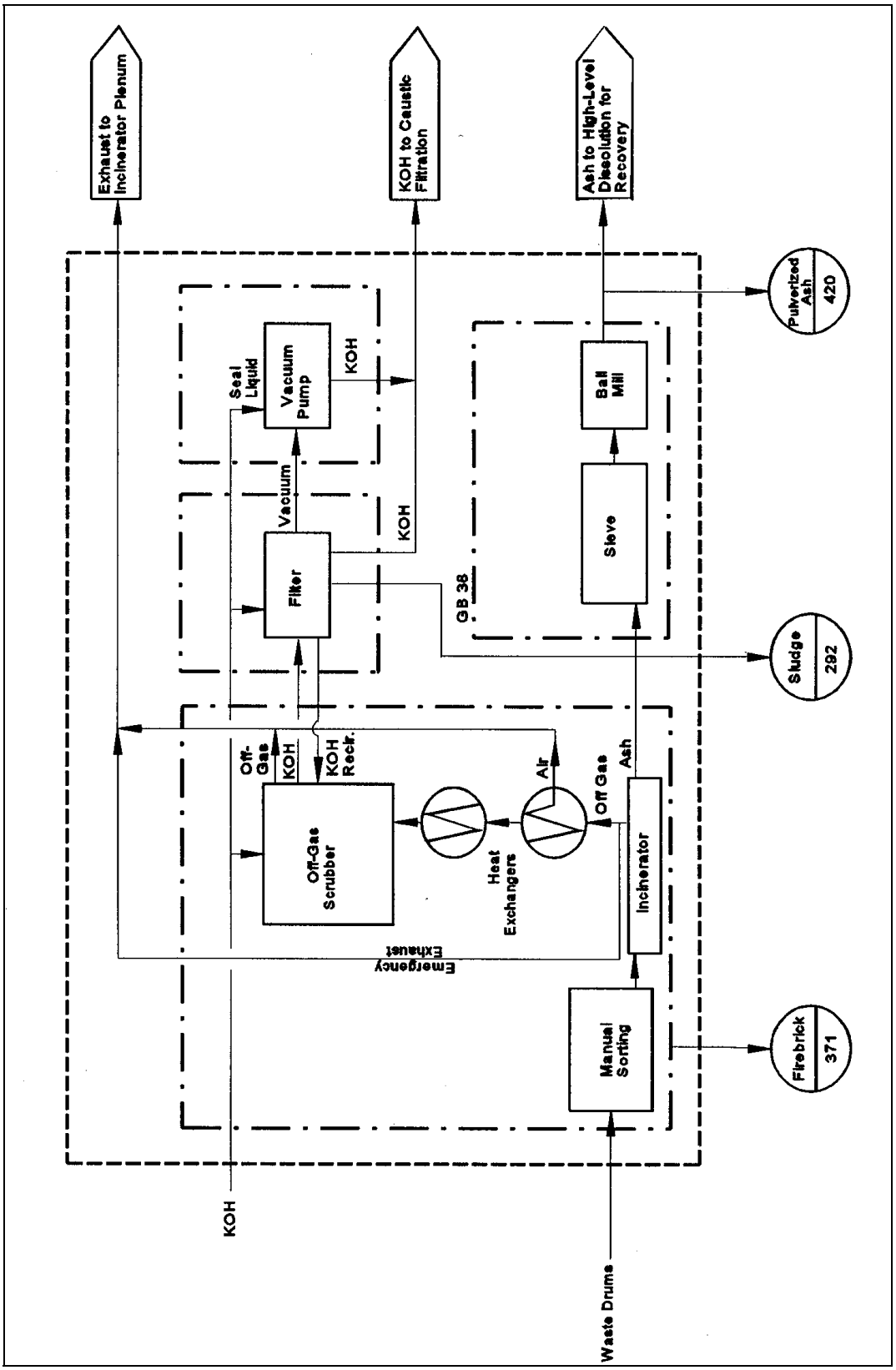

Figure 14-1. Plutonium Recovery Incineration Process.

14.1.3 Fluidized-Bed Incinerator

The FBI received low-level plutonium-contaminated combustible solid and liquid wastes. The main purpose of the FBI program was to develop new technology to reduce volume and destroy volatile constituents prior to plutonium recovery operations [P037, P052].

The first runs of the FBI were made from 1971 to 1978 in a pilot-scale unit. Test materials introduced into the incinerator included polyvinyl chloride, polyethylene, and paper. After 1974, paint thinner, tributyl phosphate, kerosene, and hydrazine hydrate were burned. In 1978, PCBs mixed as one part PCB to 4–5 parts diesel fuel or kerosene were burned. Waste burned in the pilot-scale unit was not considered a Toxic Substance Control Act (TSCA) waste because of the high efficiency of destruction achieved by this unit [P052]. Total PCBs analysis indicated concentrations of Aroclor-1254 from 24 to 27 parts per billion [P125].

The first runs of the full-scale FBI occurred from 1978 to 1981. These first runs used test materials such as newspaper, low-level waste from Building 776, combustible waste, kerosene, garage oil, and grease. Test runs conducted from 1985 to 1988 were conducted with methanol, diesel products, and nonradioactive surrogate combustibles (shredded coveralls, leather gloves, rolls of polyvinyl chloride plastic, wood, and paper) [P052].

Liquid wastes were pumped through filters into two incinerator feed tanks. From these tanks, the liquid was sprayed into the incinerator through nozzles. Solid wastes were transferred to a glovebox for hand-sorting where noncombustible materials such as metal and glass were removed. The combustible wastes were shredded and conveyed by screw feeder to the incinerator [P067].

The wastes were incinerated in fluidized beds of sodium carbonate and chromic oxide catalyst. The incinerator had a primary reactor and an afterburner. Process flue gases passed through two stages of cyclone separators, a stainless-steel sintered metal filter bank, and a one-stage HEPA filter, before being exhausted into the HEPA filter plenum of the building ventilation system. The ash (IDC 425) collected by the filters and cyclone separators was bagged out of the glovebox into drums. Even though the FBI processed low-level waste, both low-level and TRU ash were generated due to the concentrating of radionuclides from the feed material. The FBI process is illustrated by Figure 14-2 [P067].

14.2 Waste Packaging

Incinerator sludge (IDC 292) packaged prior to 1977 was placed in a polyvinyl chloride bag and sealed with tape. The bag was then double-contained in plastic and placed in a 1-gallon metal paint can containing Portland cement. Additional cement was added to the top of the waste before the paint can lid was closed. Beginning in 1977, the sludge was collected in 2- or 4-liter Nalgene bottles. Portland cement was added in layers as the bottle filled with sludge. The sludge was capped with cement, the bottle lid was installed, and the bottle was double-bagged [P016, P024]. The sludge may also be packaged in several plastic bags within the drum [P015]. Each individual package was bagged out of the glovebox and placed in two plastic bags that were sealed with tape. The packages were assayed and placed into a 55-gallon drum. Up to 25 cans or 20 bottles were placed in a drum depending on assay [P016, P024].

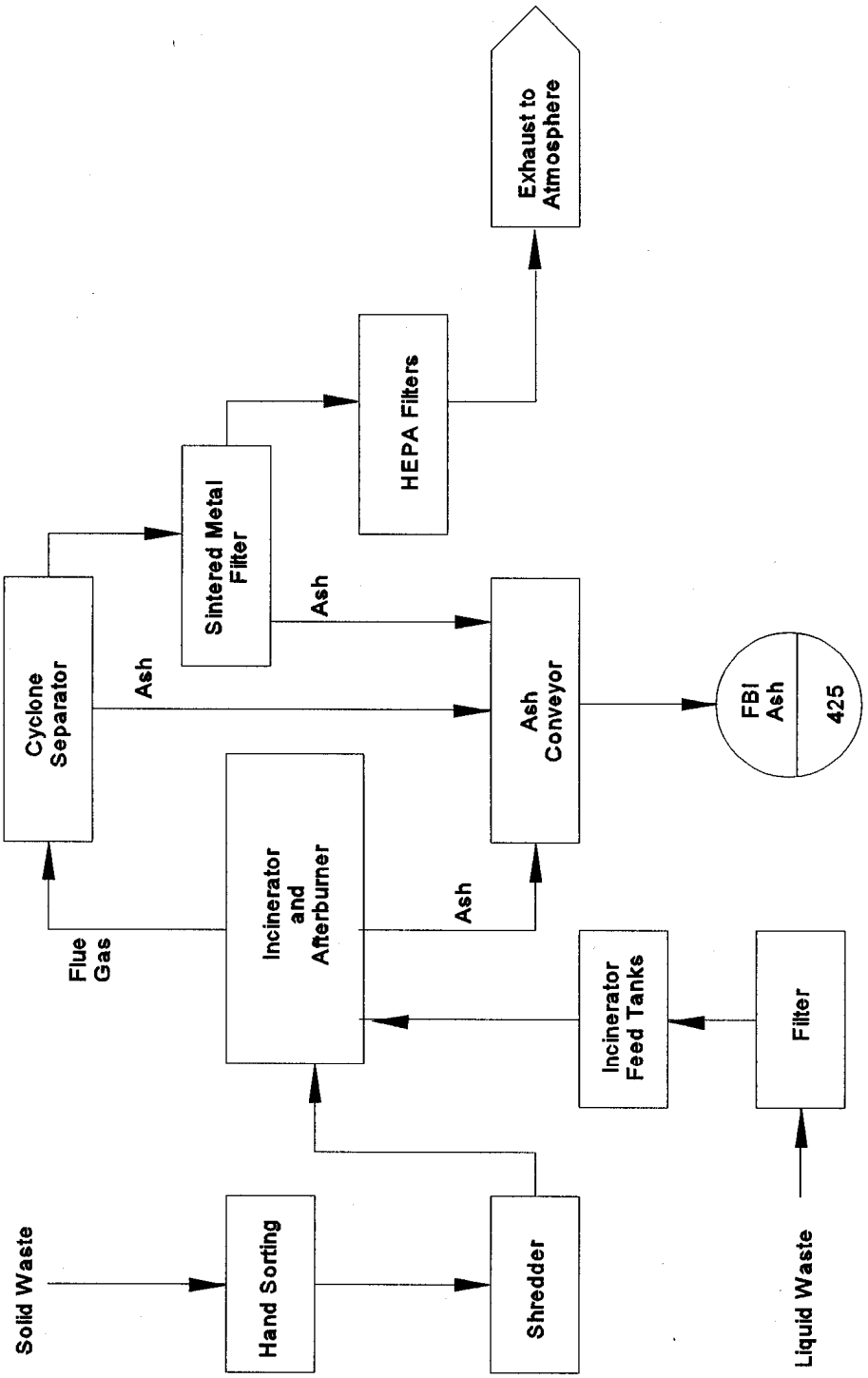

Figure 14-2. Fluidized-Bed Incineration Process.

From 1971-1973, fire brick wastes (IDCs 371 and 377) were packaged by three different methods; double-bagged and placed into Fibre-Paks (two Fibre-Paks fit into a 55-gallon drum), double-bagged and placed into a 55-gallon drum, or placed directly into a 55-gallon drum. The plastic bags were sealed with tape prior to placement in a Fibre-Pak or drum. After 1973, fire brick was double-bagged and packaged in Fibre-Paks exclusively. Fibre-Packs were assayed before being placed in a 55-gallon drum [P012, P015, P024].

Pulverized incinerator ash (IDC 420) was packaged in 1/2- or 1-gallon polyethylene bottles. The bottles were bagged out of the glovebox and placed in one or two polyethylene bags which were sealed with tape. The packages were assayed and placed into a 55-gallon drum. Up to 25 bottles were placed into a drum depending on assay [P024].

Ash heel (IDC 421) was packaged into 1/2- or 1-gallon polyethylene bottles, bagged out of the glovebox into a PVC bag. The PVC bag was then placed in one or two polyethylene bags. Each bottle was assayed and then placed in a prepared 55-gallon drum, depending on the assay results. Approximately 25 bottles fit in a drum, depending on plutonium content [P024].

Soot (IDC 422) was packaged in 1- or 2-quart polyethylene bottles. The bottles were bagged out of the glovebox and placed in two polyethylene bags, which were sealed with tape. The packages were assayed and placed into a 55-gallon drum. Up to 50 bottles were placed into a drum depending on assay [P016, P024].

Cemented ash pucks (IDC 818) were bagged out of the glovebox, double-bagged, and placed into a 55-gallon drum. Sludge and soot pucks (IDCs 807 and 820) were packaged in the same manner [P012, P016].

FBI ash (IDC 425) was packaged in small plastic bags. Several bags were bagged out of the glovebox, placed in a polyvinyl chloride bag that was sealed with tape, and the bag was placed into a 55-gallon drum [P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might have been used to line the inner drum bag. Use of 90-mil rigid polyethylene liners began in 1972 [P024]. A rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag placed inside the rigid liner were used if the drum was attached to a glovebox [P016]. A fiberboard liner and discs may also have been used between the waste and the drum liners [P008, P012, P016, P063, P064]. In addition, drums of incinerator sludge (IDC 292) may be lead-lined. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P001, P016, P024, P043].

During the 3,100 m^3 Project it was determined that for IDCs 292, 371, 377, and 807 wastes other combinations of drum bags, poly bags, and O-ring bags were sometimes used to package the wastes. Any combination of these plastic bags, provided that four layers of containment were not exceeded for IDCs 292, 377, and 807, or five layers for IDC 371, did not impact acceptability of the drums. Drums that exceeded the TRUPACT allowed containment layers were flagged for treatment in the TRIPS [P286, P306].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when

vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024]. During RTR examinations for the 3,100 m^3 Project, some IDC 292, 371, 377 and 807 wastes contained quantities of absorbent that varied from expected quantities, absorbents other than Oil-Dri® or vermiculite were identified, or absorbents were not detected [P286, P306].

Waste management and inspection protocol allowed containers of incinerator wastes to contain up to 10% of another IDC other than that assigned to the container. Other wastes could include combustibles, glass, concrete, metal, leaded gloves, and plastics [P016]. VE of some of the containers revealed several items. Ful-Flo filters laden with grease, empty cement bags, and unused polyethylene bags were identified in IDC 292 drums. Surgical gloves, asbestos insulation, foil, PVC and polyethylene bags, and a thermocouple were found in IDC 371 drums [P015].

14.3 Waste Characterization

Incinerator wastes have been characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, waste analysis, and headspace gas analysis. This section provides hazardous waste determinations based on RCRA requirements and radionuclide contaminants and potential complexing agents contained in incinerator wastes. The hazardous waste determinations for the two wastes with CBFO approved WSPs were also based on WIPP WAP requirements as well as the WIPP WAC.

Incinerator ash (IDCs 420, 425, and 818), ash heel (IDC 421), and soot (IDCs 422 and 820) are at least 50% (by volume) inorganic particulates, and incinerator sludges (IDCs 292 and 807) are at least 50% (by volume) inorganic sludge. These wastes are therefore classified as homogeneous wastes.

The incinerator sludges (IDC 292 and IDC 807) were characterized by the 3,100 m^3 Project in the *Characterization of Rocky Flats Plant Miscellaneous Cemented Sludge Waste Stream (292 and 807b),* INEEL/EXT-02-00112, and the WSP, INW222.001 [P287, P288]. A unique IDC number (696) was assigned to IDC 807 incinerator sludge in the INEEL TRIPS for the NDA systems to specifically distinguish the waste from IDC 807 Building 374 Sludge waste [C235]. The IDC associated with the drum and data sent to CBFO remained 807 to be in agreement with the WSP and associated characterization documents.

Fire brick wastes (IDCs 371 and 377) were estimated to be 80% or more (by volume) inorganic nonmetal debris that meets the CH-WAP criteria for classification as debris, and are therefore heterogeneous waste [P141]. The fire brick wastes (IDC 371 and IDC 377) were characterized by the 3,100 m^3 Project in the WSP, INW161.001 [P306].

14.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. There is no evidence that incinerator wastes exhibit any other characteristic of hazardous waste [C116]. The wastes were mixed with halogenated and nonhalogenated solvents, and are F-listed hazardous wastes. EPA HWNs applicable to some or all of the IDCs in the incinerator waste group are presented by IDC in Table 14-9.

Table 14-9. Incinerator Waste Characterization.

IDC	Title	EPA HWNs [a]
292	Incinerator Sludge (INW222.001 WSP)	D004-D011, D022, F001, F002, F003, F005, F006, F007, and F009[b]
371	Fire Brick (INW161.001 WSP)	D004-D011, F001, F002, F003, F005, F006, F007, and F009[b]
377	Coarse Fire Brick (INW161.001 WSP)	D004-D011, F001, F002, F003, F005. F006, F007, and F009[b]
420	Pulverized Incinerator Ash	D004-D011, F001, F002, F003, and F005
421	Ash Heel	D004-D011, F001, F002, F003, and F005
422	Soot	D004-D011, F001, F002, F003, and F005
423	Soot Heel	D004-D011, F001, F002, F003, and F005
425	Fluidized Bed Ash	D007 and F005
807	Cemented Incinerator Sludge (INW222.001 WSP)	D004-D011, D022, F001, F002, F003, F005, F006, F007, and F009[b]
818	Cemented Ash	D004-D011, F001, F002, F003, and F005
820	Cemented Soot	D004-D011, F001, F002, F003, and F005

a. The EPA HWNs are proposed based on AK and limited confirmatory analysis unless otherwise indicated by footnote.
b. The EPA HWNs are final per the WIPP approved WSP identified.

Characterization of FBI ash from Building 776 is supported by analytical data from samples of FBI ash taken from the Rocky Flats inventory. Samples were collected from drums of low-level ash waste. The FBI generated both TRU and low-level ash waste, and the analytical results should be applicable to the FBI ash in the INEEL inventory [P052, P125].

14.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23). The origin of the characteristic HWNs assigned to incinerator wastes is provided in Table 14-10. The table includes only the HWNs that are applicable to waste for which a specific source was identified. The HWNs are not applicable to waste generated from areas other than those listed in the table.

Table 14-10. Buildings of Origin for Characteristic Hazardous Waste Numbers.

IDC	EPA HWNs	Building/Area
292	D004-D011, D022	Building 771 Plutonium Recovery Incinerator (scrubber system sludge)
371	None	Building 371 LSA and HSA Incinerators
	D004-D011	Building 771 Plutonium Recovery Incinerator
377	None	Building 371 LSA and HSA Incinerators
	D004-D011	Building 771 Plutonium Recovery Incinerator

Table 14-10. (continued).

IDC	EPA HWNs	Building/Area
420	None	Building 371 LSA and HSA Incinerators
	D004-D011	Building 771 Plutonium Recovery Incinerator
421	D004-D011	Building 771 Plutonium Recovery Incinerator
422	None	Building 371 LSA and HSA Incinerators
	D004-D011	Building 771 Plutonium Recovery Incinerator
423	D004-D011	Building 771 Plutonium Recovery Incinerator
425	D007	Building 776 Fluidized Bed Incinerator (FBI)
807	D004-D011, D022	Building 771 Plutonium Recovery Incinerator (immobilized scrubber system sludge)

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and absorbents were added to wastes having the potential of generating free liquids [P024]. RTR and VE identified free liquids in several containers of incinerator sludge (IDC 292). However, sampling and analysis indicated that the liquids were aqueous with a pH of 12 [P015]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P024]. The materials are not compressed gases, and the drums do not contain compressed gases as confirmed by RTR and VE [P013, P015]. The materials are not DOT oxidizers as defined in 49 CFR 173.127. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid wastes, and absorbents were added to wastes having the potential of generating free liquids [P024]. Although RTR and VE identified free liquids in several containers of incinerator sludge (IDC 292), none of the drums that were shipped to WIPP had free liquids in excess of acceptable levels as defined in the CH-WAP (i.e., less than or equal to 1 inch of liquid in internal containers and less than or equal to 0.55 gal [2082 ml] total volume in a drum). Because none of the drums shipped to WIPP contained 20% by volume, aqueous waste (20% by volume is required in order to measure pH per the prescribed method in 40 CFR 261.22), the corrosive characteristic did not apply. Further, although IDC 292 was generated from filtering of caustic scrubber solution, nonrepresentative waste samples (i.e., free liquids only) indicated a pH range of 10.85 to 12 [P052, U060]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P013, P015]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides,

and other toxic compounds. The wastes in this group may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and chloroform.

Only nonhazardous materials were fed to the LSA and HSA incinerators in Building 371. Therefore, wastes generated from these incinerators do not exhibit the characteristic of toxicity [P052].

Wastes contaminated with alcohols, glycols, solvents, and metals from numerous processes may have been fed to the plutonium recovery incinerator in Building 771. The incinerator could have accepted any of the combustible, plastic, or filter wastes that were generated during the time it was operational. Therefore, it is possible that wastes generated from the plutonium recovery incinerator exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Analytical results of solid samples collected at the INEEL and used by the 3,100 m^3 Project to characterize the IDC 292 and IDC 807 wastes confirmed the presence of these metals, although only cadmium and lead had calculated UCL_{90}s greater than their respective regulatory threshold limits (RTLs) (Table 14-11) [P288, P287]. Waste streams associated with the plutonium recovery incinerator in Building 771 were assigned EPA HWNs D004-D011 [P052].

Table 14-11. Statistical Summary of Miscellaneous Cemented Sludge (INW222.001) Metals Data From the 3,100 m^3 Project (IDCs 292 and 807b) [P288, P287].

Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs Assigned[b]
Arsenic	27	26	3.88	7.56	15.0	8.56	100	D004
Barium	27	27	106	201	440	228	2,000	D005
Cadmium	27	27	215	108	960	163	20	D006
Chromium	27	27	61.8	76.6	270	9.2	100	D007
Lead	27	25	406	282	1,600	389	100	D008
Mercury	27	12	0.944	0.621	4.20	0.993	4	D009
Selenium	27	8	1.14	1.32	4.80	1.89	20	D010
Silver	27	15	1.55	1.18	6.10	1.72	100	D011

a. The Regulatory Threshold Limit (RTL) used is the TCLP limit (mg/l) for characteristic constituents multiplied by 20 to calculate the RTL for solid samples in mg/kg.

b. The HWNs are final per the WSP INW222.001 for IDCs 292 and 807b

Toxicity characteristic metals were not fed to the FBI in Building 776. FBI ash contains chromium because wastes were incinerated in fluidized beds of sodium carbonate and chromic oxide catalyst. Table 14-12 presents total and TCLP metals results from analysis performed on FBI ash. Although the total concentrations show barium, cadmium, chromium, and lead, the TCLP results indicate that only chromium was above the regulatory level. These results support the process knowledge that the ash contains chromium. Therefore, FBI ash (IDC 425) exhibits the characteristic of toxicity for chromium and is assigned EPA HWN [P052].

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating wastes fed to the incinerators. Therefore, the wastes in this group do not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Table 14-12. Metals Results for Fluidized Bed Ash [P125].

Compound	Concentration		Regulatory Level
	Total (mg/kg)[b]	TCLP (mg/L)[c]	TCLP (mg/L)
Arsenic	ND[a]	ND[a]-0.30	5.0
Barium	50.79-116.36	NDa-4.67	100.0
Cadmium	20.03-29.54	ND[a]	1.0
Chromium (Total)	7,020.41-15,750.84	89.0-113.96	5.0
Chromium (Hexavalent)	—	100.00-850.00	—
Lead	1,527.87-6,167.23	ND[a]-0.55	5.0
Silver	ND[a]	ND[a]-0.16	5.0

a. ND - Not Detected

b. mg/kg - milligrams per kilogram (parts per million)

c. mg/L - milligrams per liter (parts per million).

The plutonium recovery incinerator in Building 771 could have accepted any of the combustible, plastic, or filter wastes that were generated during the time the incinerator was operational, and feed wastes may have been contaminated with toxicity characteristic organic compounds including tetrachloroethylene, trichloroethylene, carbon tetrachloride, and benzene [P287]. These compounds were typically used for their solvent properties, and are specifically addressed in the RCRA treatment standards for listed hazardous waste. The wastes in this grouping are regulated as listed hazardous wastes (Section 14.3.1.2) and not characteristic wastes because of the presence of these compounds. Toxicity characteristic HWNs associated with the organic compounds listed above were not assigned to these wastes.

Paint thinner was used as feed material for the FBI in Building 776. A common component of paint thinner was methyl ethyl ketone. Methyl ethyl ketone was not detected in TCLP analysis of an FBI ash sample [P052]. Vinyl chloride, 1,1-dichloroethylene, chloroform, carbon tetrachloride, 1,2-dichloroethane, benzene, trichloroethylene, tetrachloroethylene, chlorobenzene, and 1,4-dichlorobenzene also were not detected in TCLP analysis. The toxicity characteristic HWNs for organic compounds (D018-D043) were not assigned to the FBI incinerator ash (IDC 425).

Analytical results for toxicity characteristic organic compounds from solid sampling of Building 771 plutonium recovery incinerator sludges (IDC 292 and IDC 807) by INEEL for the 3,100 m^3 Project are presented in Table 14-13. Carbon tetrachloride was the only organic compound detected in the solid samples with a UCL_{90} greater than its RTL. The toxicity characteristic HWN for carbon tetrachloride was not assigned because the waste carries the F001 and F002 listed HWNs for this compound. The data also indicated that the sludge wastes are not contaminated with any of the other organic toxic compounds as listed in the table [i.e., the UCL_{90} could not be calculated for any of the other analytes because all measurements (or all but one) were below the MDL] [P288, P287]. Toxicity characteristic HWNs were not assigned to the sludge wastes for these organic compounds. Other wastes (ash, ash heel, and soot) addressed in this section will need to be randomly sampled and analyzed for toxicity characteristic constituents to confirm AK and complete characterization.

Chloroform was identified in Section 9.0 as a possible contaminant of combustibles and plastics wastes that were fed to the plutonium recovery incinerator. This organic compound also was detected by INEEL in headspace gas samples used to support the WSP for IDC 292 and IDC 807 with a resultant

UCL_{90} greater than the PRQL [287]. However, the UCL_{90} calculated for the entire Miscellaneous Cemented Sludge waste stream was less than the PRQL (Table 14-16). The toxicity characteristic HWN (D022) was assigned to IDC 292 and IDC 807 wastes based on the WSP supporting data in compliance with the WAP [P286, P287, and P288].

Fire brick wastes (IDC 371 and IDC 377) were not sampled because they are heterogeneous wastes. However, the results obtained from sampling Building 771 incinerator wastes also may be applicable to fire brick wastes from this incinerator [P306].

Table 14-13. Miscellaneous Cemented Sludge Solid Sample Analysis Results for Organic Compounds From the 3,100 m^3 Project (IDCs 292 and 807b).

	Analyte	Total Number of Samples	Number of Samples above MDL[a]	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[c] (mg/kg)	EPA HWNs Assigned[e]
Volatiles	1,1-Dichloroethylene	22	1	0.282	0.464	1.33	b	14	N/A
	1,2-Dichloroethane	22	0	0.141	0.467	0.60	b	10	N/A
	Benzene	22	0	0.205	0.432	0.60	b	10	F005
	Carbon tetrachloride	22	2	4.83	1.62	23.0	12.1	10	F001/F002
	Chlorobenzene	22	0	0.205	0.432	0.600	b	2,000	N/A
	Chloroform	22	2	0.577	0.568	2.85	1.82	120	D022
	Methyl ethyl ketone	27	1	4.99	2.92	22.8	b	4,000	N/A
	Pyridine	27	1	3.84	2.55	15.3	b	100	N/A
	Tetrachloroethylene	22	2	0.729	0.647	2.90	2.23	10	F001/F002
	Trichloroethylene	22	1	0.643	0.564	3.30	b	10	F001/F002
	Vinyl chloride	22	0	0.193	0.439	0.600	b	4	N/A
Semivolatiles	1,4-Dichlorobenzene	27	0	2.29	0.527	12.0	b	150	N/A
	2,4-Dinitrotoluene	22	0	0.007	0.100	0.110	b	2.6	N/A
	Cresols	27	0	1.91	0.441	10.0	b	4,000	N/A
	Hexachlorobenzene	26[d]	7	0.798	0.297	4.10	0.731	2.6	N/A
	Hexachloroethane	27	0	2.10	0.490	11.0	b	60	N/A
	Nitrobenzene	27	0	2.10	0.487	11.0	b	40	N/A
	Pentachlorophenol	27	0	1.80	0.510	9.50	b	2,000	N/A

a. When a measurement was reported as below detection, one-half the analysis MDL was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The statistical parameters presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. The toxicity characteristic limit expressed as the RTL was used.

d. If the MDL exceeded the RTL (affecting one data point), that data was not used to calculate the statistical parameters.

e. The HWNs are final per the WSP INW222.001 for IDCs 292 and 807b.

14.3.1.2 Listed Hazardous Waste. The materials in this waste group were derived from the treatment of listed waste as defined in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31). The wastes are not, or were not derived from the treatment of, hazardous wastes from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The origin of the listed HWNs assigned to incinerator wastes are provided in Table 14-14. The table includes the HWNs that are applicable to waste for which a specific source was identified. The HWNs are not applicable to waste generated from areas other than those listed in the table.

Table 14-14. Buildings of Origin for Listed Hazardous Waste Numbers.

IDC	EPA HWNs	Building/Area
292	F001, F002, F003, F005, F006, F007, and F009	Building 771 Plutonium Recovery Incinerator (scrubber system sludge)
371	None	Building 371 LSA and HSA Incinerators
	F001, F002, F003, and F005	Building 771 Plutonium Recovery Incinerator
377	None	Building 371 LSA and HSA Incinerators
	F001, F002, F003, and F005	Building 771 Plutonium Recovery Incinerator
420	None	Building 371 LSA and HSA Incinerators
	F001, F002, F003, and F005	Building 771 Plutonium Recovery Incinerator
421	F001, F002, F003, and F005	Building 771 Plutonium Recovery Incinerator
422	None	Building 371 LSA and HSA Incinerators
	F001, F002, F003, and F005	Building 771 Plutonium Recovery Incinerator
423	F001, F002, F003, and F005	Building 771 Plutonium Recovery Incinerator
425	F005	Building 776 Fluidized Bed Incinerator (FBI)
807	F001, F002, F003, F005, F006, F007, and F009	Building 771 Plutonium Recovery Incinerator (immobilized scrubber system sludge)

Only nonhazardous materials were fed to the LSA and HSA incinerators in Building 371. Therefore, wastes generated from these incinerators are not listed hazardous wastes [P052].

Tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were used for cleaning and degreasing. Methylene chloride was used primarily for paint removal. Combustible, plastic, and filter wastes contaminated with these compounds may have been fed to the plutonium recovery incinerator in Building 771. The waste streams associated with the Building 771 plutonium recovery incinerator are assigned EPA HWNs F001 and F002. Since process knowledge indicates that halogenated solvents were not fed to the FBI, EPA HWNs F001 and F002 will not be applied to FBI ash [P052].

Combustible, plastic, and filter wastes contaminated with acetone, methanol, and xylene may have also been fed to the plutonium recovery incinerator in Building 771. These nonhalogenated solvents are listed solely for the characteristic of ignitability, and even though the plutonium recovery incinerator waste streams do not exhibit this characteristic, these solvents may have been commingled and may have been ignitable at the point of generation. As a conservative measure, the waste streams associated with the Building 771 plutonium recovery incinerator were assigned the EPA HWN F003.

Methanol was used as feed material for the FBI [P052]. Methanol is listed as an F003 waste solely for the characteristic of ignitability; however the FBI waste is not a liquid and therefore does not exhibit the characteristic of ignitability. Therefore, IDC 425 is not an F003-listed hazardous waste.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating wastes fed to the incinerators. Therefore, the F004 HWN is not applicable to the wastes in this group.

Benzene and toluene were used as solvents in laboratory operations. The combustible wastes that fed the plutonium recovery incinerator may have been contaminated with these solvents. Benzene and toluene were detected in several headspace gas samples collected at the INEEL for the 3,100 m^3 Project for IDC 292 and IDC 807 wastes (Table 14-16). The UCL_{90} for benzene was well below the PRQL, while the UCL_{90} for toluene was above the PRQL [P288]. The paint thinner fed to the FBI, may have contained toluene and methyl ethyl ketone (common components of paint thinner). Analysis of a single sample of FBI ash confirms the presence of listed solvents. Toluene and methyl ethyl ketone were detected at the highest concentrations in the waste. Several other organic solvents were detected in the FBI ash, but at low concentrations (less than 0.2 mg/kg) [P052]. The plutonium recovery incinerator and FBI wastes were derived from the treatment of listed hazardous waste and were assigned EPA HWN F005 [P052].

The statistical evaluations of recent headspace gas sampling results for the fire brick (IDC 371 and IDC 377) and the miscellaneous cemented incinerator sludges (IDC 292 and IDC 807) waste streams compiled for the 3,100 m^3 Project are presented in Tables 14-15 and 14-16, respectively. This data confirmed the presence of 1,1,1-trichloroethane, carbon tetrachloride, toluene, and trichloroethylene with UCL_{90}s greater than their PRQLs in samples collected from fire brick waste containers. The presence of acetone, benzene, methylene chloride, tetrachloroethylene, and xylene was also confirmed for some containers, although their calculated UCL_{90}s for the waste stream were below their PRQLs (Table 15-12). The presence of 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, acetone, benzene, carbon tetrachloride, chloroform, methylene chloride, tetrachloroethylene, toluene, trichloroethylene, and xylene was confirmed for the IDC 292 and IDC 807 incinerator sludges (Table 14-16). However, only 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, and toluene had calculated UCL_{90}s are greater than their respective PRQLs [P324, P306].

In addition to the recent INEEL headspace gas sampling results, headspace analysis performed on samples of incinerator wastes (IDCs 292, 371, 422, and 818) obtained at INEEL, reported in 1995, confirmed the presence of F-listed solvents. The detected F-listed compounds in which the calculated UCL_{90} was above the PRQL were as follows: [P033]

- 1,1,1-trichloroethane (IDCs 292, 371, and 422 only)
- 1,1,2-trichloro-1,2,2-trifluoroethane (IDC 422 only)
- carbon tetrachloride (IDC 371 only)
- methylene chloride (IDC 422 only)
- toluene (IDCs 292 only)
- trichloroethylene (IDC 371 only).

Toluene was also detected in the headspace of a single sample of coarse fire brick (IDC 377) obtained from Rocky Flats inventory.

Table 14-15. Statistical Evaluation of all the Fire Brick and Coarse Fire Brick (INW161.001) HSG Data From the 3,100 m^3 Project [P324, P306].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs[f]
1,1,1-Trichloroethane	73	58	45.2	122	970	66.0	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	73	0	0.136	0.289	1.85	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	73	1	0.097	0.275	2.10	b	10	F001/F002[d]
1,1-Dichloroethane	73	5	0.210	0.412	2.45	0.492	10	N/A
1,1-Dichloroethylene	72	14	1.26	3.67	24.0	2.59	10	N/A
1,2,4-Trimethylbenzene	73	4	0.133	0.239	1.45	0.329	10	N/A
1,2-Dichloroethane	73	11	0.244	0.507	2.80	0.453	10	N/A
1,3,5-Trimethylbenzene	73	4	0.185	0.408	2.70	0.520	10	N/A
Acetone	73	63	7.23	8.03	32.0	8.54	100	F003[d]
Benzene	73	18	0.200	0.330	2.00	0.304	10	F005[d]
Bromoform	73	0	0.091	0.214	1.40	b	10	N/A
Butanol	73	5	0.315	0.558	3.00	0.697	100	N/A
Carbon tetrachloride	73	16	8.17	64.4	550	29.7	10	F001[e]
Chlorobenzene	73	0	0.150	0.322	2.10	b	10	N/A
Chloroform	73	57	2.37	6.13	47.0	3.42	10	N/A
Cis-1,2-dichloroethylene	73	1	0.221	0.504	3.35	b	10	N/A
Cyclohexane	73	0	0.160	0.324	2.05	b	10	N/A
Ethyl benzene	73	2	0.243	0.577	3.85	1.50	10	N/A
Ethyl ether	73	0	0.178	0.335	2.00	b	10	N/A
Methanol	73	0	2.93	4.45	33.9	b	100	F003[d]
Methyl chloride	5	1	0.648	0.547	1.30	b	10	N/A
Methyl ethyl ketone	73	43	0.897	1.17	6.00	1.13	100	N/A
Methyl isobutyl ketone	73	4	0.176	0.394	2.60	0.498	100	N/A
Methylene chloride	73	34	2.63	10.7	90.0	5.02	10	F002[d]
Tetrachloroethylene	73	15	0.687	2.02	14.0	1.39	10	F001/F002[d]
Toluene	73	65	9.40	63.0	540	19.5	10	F005[e]
Trans-1,2-dichloroethylene	73	0	0.131	0.266	1.70	b	10	N/A
Trichloroethylene	73	16	40.9	109	570	77.5	10	F001/F002[c]
m&p-Xylene	73	4	0.192	0.404	2.65	0.523	10	F003[d]
o-Xylene	73	3	0.198	0.443	2.95	0.680	10	F003[d]

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. HWN originally assigned in the WSPF based solely on AK; the assignment was subsequently confirmed by HSG analysis.

f. The HWNs are final per the WSP INW161.001.

Table 14-16. Statistical Evaluation of all Miscellaneous Cemented Sludge (IDCs 292 and 807b) HSG Data From the 3,100 m^3 Project, INW222.001 [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum[c] (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs[e]
1,1,1-Trichloroethane	200	129	18.8	44.8	300	23.8	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	200	0	0.101	0.183	1.60	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	200	13	2.36	31.8	450	14.3	10	F001/F002[c]
1,1-Dichloroethane	200	19	0.253	1.14	15.0	0.602	10	N/A
1,1-Dichloroethylene	200	20	0.331	0.860	6.58	0.586	10	N/A
1,2,4-Trimethylbenzene	200	20	0.128	0.225	1.65	0.195	10	N/A
1,2-Dichloroethane	200	1	0.120	0.219	2.00	b	10	N/A
1,3,5-Trimethylbenzene	200	11	0.111	0.186	1.65	0.188	10	N/A
Acetone	200	76	1.27	4.14	43.0	1.88	100	F003[d]
Benzene	200	101	0.216	0.439	5.20	0.272	10	F005[d]
Bromoform	200	0	0.052	0.091	0.800	b	10	N/A
Butanol	200	40	0.514	1.87	22.2	0.900	100	N/A
Carbon tetrachloride	200	94	2.23	20.9	290	5.01	10	F001/F002[d]
Chlorobenzene	200	0	0.088	0.160	1.40	b	10	N/A
Chloroform	200	13	0.491	3.71	45.0	1.89	10	D022[d]
Cis-1,2-dichloroethylene	200	2	0.139	0.285	2.40	0.760	10	N/A
Cyclohexane	200	99	0.688	0.898	4.60	0.804	10	N/A
Ethyl benzene	200	18	0.141	0.230	1.30	0.213	10	N/A
Ethyl ether	200	0	0.214	0.395	2.80	b	10	N/A
Methanol	200	1	4.93	6.84	44.4	b	100	F003[d]
Methyl chloride	125	21	0.372	1.05	11.0	0.675	10	N/A
Methyl ethyl ketone	200	12	0.303	0.613	5.70	0.544	100	N/A
Methyl isobutyl ketone	200	13	0.159	0.370	3.90	0.298	100	N/A
Methylene chloride	200	36	1.46	9.21	128	3.46	10	F002[d]
Tetrachloroethylene	200	40	0.163	1.07	15.0	0.383	10	F001/F002[d]
Toluene	200	199	17.0	11.4	59.0	18.1	10	F005[c]
Trans-1,2-dichloroethylene	165	1	0.114	0.177	1.19.0	b	10	N/A
Trichloroethylene	200	35	0.766	2.93	27.0	1.41	10	F001/F002[d]
m&p-Xylene	200	25	0.293	0.988	12.0	0.553	10	F003[d]
o-Xylene	200	13	0.169	0.470	5.70	0.345	10	F003[d]

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.
b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.
c. HWN assigned based on AK and confirmatory HSG analysis.
d. HWN assigned based solely on AK.
e. The HWNs are final per the waste stream profile INW222.001.

VE of some IDC 292 containers identified Ful-Flo filters, empty cement bags, and unused polyethylene bags. These additional miscellaneous waste items comprise less than 10% of the waste stream. It was also assumed that IDC 371 and IDC 377 fire brick wastes could contain up to 10% of combustible and plastic wastes. The mixture rule (40 CFR 261.3(a)(2)(iv)) was applied to these two waste streams in their respective waste steam profiles due to the presence of filter media (on the assumption that the Ful-Flo filters were electroplating waste items) or combustible and plastic wastes, and the EPA HWNs F006, F007, and F009 were assigned to both waste streams. [P286, 287, P288, and P306].

The materials in this waste group are not hazardous waste from specific sources because they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous wastes.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

14.3.2 Radionuclides

The combustible wastes processed by the Building 771 incinerator were contaminated primarily with weapons-grade plutonium and americium-241 [P163]. However, combustibles sent to the incinerator were generated by numerous production processes, and incinerator wastes also will be contaminated with enriched uranium. Documented assay results for IDC 377 confirm the presence of uranium-235 [P016].

Approximately 90 wt% of the bulk is exhausted from the incinerator system as combustion product gases. All radionuclide contaminants remain behind after combustion resulting in an ash having a plutonium concentration of up to 10 weight percent [C180, P035, P163]. The sludge and soot removed from the off-gas system, and the fire brick incinerator liner removed during maintenance activities will contain most of the same constituents as the combustible feed material from which they were derived [P035].

The pilot-scale fluidized-bed incinerator (container prefix 0075) was developed in Building 776 to treat low-level wastes [C184, U059]. The wastes fed to the incinerator were contaminated with low-levels of plutonium [P024]. Analysis indicates that the plutonium is weapons-grade [P125].

It is not known where the wastes fed to the Building 371 incinerators originated. It is assumed that the combustible wastes originated from the same areas as those processed by the Building 771 incinerator and, therefore, could be contaminated with weapons-grade plutonium, americium-241, and enriched uranium. Since these incinerators never became operational, and ran only for the startup operation test program, only a small amount of waste would have been generated.

In addition to the incinerators in Building 371, Building 371 immobilized residues in cement from plutonium recovery operations in preparation for shipment. Residues immobilized may include Building 771 incinerator sludge or other incinerator wastes [P067].

Solid waste treatment, repackaging, and size reduction operations were conducted in the SRV in Building 776. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked incinerator waste containers have the potential to contain contaminated materials from any of the incineration processes [P067, U077].

The physical and chemical forms of the radionuclides expected to be present and any waste components that could effect radioassay measurements are summarized in Table 14-17.

Table 14-17. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	IDC 292: Radionuclide contaminants are in hydroxide form because IDC 292 sludge was produced from filtering potassium hydroxide scrubber solution [P052, P061].
	IDCs 371/377: The surface of the fire brick was contaminated with a "glaze" of actinide oxides [P035].
	IDC 420: Radionuclides may be in the form of oxides or chlorides [P163]. Analysis indicates 1.8-3.8 wt% plutonium oxide [C180].
	IDC 421: Solids were filtered out of plutonium nitrate solution and dried on a hotplate and are assumed to be in an oxide form [P163].
	IDC 422: Radionuclides may be in the form of oxides or chlorides [P163].
	IDC 425: Radionuclides may be in the form of oxides or chlorides [P052].
Hydrogen Content	IDC 292: Headspace gas analysis indicates 1.8-23.2 vol% hydrogen and an average of less than 0.5 vol% hydrocarbons [P015].
	IDCs 371/377: Headspace gas analysis of IDC 371 indicates hydrogen from 17.1 vol% to none detected and an average of 0.35 vol% hydrocarbons. One sample of IDC 377 indicated 0.02 vol% hydrogen and 0.04 vol% hydrocarbons [P015].
	IDC 420: Measured water content of 0.4 to 1.0 wt%. Water and hydrocarbon content of ash could exceed 10 wt% based on water content and loss on ignition data [C180].
	IDC 421: Measured water content of 1.4 to 3 wt%. Water and hydrocarbon content could exceed 10 wt% based on water content and loss on ignition data for ash [C180].
	IDC 422: Small quantities of hydrocarbons have been detected in headspace gas samples [P033].
	IDC 425: Analysis indicates 1.11% moisture content [P125].
Other Interfering Waste Contaminants	IDC 292: May contain trace amounts of beryllium and cadmium [P035].
	IDCs 371/777: Typically comprised of 96% aluminum oxide [P024, P035].
	IDC 420: Analysis indicates 0.95-5.7 wt% aluminum oxide, 0.83-8.3 wt% magnesium oxide, and 0.44-0.88 wt% chromium (III) oxide [C180]. An average of 0.6 wt% fluoride and 2.5 wt% chloride were also measured [P035].
	IDC 421: In general, ash heel will contain the same constituents as ash. Calcium fluoride and aluminum nitrate may also be present [P163].
	IDC 422: May contain minor amounts of aluminum oxide [P035].
	IDC 425: Contains chromium oxide, aluminum oxide, and sodium chloride [P052]. Analysis indicates 4.1-9.5% aluminum, 208-342 ppm magnesium, 23-25 ppm boron, 0.2-3.2% chloride, and 24-3600 ppm fluoride [P125]. See Table 14-4 for cadmium and chromium concentrations.

Table 14-17. (continued).

Parameter	Results of Evaluation
Physical Matrix Parameters	IDC 292: Damp mass with past consistency to a dryer mass containing some fines [P035].
	IDCs 371/377: The surface of the fire brick is contaminated with a "glaze" containing various metal oxides. The density of fire brick is 2.44 g/cm^3 [P035].
	IDC 420: Mixture of coarse, granular, fine, and very fine (less than 100 mesh) particulate. Ash will contain some metal and unburned feed materials [P035].
	IDC 421: Mixture of fine and very fine (less than 100 mesh) particulate] [P035].
	IDC 422: Mixture of fine and very fine (less than 100 mesh) particulate] [P035].
	IDC 425: Particle size data indicate 52.6 wt% is 500-1000 μm, 24.2 wt% is 212-500 μm, and 13.3 wt% is greater than 1000 μm] [P125].

14.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix.

Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1 [P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P286, P306].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 14-18. The building or area of generation for containers in the INEEL inventory is identified by container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The generation dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 14-18. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
292	371	0011	Note a	10/23/85 - 5/1/86	WG Pu, EU, ^{241}Am
292	371	0032	Aqueous Recovery	11/5/83 - 9/24/85	WG Pu, EU, ^{241}Am
292	371	0048	Note a	7/27/82	WG Pu, EU, ^{241}Am
292	371	0076	Note b	3/18/81 - 3/18/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
292	771	0001	Aqueous Recovery	5/28/80 - 2/5/86	WG Pu, EU, ^{241}Am
292	771	0002	Aqueous Recovery	9/25/81 - 8/14/85	WG Pu, EU, ^{241}Am
292	776	0003	Pyrochemical Operations	6/16/83	WG Pu, EU, ^{241}Am
292	776	0019	Size Reduction	9/8/83 - 8/12/86	WG Pu, EU, ^{241}Am
292	776	0025	Drum Repack	7/13/84 - 3/29/85	WG Pu, EU, ^{241}Am
292	776	0040	Waste Processing/Final Packaging	6/16/80 - 9/14/82	WG Pu, EU, ^{241}Am
292	776	0041	Waste Processing/Final Packaging	4/3/84	WG Pu, EU, ^{241}Am
292	776	0075	Waste Processing Development	4/17/85 - 4/17/85	WG Pu
371	any	0089	Note b	12/26/72 - 4/5/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
371	771	0001	Aqueous Recovery	1/3/73	WG Pu, EU, ^{241}Am
371	771	0002	Aqueous Recovery	2/8/73 - 5/18/87	WG Pu, EU, ^{241}Am
371	776	0019	Size Reduction	6/4/84 - 2/18/86	WG Pu, EU, ^{241}Am
371	776	0025	Drum Repack	4/30/84 - 4/23/85	WG Pu, EU, ^{241}Am
377	771	0002	Aqueous Recovery	5/18/87 - 6/11/87	WG Pu, EU, ^{241}Am
377	776	0025	Drum Repack	3/29/85	WG Pu, EU, ^{241}Am
420	771	0001	Aqueous Recovery	12/6/83	WG Pu, EU, ^{241}Am
422	371	0011	Operations within Building 371	1/29/86 - 2/6/86	WG Pu, EU, ^{241}Am
422	771	0001	Aqueous Recovery	3/18/82 - 6/3/83	WG Pu, EU, ^{241}Am
422	779	0010	Pyrochemical Technology	3/7/85	prefix/IDC conflict
425	776	0075	Waste Processing Development	7/21/81 - 7/24/81	WG Pu
807	371	0011	Operations within Building 371	10/23/85 - 7/9/87	WG Pu, EU, ^{241}Am
807	371	0032	Aqueous Recovery	4/21/86	WG Pu, EU, ^{241}Am
807	776	0019	Size Reduction	11/17/86	WG Pu, EU, ^{241}Am
818	371	0011	Operations within Building 371	10/13/86 - 10/24/86	WG Pu, EU, ^{241}Am
820	371	0011	Operations within Building 371	1/1/86 - 10/22/86	WG Pu, EU, ^{241}Am

a. This prefix was assigned to an MBA in Building 371 that was not defined or was redefined after this waste was generated. It was assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

b. Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompasses all RF buildings and processes that generated fire brick transuranic wastes. The characterization brackets the miscellaneous fire brick wastes generated in these time periods and identified by these IDCs and container prefixes.

WG = weapons grade DU = depleted uranium EU = enriched uranium

14.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the Fire Brick and Coarse Fire Brick waste stream (IDCs 371 and 377) are summarized in Tables 14-19 and 14-20. The overall yield for the fire brick waste radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 14-19 and Table 14-20 present the yield and the radionuclide and related radioassay information, respectively.

Table 14-19. Overall Radioassay Yield for the Fire Brick and Coarse Fire Brick Waste Stream [P322].

Container Status	Total Number of Containers	Percent Yield
Distinct containers	131	
"WIPPOK" containers	102	78%
"Treatment" containers	0	
"Deficient / Permanently Rejected" containers	29	22%

Table 14-20. Radionuclide and Related Quantities for the Fire Brick and Coarse Fire Brick Waste Stream[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	2.264E+00	2.670E+00	1.125E-04	2.385E+01	123
TRU Activity (Ci)	2.213E+00	2.612E+00	1.075E-04	2.320E+01	123
TRU Activity Concentration (nCi/g)	3.816E+04	4.334E+04	1.093E+00	3.654E+05	123
Thermal Power (W)	6.907E-02	8.237E-02	6.627E-10	7.333E-01	125
Thermal Power Density (W/ft^3)	9.403E-03	1.121E-02	9.022E-11	9.984E-02	125
Plutonium Fissile Gram Equivalent (g)	2.663E+01	3.438E+01	7.101E-05	3.175E+02	125
Americium-241 (g)	6.784E-02	7.449E-02	1.679E-03	4.490E-01	117
Plutonium-238 (g)	3.086E-03	3.586E-03	1.544E-07	3.188E-02	121
Plutonium-239 (g)	2.584E+01	3.164E+01	1.383E-03	2.899E+02	121
Plutonium-240 (g)	1.602E+00	1.998E+00	8.412E-05	1.850E+01	121
Plutonium-241 (g)	3.707E-02	4.278E-02	2.544E-06	3.451E-01	121
Plutonium-242 (g)	8.180E-03	1.056E-02	6.324E-07	8.670E-02	121
Uranium-233 (g)	ND	ND	ND	ND	0
Uranium-234 (g)	3.942E-03	7.662E-03	1.180E-05	4.029E-02	51
Uranium-235 (g)	3.739E+00	7.181E+00	1.097E-02	3.747E+01	50
Uranium-238 (g)	5.596E+00	7.315E-01	5.079E+00	6.113E+00	2

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. This also verifies the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

Radioassay data collected in the 3,100 m^3 Project for the Miscellaneous Cemented Sludge waste stream (IDCs 292 and 807) are summarized in Tables 14-21 and 14-22. Again, the overall yield for the sludge radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 14-21 and Table 14-22 present the yield and the radionuclide and related radioassay information, respectively. The data for the individual radioassay systems information for both waste streams are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 14-21. Overall Radioassay Yield for the Miscellaneous Cemented Sludge Waste Stream (INW222.001) (IDCs 292 and 807b) [P322].

Container Status	Total Number of Containers	Percent Yield
Distinct containers	464	
"WIPPOK" containers	410	88%
"Treatment" containers	1	0.2%
"Deficient / Permanently Rejected" containers	53	11%

Table 14-22. Radionuclide and Related Quantities for the Miscellaneous Cemented Sludge Waste Stream (INW222.001) (IDCs 292 and 807b)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	1.581E+00	1.898E+00	-5.941E-03	1.327E+01	459
TRU Activity (Ci)	1.568E+00	1.902E+00	-5.953E-03	1.330E+01	459
TRU Activity Concentration (nCi/g)	1.653E+04	2.591E+04	-2.884E+01	2.239E+05	459
Thermal Power (W)	4.953E-02	6.004E-02	-1.865E-04	4.179E-01	459
Thermal Power Density (W/ft^3)	6.740E-03	8.169E-03	-2.537E-05	5.686E-02	459
Plutonium Fissile Gram Equivalent (g)	1.741E+01	2.025E+01	-7.026E-02	1.499E+02	459
Americium-241 (g)	6.197E-02	1.429E-01	-1.285E-04	2.111E+00	455
Plutonium-238 (g)	2.071E-03	2.304E-03	-7.800E-06	1.660E-02	458
Plutonium-239 (g)	1.726E+01	2.014E+01	-6.987E-02	1.487E+02	458
Plutonium-240 (g)	1.054E+00	1.223E+00	-4.249E-03	9.043E+00	458
Plutonium-241 (g)	2.943E-02	3.698E-02	-1.285E-04	2.735E-01	458
Plutonium-242 (g)	6.714E-03	9.303E-03	-3.194E-05	6.798E-02	459
Uranium-233 (g)	6.120E-02	4.650E-02	7.080E-03	1.267E-01	6
Uranium-234 (g)	2.163E-03	1.063E-02	2.242E-05	7.137E-02	46
Uranium-235 (g)	7.563E-01	3.627E+00	1.518E-03	2.633E+01	54
Uranium-238 (g)	1.312E+03	3.560E+03	1.655E+00	1.297E+04	13

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

c. The negative low values are from the "Deficient / Permanently Rejected" category. These assays are outside the systems capabilities. Since this report is merely summarizing the data stored in TRIPS the values were left in for completeness.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

An additional five containers from the incinerator waste group were assayed as one waste stream during the 3,100 m^3 Project with the PAN/Gamma. The wastes included in this category are incinerator ash (IDC 420), soot (IDC 422), and fluid bed ash (IDC 425). The radionuclide and related radioassay information for these wastes is presented in Table 14-23. As indicated in the table, only five drums were assayed. These IDCs were not included in the INW292.001 or INW161.001 WSPs and no drums were shipped to the WIPP facility. The data for the individual radioassay systems information are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 14-23. Radionuclide and Related Quantities for Incinerator Ash (IDC 420), Soot (IDC 422), and Fluid Bed Ash (IDC 425) wastes[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	6.249E+00	1.366E+01	-6.800E-05	3.068E+01	5
TRU Activity (Ci)	6.266E+00	1.370E+01	-6.800E-05	3.076E+01	5
TRU Activity Concentration (nCi/g)	1.553E+05	3.442E+05	-5.373E-01	7.710E+05	5
Thermal Power (W)	1.968E-01	4.302E-01	-2.000E-06	9.662E-01	5
Thermal Power Density (W/ft^3)	3.347E-02	6.533E-02	2.700E-05	1.315E-01	4
Plutonium Fissile Gram Equivalent (g)	7.108E+01	1.547E+02	-7.840E-04	3.478E+02	5
Americium-241 (g)	1.961E-01	4.300E-01	-2.000E-06	9.652E-01	5
Plutonium-238 (g)	1.393E-02	2.718E-02	4.000E-06	5.469E-02	4
Plutonium-239 (g)	6.979E+01	1.525E+02	-7.800E-04	3.425E+02	5
Plutonium-240 (g)	4.361E+00	9.528E+00	-4.900E-05	2.140E+01	5
Plutonium-241 (g)	1.040E-01	2.273E-01	-1.000E-06	5.105E-01	5
Plutonium-242 (g)	2.322E-02	4.530E-02	7.000E-06	9.116E-02	4
Uranium-233 (g)	1.796E-02	N/A	1.796E-02	1.796E-02	1
Uranium-234 (g)	3.905E-03	N/A	3.905E-03	3.905E-03	1
Uranium-235 (g)	2.383E+00	1.768E+00	1.133E+00	3.633E+00	2
Uranium-238 (g)	4.234E+01	N/A	4.234E+01	4.234E+01	1

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. This also verified the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available. N/A = Not Applicable. The standard deviation is not applicable for a single measurement.

c. The negative low values are from the "Deficient / Permanently Rejected" category. These assays were outside the systems capabilities. Since the data stored in TRIPS was merely summarized in the report, the values were left in for completeness.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

14.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant, including wiping down filter frames. If combustibles fed to the incinerator were contaminated with these complexing agents, incinerator wastes may contain trace quantities of these compounds.

14.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the Fire Brick and Coarse Fire Brick waste stream (IDCs 371 and 377), the yield of successful RTR examinations was approximately 98% [P323]. Conversely, approximately 2% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: the containers did not meet criteria for protection against sharp objects and presence of excess free liquids [P323].

For the Miscellaneous Cemented Sludge waste stream (IDCs 292 and 807b), the yield of successful RTR examinations was approximately 81.5% [P323]. Conversely, approximately 18.5% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: presence of excess free liquids, the presence of sealed inner containers greater than 4 liters; and the layers of confinement were exceeded for the assigned shipping category [P323].

There were two other IDCs that had containers examined by RTR for the 3,100 m^3 Project, IDC 818, Cemented Incinerator Ash and IDC 820, Cemented Soot. The yield of successful RTR examinations for both of these IDCs was 100%. The numbers of containers examined for IDCs 818 and 820 were 7 and 25, respectively.

VE indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

15. LEAD–CONTAINING WASTE

This waste group consists of lead-containing wastes generated by the production, recovery, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations. The waste was generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779, and consists primarily of heavy non-special source (non-SS) metal, lead, leaded rubber glovebox gloves, and leaded aprons [P001, P012]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 15-1 [U092].

Leaded rubber gloves and aprons (IDC 339) were characterized under the CBFO WSP, INW252.001 [P305, P308]. Although a WSP (INW298.001) was initially planned for the tantalum (IDC 320) and lead (IDC 321) wastes, it was determined that due to the density of the waste materials, the drums could not be sufficiently characterized by radioassay [P322].

Table 15-1. Lead-Containing Wastes in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
320	Tantalum [C063] Heavy Non-SS Metal [P001]	July 1979 – June 1988
321	Lead [P012]	October 1987-November 1987
339	Leaded Rubber Gloves and Aprons [C063] Leaded Drybox Gloves and Other Leaded Rubber [C063] Leaded Drybox Gloves, Not Acid Contaminated [P001]	August 1980 – July 1988

Item Description Code 320, Heavy Non-SS Metal: This waste consists of heavy non-SS metals generated in Buildings 371, 559, 707, 771, 776, 777, and 779 [P016, U092, U059]. Heavy non-SS metals include metals above copper on the periodic table. Tantalum items include crucibles, funnels, boats, process fixtures, pour rods, stir rods, and various other equipment that were used to handle molten plutonium [P001, P014, P016, P083]. The waste consists primarily of tantalum but also includes metals such as tungsten, platinum, and depleted uranium [P083]. Mercury containing devices (i.e., batteries, thermometers, gauges, and switches) may also be present [P052]. In addition, prior to 1987, the waste could contain lead materials such as bricks, tape, sheeting, and glovebox parts. IDC 321 was created in 1987 specifically for lead waste [P016]. IDC 320 was redefined from tantalum to heavy non-SS metal in 1985 to be more inclusive [C063].

Item Description Code 321, Lead: This waste consists primarily of radiation shielding in the form of lead bricks, tape, sheeting, and glovebox port covers [P016, P037, P049, P083, P116]. This IDC may also contain lead-acid batteries [P052]. The waste was generated by production operations in Building 707 and recovery, purification, and size reduction activities Building 776 [U092, U059]. IDC 321 was created in 1987 to sort lead waste from other heavy metals [C050, P016].

Item Description Code 339, Leaded Drybox Gloves: This waste consists of leaded drybox (glovebox) gloves and leaded aprons generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P049, P083]. Leaded gloves were used in gloveboxes to reduce radiation exposure to personnel. IDC 339 also includes lead aprons that were also used to reduce radiation exposure. Leaded gloves were fabricated with three layers: a neoprene layer, a lead oxide layer, and a Hypalon layer [P035, P012]. Two types of leaded gloves were used: S6 and S2P2. The only differences in these two types of gloves were the weight of the gloves and the thickness of the Hypalon layer [P016, C051]. Prior to 1986, all leaded glovebox gloves, both acid contaminated and not acid contaminated, were accumulated together as IDC 339. In 1986, IDC 341 was created to sort gloves that were generated in an environment where they

may have been exposed to acid [C050, P035]. The major concern was that nitric acid would react with the lead oxide layer of the gloves and form reactive lead nitrate, organic nitrates, or nitro-organic compounds [P016, P024, P120, C096].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the leaded rubber gloves and aprons waste (IDC 339) are listed in Table 15-2 [P305]. Typical waste material parameters, including typical packaging materials for the waste as identified for the 3,100 m^3 Project are presented in Table 15-3 [P305].

Table 15-2. Items Identified by RTR for Leaded Rubber Gloves and Aprons Waste (IDC 339) During the 3,100 m^3 Project [P305].

Item[a]	Comment
Miscellaneous Metal Items	Electrical wire waste material was identified during RTR examination.
Glass	RTR examination identified a small amount of glass waste material. This glass has not been identified as leaded glass
Iron based metals/alloys	A small amount of iron-based metals/alloys was identified during RTR examination.
Inorganic liquid	The RTR examination indicated the presence of residual liquid. Containers with liquids above the WAC were not shipped to the WIPP. Compliance with the WAC free liquids criteria was confirmed using RTR and VE.

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to the WIPP.

Table 15-3. Typical Waste Material Parameters for Leaded Rubber Gloves and Aprons Waste (IDC 339) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gal drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Cellulosics	Fiberboard liner and disks, cloth and paper items
Plastics (waste material)	Poly bags, poly bottles
Other Metals	Leaded gloves, lead liner
Rubber	Neoprene, Hypalon®
Other Inorganic Materials	Vermiculite, Oil-Dri®

15.1 Waste Generation

Lead-containing wastes were generated by production, recovery, purification, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations at the site. Process flow diagrams for lead-containing waste generating processes are provided in archived WSRIC information [P060, P061, P062, P070, P077, P078, P079, P081, P082].

15.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the construction of Building 707 in 1972. Building 707 was constructed after the 1969 fire in Building 776 which shut down foundry and machining operations in that building [P053].

The foundry in Building 707 cast molten plutonium into classified components, subassemblies, and assemblies. Other parts were manufactured by rolling, forming, and machining plutonium ingots also cast in the foundry. Components were assembled using a number of welding and joining techniques in Buildings 707, 777, and 7715. Production support operations in Buildings 707 and 777 included a variety of inspection, calibration, measurement, weighing, leak testing, and cleaning activities to assure that the parts met stringent specifications. Rejected plutonium parts, scraps, and turnings were returned to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to Building 771 to be recovered [P052, P053].

Plutonium metal was placed in tantalum crucibles and funnels and was heated inside a furnace vessel during the casting process. The used tantalum was oxidized and then returned to the furnace gloveboxes for reuse. Tantalum items to be discarded were processed by heating the items in a "burn-box" to convert adhering plutonium metal to plutonium oxide. After cooling, the tantalum items were scraped or brushed off to remove the plutonium oxide [P024].

Halogenated solvents were used in production operations to clean and degrease plutonium parts and metal. In addition, the solvents were used with cutting oils to cool plutonium parts during machining. Carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloroethylene, and methylene chloride were the primary solvents historically used during plutonium production. Tetrachloroethylene was replaced by 1,1,1-trichloroethane for degreasing during the 1973 time frame. Several nonhalogenated solvents were also used for cleaning and degreasing, primarily during efforts to reduce use of halogenated solvents [P023, P052]. These solvents included isopropyl alcohol, ethanol, and acetone [P052, P067, P053]. Building 777 housed the carbon tetrachloride and 1,1,1-trichloroethane systems that collected and filtered solvents generated during production operations. In addition to parts cleaning and degreasing, solvents were also used to clean plutonium operation glovebox lines [P053].

15.1.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Building 771 housed operations that recovered plutonium from waste materials and other sources [P053]. Plutonium purification was performed primarily in Buildings 371, 771, 776, and 7715 [P052].

Recovery operations in Building 771 used acid to dissolve solid materials containing plutonium. The resulting solutions were processed by a series of ion exchange, precipitation, calcination, fluorination, and reduction operations to produce purified plutonium metal to be recycled back into production operations. Potassium hydroxide, potassium fluoride, hydrogen peroxide, and nitric, hydrochloric, and hydrofluoric acids were the primary reagents used for plutonium recovery operations [P053, P061, P067, P083, U047].

Plutonium metal from returned parts and metal from other DOE facilities was purified at Rocky Flats. Plutonium-241 decays to americium-241, which decreases the effectiveness of the plutonium parts.

Plutonium parts were disassembled in Building 777 [P053, P113]. Beginning in 1967, the MSE process in Building 776 recovered americium from plutonium metal using sodium chloride, potassium chloride, and magnesium chloride [P053]. Americium was separated from the MSE residue salts using potassium hydroxide precipitation followed by an ammonium thiocyanate anion exchange process. In 1975, the process changed to cation exchange followed by anion exchange (no thiocyanate) and then precipitation using oxalic acid [P113, U047]. The process changed again the following year to the salt scrub process which used a magnesium/zinc or a magnesium/aluminum extractant [U047]. The purified plutonium metal from MSE was either sent to the foundry in Building 707 or sent to the electrorefining process in Building 371 or Building 776 if the metal contained other impurities [P053, U047].

Spray leaching (Building 771) and hydride leaching (Building 779) also used acids to remove plutonium surface contamination from uranium metal and other metals or beryllium contamination from plutonium metal [P061, P062]. From 1970 to 1975, heavy non-SS metal contaminated with plutonium above the EDL was processed by spray leaching in Building 771. Starting in 1975, hydride leaching in Building 779 was used to remove recoverable amounts of plutonium from heavy non-SS metal [P024, P058]. These processes used nitric, hydrochloric, sulfuric, and sulfamic acids [P053, P061, P062].

15.1.3 Laboratory

Buildings 371, 559, and 771 housed the main analytical laboratories at the site. The laboratories' primary function was to provide analytical support to production activities in addition to supporting recovery, purification, and liquid waste treatment operations. Each of the laboratories used numerous acids, bases, solvents, and other chemical reagents.

Building 371 had an analytical laboratory and a chemical standards laboratory. The chemical standards laboratory prepared standards for various users and inspects standards that have been used in the field. The analytical laboratory analyzed samples from various operations on site. The types of analyses performed included [P081]:

- Total Alpha Activity
- Isotopic Analysis
- X-Ray Emission
- X-Ray Diffraction
- Plutonium, Uranium, and Americium Content
- Corrosivity
- Ignitability.

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process. The types of analyses performed included [P067]:

- Emission spectroscopy
- Atomic absorption
- Infrared analysis
- Gallium analysis
- Plutonium assay
- Carbon analysis
- Uranium analysis
- Raschig ring analysis
- Tritium analyses
- Nonroutine chemical analysis
- Anion/cation solution analysis
- Isotopic analysis
- Thermal analysis
- Gas analysis
- Spark source mass spectroscopy
- X-ray analysis

Building 771 housed analytical and chemical standards laboratories. The chemical standards laboratory prepared control sample standards for the analytical laboratories in Buildings 371, 559, and 771 [P061]. The analytical laboratory provided analyses in support of plutonium operations. The types of analyses performed included [P061, P067]:

- X-Ray fluorescence
- Alpha/gamma scintillation
- Atomic absorption
- Laser fluorimetry
- Spectrophotometry
- Calorimetry
- Gamma spectroscopy
- Titrations

The laboratories used a variety of reagents and solvents including:

Acids/Bases

- boric [P067]
- hydrochloric [P061, P067, P081]
- hydrofluoric [P061, P067, P081]
- nitric [P061,P067, P081]
- perchloric [P067]
- phosphoric [P067]
- sodium hydroxide [P061, P067, P083]
- sulfamic [P067]
- sulfuric [P067, P083]
- tartaric [P067]

Reagents

- ammonium hydroxide [P083]
- ammonium molybdate [P067]
- ceric ammonium nitrate [P067]
- ceric sulfate [P083]
- ferrous sulfamate [P067]
- ferric chloride [P067]
- potassium bromide [P083]
- potassium chloride [P067]
- sodium fluoride [P067]
- total ionic strength adjusting buffer (contains diaminocyclohexane tetraacetic acid) [P061]
- trioctyl phosphene oxide [P061, P081]

Organic Solvents

- acetone [P083]
- benzene [P053]
- carbon disulfide [P083]
- carbon tetrachloride [P053, P067, P083]
- methanol [P083]
- methylene chloride [P053, P083]
- petroleum ether [P083]
- toluene [P083]

Organic Solvents (continued)

- chloroform [P053, P067, P083]
- cyclohexane [P061]
- ethanol [P083]
- isooctane [P083]
- isopropanol [P083]
- tributyl phosphate [P083]
- 1,1,1-trichloroethane [P083]
- trichloroethene [P083]
- 1,1,2-trichloro-1,2,2-triflouroethane [P067, P083]
- xylene [P083]

15.1.4 Research and Development

Research and Development included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed much of the R&D operations at the plant. Other areas at the plant supporting R&D included Buildings 559, 771, 776, 777, and 881 [P053].

The purpose of Building 779 was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials that might be used in plutonium operations. Other activities in Building 779 included developing improvements to the manufacturing process and finding new ways to recover plutonium and associated actinides. Another function was to develop a better understanding of the aging and shelf-life limitations of Rocky Flats products. Most of the materials used, and wastes generated, in this facility were the same as those in the production and recovery buildings, as much of the work conducted involved improvement of existing processes [P053]. However, processing of neptunium, curium, and cerium was also conducted [P053, U047].

The plant conducted special order work for other facilities in the DOE complex, the DOD, or other federal departments or agencies. One example is the introduction of radionuclide tracers into pits destined for off-site test shots. This work took place in the 1960s and well into the 1970s. Materials such as americium-240, plutonium-238, neptunium, curium, and cerium were blended in with the regular component materials for the purpose of studying performance of the different weapon components based on post-test distribution of the rare tracers. These tracer materials were kept separate from the regular production material streams, and special recovery operations in Building 771 specialized in recovering these more exotic materials [C072, P053].

From approximately 1959 to the mid-1970s, Rocky Flats was involved in "Project Plowshare." The mission of the program was to develop technology for using nuclear explosives for peaceful applications such as excavation and uncovering of deep mineral deposits. Materials used in the manufacturing of these components were the same as those used in the production buildings [P053].

15.1.5 Waste Treatment

Waste processing at Rocky Flats has included both liquid and solid process wastes. Liquid waste treatment operations have had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building 771. Radionuclides were removed by precipitation, and the resulting slurry filtered. The solids removed from filters were combined with cement or other solidifying agents. The aqueous waste from this first stage goes through a second precipitation [P053]. These processes used sodium hydroxide, ferric sulfate, magnesium sulfate, and calcium chloride [P109]. See Section 23.0, Solidified Aqueous Sludge Building 774, for a detailed description of these processes.

Around 1965, an evaporator was installed in Building 774 to treat liquids from the second stage treatment and from the solar ponds. The concentrate from the evaporator was introduced into a steam-heated double-drum dryer that produced a salt waste. The Building 774 evaporator was taken out in 1979, and the liquids from the second stage treatment and solar ponds have since been transferred to Building 374 for additional treatment [P053].

Building 774 also processed organic liquid wastes. Plutonium-contaminated organic liquids were generated from plutonium machining [P053]. The spent organic liquid was filtered and then mixed with a solidifying agent. The process was later changed to a one step process in which the organic liquid was mixed with Envirostone (gypsum cement) and allowed to set up [P109]. See Section 25.0, Solidified Organic Waste for a detailed description of these processes.

Treatment of solid transuranic wastes was conducted in Buildings 771 and 776. Building 771 processed wastes containing plutonium above the EDL while Building 776 processed wastes below the EDL.

Operations in Building 771 processed wastes including Raschig rings, HEPA filters, and sludges from the filter plenum and from process piping. Filters were disassembled to remove plutonium-contaminated dust. Process piping removed from service was cut up and cleaned of built-up sludge. Sludge from the process piping and from the filter plenum was dissolved in nitric acid to recover plutonium. Until 1984, plutonium was recovered from Raschig rings by nitric acid leaching [P061].

Size reduction in Building 776 removed materials from drums and sorted them in an airlock vault. Materials such as light metals, filters, glass, combustibles, and Raschig rings were then put into containers with like materials [P067]. From 1970 to 1973, each generating area packaged leaded gloves. Acid contaminated glovebox gloves may have been washed by hand prior to 1974; however, this has not been verified [C099, C100, P012]. Beginning in 1974, acid-contaminated leaded gloves were sent to Building 776 where they were washed with hot water in a ball-mill prior to packaging. Later, nonacid-contaminated leaded gloves above the EDL were also washed in the ball-mill to remove radioactive surface contamination [P024]. The ball-mill washing process was discontinued in 1989 [P052]. However, any unwashed acid-contaminated leaded gloves generated since 1989 were assigned IDC 341 (not in INEEL inventory) [P024, P067].

Advanced size reduction operations in Building 776 disassembled or cut plutonium-contaminated gloveboxes and miscellaneous large equipment into sizes that could be packaged in approved containers [P110].

The fluidized-bed incinerator in Building 776 received low-level plutonium-contaminated combustible solid and liquid wastes [P067]. Building 771 also housed an incinerator for processing combustible wastes [P061, U047]. See Section 14.0, Incinerator Waste, for a detailed description of the incineration processes.

15.1.6 Maintenance

Routine and non-routine maintenance at Rocky Flats included utilities, strip-out operations, and other general maintenance and cleanup activities.

Utility systems include HVAC systems, fume scrubbers, and process vacuum systems. The HVAC systems contain air supply units for filtering incoming air and plenums for filtering exhaust air. Scrubbers housed in Buildings 371, 559, 771, and 779 used potassium or sodium hydroxide to neutralize acid fumes from various process off-gas streams and glovebox exhaust streams. Process vacuum systems provide an

absolute pressure at a vacuum header that serves as a means to transfer fluids on demand by valving arrangements [P061, P067].

Another maintenance activity that may have generated lead-containing wastes was the strip-out of glovebox lines, process piping, valves, and associated systems. Strip-out activities were performed when a glovebox line was scheduled to be replaced or during renovation. Solvents such as trichloroethylene or 1,1,1-trichloroethane may have been used during this type of operation for decontamination [P067, P108].

Lead-containing wastes may have also originated from cleanup of the 1969 fire that spread through combustible materials in several hundred inter-connected gloveboxes in Building 776. Another incident that may have generated lead containing wastes occurred when tritium-contaminated plutonium was processed from April 9, 1973 through April 25, 1973 in Building 779 causing a tritium release to the atmosphere and elevated tritium levels in surface waters, process wastes, equipment, gloveboxes, and exhaust plenums [P024, P053].

15.2 Waste Packaging

Heavy non-SS metal (IDC 320) and lead (IDC 321) were placed directly into a lined 55-gallon drum or double-bagged out of the glovebox line. After removal from the glovebox, the waste was placed in the drum or in Fibre-Paks which were then placed in the drum. Prior to packaging, sharp edges were taped to prevent puncturing the liners [P012, P015, P024].

Leaded drybox gloves (IDC 339) were placed directly into a lined 55-gallon drum or double-bagged out of the glovebox line in two PVC or polyethylene bags [P012, P015, P021, P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or one or two polyethylene drum bags [P012, P015, P016, P024, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners [P012, P016, P063, P064]. Lead drum liners placed between the drum and rigid liner were also used in some instances [P024]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

It was determined from RTR examinations performed during the 3,100 m^3 Project that several combinations of drum bags, poly bags, and O-ring bags may have been used to package IDC 339 waste. Any combination of these plastic bags, provided that four layers of containment were not exceeded, did not impact acceptability of the drum. Drums that exceeded TRUPACT allowed containment layers were flagged for treatment in TRIPS [P305].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

During the 3,100 m^3 Project, RTR examinations indicated that quantities of absorbent can vary significantly from expected quantities, and some drums may contain no absorbent. In addition, Oil-Dri® and vermiculite may be used in some drums outside the expected time periods [P305].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. VE of drums of leaded gloves identified surgical gloves; rags; paper; cloth towels, booties, and glove liners; neoprene rubber sheets and window gaskets; a polyethylene bottle and skirting [P015, U015]. VE of one heavy metal drum found cloth towels [U011].

15.3 Waste Characterization

Lead-containing wastes were characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. A hazardous waste determination for lead-containing wastes based on RCRA requirements as well as radionuclide contaminants and potential complexing agents contained in the waste is provided in this section. The hazardous waste determination for the leaded rubber gloves and aprons WSP were based on RCRA and WIPP WAP requirements as well as the WIPP WAC regarding radionuclide contamination [P305, P308, U103].

These wastes contain at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and are heterogeneous wastes [P141].

15.3.1 Hazardous Waste Determination

Some heavy metal wastes are not regulated as hazardous waste as defined in 40 CFR 261.7 (empty container). Lead containing wastes may exhibit the characteristic of corrosivity due to the presence of lead-acid batteries. Leaded gloves generated prior to 1974 were at one time thought to possibly exhibit the characteristic of reactivity due to the reaction with nitric acid at elevated temperatures. However, during a re-evaluation of the reactivity characteristic, it was determined that the conditions necessary for the formation of lead nitrate and nitro-organic compounds do not exist in the leaded rubber gloves and aprons waste and the reactivity characteristic is not applicable [U097]. Lead-containing wastes may exhibit the characteristic of toxicity for lead and mercury. There is no historical evidence that lead-containing wastes exhibit any other characteristic of hazardous waste [C101]. EPA HWNs applicable to some or the entire lead-containing waste group are presented by IDC in Table 15-4 [U092].

Table 15-4. Characterization of Lead-Containing Wastes.

IDC	Title	EPA HWNs
320	Heavy Non-SS Metal	D008 and D009
321	Lead	D002 and D008
339	Leaded Drybox Gloves	D008, D022, F001, F002, F003, F005, F006, F007, and F009

15.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as corrosive waste (40 CFR 261.22), as reactive waste (40 CFR 261.23), and as toxic waste (40 CFR 261.24). The materials do not exhibit the characteristic of ignitability (40 CFR 261.21).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, nor do they contain free liquids [P009, P015, P021, U011, U015]. In addition, absorbents were added to wastes having the potential of generating free liquids (i.e., leaded gloves which had been washed). These materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P016, P024]. The materials are not compressed gases, nor do the containers contain compressed gases [P009, P015, P021, U011, U015].

The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: Lead waste (IDC 321) may meet the definition of corrosivity as defined in 40 CFR 261.22 due to the presence of lead-acid batteries [P052]. With the exception of lead-acid batteries, the waste materials are not liquid, nor do they contain free liquids [P009, P015, P021, U011, U015]. In addition, absorbents were added to wastes having the potential of generating free liquids (i.e., leaded gloves which had been washed). Therefore, EPA HWN D002 is only applicable to lead waste (IDC 321) containing lead-acid batteries identified during RTR or VE.

Reactivity: Leaded drybox gloves and aprons (IDC 339) generated before 1974 were previously thought to meet the definition of reactivity as defined in 40 CFR 261.23 due to explosive reaction with nitric acid at elevated temperatures. However, during a re-evaluation of the reactivity characteristic, it was determined that the conditions necessary for the formation of lead nitrate and nitro-organic compounds do not exist in the leaded rubber gloves and aprons waste and the reactivity characteristic is not applicable [U097]. Leaded rubber gloves and aprons (IDC 339), heavy non-SS metal (IDC 320), and lead (IDC 321) do not meet the definition of reactivity. The materials in this waste group are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173 [P012, P015, P024]. Explosives were not handled or used around radioactive material. The EPA HWN D003 is not applicable to lead containing wastes.

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. Wastes in this group may exhibit the characteristic of toxicity for lead and mercury metals.

IDC 321 was created specifically for lead waste. Prior to 1987, heavy non-SS (IDC 320) drums contained lead items [P015]. Analytical data indicate that unused leaded gloves (IDC 339) subjected to the TCLP test, leach lead at levels above the regulatory limit. Analytical data have not been obtained for used leaded gloves [P016, C095]. Therefore, EPA HWN D008 is assigned to the lead-containing wastes (IDCs 320, 321 and 339). Heavy metal waste (IDC 320) may also contain mercury-containing devices (i.e., batteries, thermometers, gauges, and switches) and is also assigned EPA HWN D009 [P052].

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating lead-containing wastes. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene were used for cleaning and degreasing. Chloroform was used in laboratory analysis. During process operations, lead-containing wastes may have come in contact with these organic compounds. Headspace gas analysis detected carbon tetrachloride, chloroform, and 1,1-dichloroethylene in drums of leaded gloves (IDC 339) [P033, U030]. Carbon tetrachloride is discussed in the Listed Hazardous Waste Section. The toxicity characteristic HWN (D022) was applied to this waste stream because the analyses of headspace gas samples for chloroform resulted in a UCL_{90} greater than the PRQL. The toxicity characteristic for 1,1-dichloroethylene was not applied to this waste stream because its concentrations in headspace gas samples did not result in a UCL_{90} greater than the PRQL.

15.3.1.2 Listed Hazardous Waste. The materials in this waste group are not, or were not mixed with, waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31), hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were used in production, laboratory, and maintenance operations. Acetone, methanol, xylene, benzene, carbon disulfide, and toluene were used in laboratory operations. During process operations, lead-containing wastes may have come in contact with these compounds. However, some of the heavy metal wastes consist of crucibles which, if empty, are not regulated as hazardous wastes as defined in 40 CFR 261.7. Leaded gloves from a glovebox were part of a container-like apparatus and, when discarded, are not a hazardous waste simply because solvents or other hazardous materials were used in the glovebox. Also, leaded gloves and heavy metal wastes such as labware that were wiped down with solvents for decontamination purposes are not regulated as listed hazardous wastes. This was clarified by the Colorado Department of Public Health and Environment [C093]. Therefore, it was determined that these wastes are not F001-, F002-, F003-, or F005-listed hazardous waste.

Although the wastes presented in this group are not F-listed hazardous wastes, headspace analyses performed on samples of heavy non-SS metal (IDC 320) and leaded gloves (IDC 339) obtained at INEEL prior to the 3,100 m^3 Project confirmed the presence of organic solvents. The detected compounds in which the UCL_{90} was above the PRQL were as follows [P033]:

- 1,1,1-trichloroethane (IDC 339 only)
- 1,1,2-trichloro-1,2,2-trifluoroethane (IDC 339 only)
- carbon tetrachloride (IDC 339 only)
- methylene chloride (IDC 339 only)
- toluene (IDC 320 only).

RFP waste management and inspection protocol allowed containers of the leaded rubber gloves and aprons waste to contain up to 10% of other IDC wastes. Other wastes that could be present in containers of IDC 339 waste are combustibles, glass, concrete, metal, and plastics. These other wastes carry F-listed HWNS. The associated F-listed HWNs were assigned by the 3,100 m^3 Project to the IDC 339 leaded rubber gloves and aprons waste in the CBFO approved WSP, INW252.001 based on the mixture rule (40 CFR 261.3(a)(2)(iv)) and headspace gas results (Table 15-5).

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating lead-containing wastes and no F004 listed solvents were detected in any of the headspace gas samples collected. Therefore, this waste group is not an F004-listed hazardous waste.

The statistical evaluation of the headspace gas samples collected at the INEEL for the 3,100 m^3 Project for the tantalum (IDC 320) and lead (IDC 321) wastes are presented in Table 15-6. Although the data does confirm the presence of F-listed constituents, the only compound with concentrations resulting in a UCL_{90} greater than its PRQL was cyclohexane.

Table 15-5. Statistical Evaluation of all the Leaded Rubber Gloves and Aprons HSG Data for the 3,100 m^3 Project (INW252.001, IDC339) [P324].

Analyte	Total Number of samples	Number of samples above MDL[a]	Mean (ppmv)	Standard deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	153	136	75.6	134	890	90.4	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	148	0	0.617	1.07	5.00	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	150	54	4.49	29.4	322	9.68	10	F001/F002[d]
1,1-Dichloroethane	142	91	1.56	2.64	27.0	1.92	10	N/A
1,1-Dichloroethylene	133	10	0.825	1.33	9.70	1.41	10	N/A
1,2,4-Trimethylbenzene	148	2	0.701	1.18	5.00	3.26	10	N/A
1,2-Dichloroethane	145	73	1.06	1.15	4.80	1.24	10	N/A
1,3,5-Trimethylbenzene	147	1	0.646	1.06	4.60	b	10	N/A
Acetone	152	143	46.2	37.5	320	50.3	100	F003[d]
Benzene	141	79	1.08	1.24	8.60	1.26	10	F005[d]
Bromoform	150	0	0.340	0.623	3.89	b	10	N/A
Butanol	153	9	2.82	6.05	50.0	5.64	100	N/A
Carbon tetrachloride	153	127	400	962	7400	510	10	F001[c]
Chlorobenzene	142	2	0.567	0.875	4.60	2.47	10	N/A
Chloroform	153	149	29.6	94.3	900	39.6	10	D022[c]
Cis-1,2-dichloroethylene	141	0	0.665	1.02	4.90	b	10	N/A
Cyclohexane	141	4	0.726	1.11	4.80	1.63	10	N/A
Ethyl benzene	142	39	0.729	1.07	4.55	0.952	10	N/A
Ethyl ether	139	0	0.728	1.11	4.96	b	10	N/A
Methanol	153	0	6.48	9.05	46.3	b	100	F003[d]
Methyl chloride	14	13	33.4	23.9	90.0	42.4	10	N/A[e]
Methyl ethyl ketone	152	90	3.65	5.76	50.0	4.44	100	N/A
Methyl isobutyl ketone	153	40	1.53	3.90	34.5	2.34	100	N/A
Methylene chloride	140	108	16.6	90.5	974	27.9	10	F001/F002[c]
Tetrachloroethylene	150	13	0.531	1.03	7.50	0.920	10	F001/F002[d]
Toluene	145	136	5.43	5.69	44.0	6.06	10	F005[d]
Trans-1,2-dichloroethylene	144	0	0.583	1.02	4.85	b	10	N/A
Trichloroethylene	148	30	1.14	2.46	19.0	1.73	10	F001/F002[d]
m&p-Xylene	146	61	0.868	1.13	5.00	1.06	10	F003[d]
o-Xylene	143	71	0.753	0.854	4.37	0.884	10	F003[d]

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analyses.

d. HWN assigned based solely on AK.

e. Methyl chloride was detected in more than 25% of HSG samples as a tentatively identified compound and has been added to the target analyte list. Methyl chloride is not a listed compound and no HWN applies [C246].

Additional F-listed solvents were detected in headspace samples of lead-containing wastes (IDCs 320, 321, and 339) obtained at Rocky Flats (results queried in 1996). The detected F-listed compounds in which the UCL_{90} was above the PRQL are: [U030].

- 1,1,1-trichloroethane (IDCs 320 and 339)
- carbon tetrachloride (IDCs 320 and 339)
- toluene (IDC 339 only).

The F003 code was assigned to the leaded rubber gloves and aprons waste for acetone, methanol, and xylene [P305]. Although the waste addressed by this profile is not ignitable, the waste has been assigned the F003 code as a conservative measure because the F003 solvents may have been commingled with other listed solid wastes at the point of generation; e.g., application to the combustible waste materials. Headspace gas sampling results (Table 15-5) confirmed the presence of the compounds with detects of acetone, methanol, and xylene in several samples, although the headspace gas data was not above the UCL_{90} for any of these compounds.

EPA HWCs F006, F007, and F009 also were assigned to the leaded rubber gloves and aprons waste stream due to the presence of combustible and plastic wastes. Combustible and plastic wastes were generated during aqueous waste treatment operations in Buildings 374 and/or 774, which included spent stripping, cleaning, and plating solutions where cyanides were used in the process, and sludges from electroplating operations may have been contaminated with electroplating wastes.

The materials in this waste group are not hazardous waste from specific sources because they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

15.3.2 Radionuclides

The radioisotopes potentially contained in the lead-containing wastes, as well as the chemical form of radionuclide contaminants and radioassay interferences are identified in this section. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0. Wastes from some of the processes described below may not be contained in the inventory based on the assigned prefixes. However, as explained in Section 15.3.2.6, it is assumed that repackaged drums could contain waste generated from any process.

Table 15-6. Statistical Evaluation of all the Tantalum and Lead waste HSG Data From the 3,100 m^3 Project, (IDCs 320 and 321) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	101	82	6.92	15.5	110	9.14	10	N/A
1,1,2,2-Tetrachloroethane	101	0	0.041	0.085	0.700	b	10	N/A
1,1,2-Trichloro-1,2,2-Trifluoroethane	101	10	0.177	0.744	5.30	0.502	10	N/A
1,1-Dichloroethane	101	13	0.121	0.345	3.00	0.251	10	N/A
1,1-Dichloroethylene	101	1	0.115	0.257	1.45	b	10	N/A
1,2,4-Trimethylbenzene	101	8	0.052	0.117	1.09	0.110	10	N/A
1,2-Dichloroethane	101	23	0.196	0.581	3.90	0.356	10	N/A
1,3,5-Trimethylbenzene	101	6	0.053	0.102	0.763	0.115	10	N/A
Acetone	101	97	10.3	23.8	200	13.4	100	N/A
Benzene	101	44	0.339	1.35	13.0	0.604	10	N/A
Bromoform	101	0	0.023	0.044	0.28	b	10	N/A
Butanol	101	35	0.362	0.733	5.25	0.524	100	N/A
Carbon Tetrachloride	101	30	0.072	0.279	2.73	0.139	10	N/A
Chlorobenzene	101	6	0.056	0.128	1.16	0.133	10	N/A
Chloroform	101	71	0.374	0.558	3.00	0.460	10	N/A
Cis-1,2-Dichloroethylene	101	0	0.069	0.157	1.35	b	10	N/A
Cyclohexane	101	20	9.10	85.6	860	34.5	10	N/A
Ethyl Benzene	101	14	0.113	0.245	1.90	0.202	10	N/A
Ethyl Ether	101	0	0.072	0.196	1.89	b	10	N/A
Methanol	101	0	5.00	2.69	15.0	b	100	N/A
Methyl Chloride	1	1	24.0		24.0	b	10	N/A
Methyl Ethyl Ketone	101	86	2.25	5.34	46.0	2.99	100	N/A
Methyl Isobutyl Ketone	101	54	1.55	4.68	25.0	2.37	100	N/A
Methylene Chloride	101	54	0.735	2.05	15.0	1.10	10	N/A
Tetrachloroethylene	101	2	0.036	0.080	0.55	0.210	10	N/A
Toluene	101	88	4.64	10.4	83.0	6.08	10	N/A
Trans-1,2-Dichloroethylene	101	0	0.053	0.094	0.663	b	10	N/A
Trichloroethylene	101	23	0.323	1.95	18.8	0.859	10	N/A
m&p-Xylene	101	30	0.266	0.705	5.66	0.435	10	N/A
o-Xylene	101	20	0.131	0.300	2.00	0.220	10	N/A

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

15.3.2.1 Plutonium Production. Radionuclide contamination in waste from Building 707 primarily consists of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers [C171, C174, C184, C185, P053, P164, P167].

Building 777 performed disassembly of site-return parts and fabrication operations including machining, briquetting, assembly, and production support processes (container prefixes 0004, 0023, and 0024) [C184, P052, U059, P079]. Wastes from fabrication operations will be contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations will be contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053].

Buildings 707 and 777 handled actinides in metal or oxide form only [P060, P079]. The actinide metals will likely have partially or completely oxidized because of the reaction with dry air, and some could possibly have formed a hydroxide layer from reaction with moist air. Radioassay interferences may include beryllium from Part V metal fabrication in Building 707, and calcium fluoride which was sprayed onto graphite molds in Building 707 prior to casting [C184, P060]. Other interfering waste contaminants include aluminum, beryllium, and stainless steel (chromium) which were machined in Building 777 [P079].

15.3.2.2 Plutonium Recovery and Purification Wastes from recovery operations in Building 371 contain weapons-grade plutonium primarily from electrorefining [C184, P067]. A limited amount of the waste could also have been generated from aqueous recovery operations that only ran for a short time in 1982. Aqueous recovery operations were designed for recovering and purifying weapons-grade plutonium [C184, P164].

The feed materials to the recovery and purification processes (container prefixes 0001 and 0002) in Building 771 were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated are contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Radionuclides from aqueous recovery operations vary widely in chemical form depending on the specific process the waste originated, and because the majority of the aqueous processes were performed within one large MBA (container prefixes 0001 and 0002), the specific process can not be determined. The different actinide forms are plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Wastes from the americium recovery glovebox lines (container prefix 0006) in Building 771, used for extraction of americium from site-return plutonium, contain a significant amount of americium-241 [C184, P053, P164, U059]. The americium was in a chloride, hydroxide, nitrate, oxalate, and oxide chemical form during different steps of the process. Prior to 1975, ammonium thiocyanate was also used [P053].

The Oralloy leach process (container prefix 0074) in Building 771 chemically separated plutonium surface contamination from enriched uranium hemishells using nitric acid. The chemical form of the radionuclides are plutonium nitrate and uranyl nitrate [C184, P061, P163, U059].

Site-return metal and other non-specification plutonium were processed by pyrochemical operations in Building 776 (container prefix 0003) to produce plutonium for use in the foundry [C184, P053, U059]. The molten salt extraction process removed americium-241 from site-return and other

non-specification plutonium. Electrorefining was used to purify plutonium metal that did not meet foundry specifications. Since metal was the feed and product to the MSE and electrorefining processes, wastes generated from these processes are contaminated with actinide metals which will probably have formed an oxide or hydroxide layer from reaction with dry and moist air. Direct oxide reduction was developed to convert plutonium dioxide to plutonium metal [P163, P175]. MSE residue salts, which contain actinide chlorides, were the feed to the salt scrub process. Metal was the product of this process as well, so the radionuclide contaminants could be in a metal, oxide, and/or hydroxide form. Radioassay interferences may include chloride salts (i.e., sodium, potassium, magnesium, calcium, and zinc) [P163].

Hydride operations in Building 779 (container prefix 0055) recovered plutonium from various substrates by reacting plutonium metal with gaseous hydrogen in an argon-inerted glovebox [P052, U059, P062, P163]. Hydriding produced plutonium metal for use in the foundry or non-specification feed to pyrochemical operations, in addition to plutonium oxides sent for aqueous recovery [C184, P062]. The hydriding process formed plutonium hydride that was converted to plutonium dioxide by oxidizing the material in an air atmosphere [P163].

15.3.2.3 Laboratory. The analytical laboratory in Building 371 (container prefix 0071) provided analytical support for process control and performed analyses on feed materials and residues from recovery operations in Building 371 [P053, U059, P081]. The laboratory also analyzed samples from various operations at the site, but primarily from Building 374 [P081]. The Building 371 chemical standards laboratory prepared standards for various users and inspected standards that were used throughout plant site [P053]. Wastes from these laboratories are contaminated with weapons-grade plutonium and enriched and depleted uranium.

The Building 559 analytical laboratory (container prefix 0029) performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, U059, U073]. The primary mission of this laboratory was analysis of site-return and feed materials, in addition to recovery, purification, and foundry products [P053].

The Building 771 analytical laboratory (container prefix 0037) received samples from recovery operations in the building as well as from the foundry [P067, U059]. The samples included plutonium metal turnings, plutonium oxide, acidic plutonium solutions, and various process residues [P061]. In addition, the analytical laboratory analyzed samples from R&D laboratories in Buildings 771 and 779 (see Section 15.3.2.4) [P067, P061]. The chemical standards laboratory (container prefix 0038) prepared uranium, plutonium, and americium nitrates used as control standards for the Buildings 371, 559, and 771 analytical laboratories [P067, P061]. The laboratory also produced nondestructive assay standards used at drum counters and fluoride standards for chemical operations [P061].

The metallography laboratory (container prefix 0021) in Building 777 prepared and examined metallographic specimens in support of R&D operations (plutonium metallography, nuclear and nonnuclear joining, quality engineering, and product physical chemistry) and, therefore, may contain any of the radionuclides used during R&D activities (Section 15.3.2.4) [C184, U059, P079]. The Building 777 tritium surveillance laboratory analyzed solid, liquid, and gas samples from throughout the plant site for tritium content [U078].

Because the laboratories supported all phases of weapons production, the chemical form of the radionuclide contaminants and radioassay interferences vary widely depending on the type of sample analyzed.

15.3.2.4 Research and Development. Projects using transuranic radionuclides were done in Buildings 771, 776, 777, 779, and 881. Most of the documentation pertaining to R&D activities does not specify locations in which the work was performed, and unless otherwise noted, it was assumed that any of the radioisotopes could have been handled in the R&D areas of any of these buildings. In addition to weapons-grade plutonium, americium-241, and enriched and depleted uranium, the following radioisotopes were processed during R&D activities [C134, C137, C185, P053, P164, P167, P189, P190, P194, P195, P198, P200, U064]:

- americium-240
- curium-244
- neptunium-237
- plutonium-238, -240, -241, and -242
- low NGS plutonium (≈3% Pu-240)
- power grade plutonium (up to 20% Pu-240 and 1% Pu-241)
- thorium-228
- uranium-233, -235, -236, and –238.

A summary of the projects and time periods that these and other radionuclides were used is presented in Section 3.0.

In Building 771, special recovery anion exchange (container prefix 0045) separated plutonium from other materials that were not suitable for the regular recovery processes [C154, P052, P061]. Chemical technology (container prefix 0042) conducted aqueous R&D activities while plutonium metallurgy operations (container prefix 0078) performed alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C184, U059, P061]. These processes may have used numerous radioisotopes.

A pilot-scale fluidized-bed incinerator (container prefix 0075) was developed in Building 776 to treat low-level waste [C184, U059]. The waste fed to the incinerator was contaminated with low levels of plutonium [P024].

The coatings laboratory (container prefix 0016) in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium [P052, U059, P079]. This research and development facility supported production processes [P052, P079]. The special weapons area (container prefix 0066) in Building 777 was a research and development facility which assembled war reserve and other specially fabricated parts [U059, P079]. The process was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

Pyrochemical technology (container prefixes 0010 and 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations [P067, U059, P062]. These processes included direct oxide reduction, molten salt extraction, electrorefining, salt scrub for MSE, salt scrub for electrorefining, pyrochemical salt recycle, anode alloy, and pyroredox [C182, P062]. Most of the materials used in Building 779 were the same as those in the weapons-production

areas and, therefore, are contaminated primarily with weapons-grade plutonium and enriched uranium [P053]. However, other R&D activities in the building may have used a variety of other radionuclides [C171, C184].

15.3.2.5 Liquid Waste Treatment. Aqueous waste treatment operations in Buildings 374 and 774 received wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. Other radionuclides may also be found in the waste streams from R&D, analytical, and special order work [P164]. Radionuclide contaminants are removed from the aqueous wastes by precipitation using sodium hydroxide, are primarily in the form of hydroxides [P163]. Radioassay interferences may include magnesium sulfate and calcium chloride reagents used in the process [P106, P163].

Building 774 also processed organic liquid wastes. Organic wastes are comprised of a variety of oils and solvents. Most of the oils were from spent lathe coolant used in the plutonium machining area and lubricating oils used in machines throughout the plant [P164]. The majority of the transuranic organic liquids were oils and solvents from plutonium machining and degreasing operations in Buildings 707 and 777 and, therefore, are contaminated with actinide metals and oxides [P052]. A more detailed discussion of the wastes treated in these buildings is provided in Sections 22.0 through 25.0.

15.3.2.6 Size Reduction/Repackaging/Solid Waste Treatment. Solid waste treatment, repackaging, and size reduction operations were conducted in the SRV in Building 776. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, U077]. Size reduction included cutting up gloveboxes or ducting, and crushing HEPA filters. Solid waste treatment activities included washing leaded gloves and scrap metal with hot water in a ball-mill washer to recover plutonium [C053, P067, P164].

The full-scale fluidized bed incinerator (container prefix 0050) was designed to treat low-level waste. However, the waste generated from this incinerator is not likely transuranic [C184, P052].

15.3.2.7 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC [P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241; plutonium-238, -239, plutonium -240, and –241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227, P322]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities are calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240, P322]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P305, P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 15-7. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 15-7. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
320	371	0017	Aqueous Recovery	10/8/85	WG Pu, ^{241}Am
320	371	0032	Aqueous Recovery	12/4/86	WG Pu, ^{241}Am
320	371	0039	Note a	11/6/85	WG Pu, EU, ^{241}Am, DU
320	559	0029	Analytical Laboratory	3/24/83 - 3/11/85	WG Pu, EU, ^{241}Am, DU
320	707	0012	Foundry and Casting Operations	3/23/81 - 6/24/88	WG Pu
320	707	0015	Metal Fabrication-Part V	6/13/80	WG Pu
320	707	0022	Metal Fabrication-Machining	7/13/84 - 12/18/87	WG Pu
320	707	0031	Metal Fabrication-Assembly	8/8/85 - 5/27/87	WG Pu
320	771	0002	Aqueous Recovery	7/27/79 - 10/22/85	WG Pu
320	771	0005	Aqueous Recovery	11/6/85	WG Pu
320	771	0037	Analytical Laboratory	3/18/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
320	771	0078	Plutonium Metallurgy Development	8/18/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
320	771	0078	Plutonium Metallurgy Development	5/2/85	WG Pu, EU, ^{241}Am, DU
320	771/881	0045	Note b	7/21/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
320	776	0003	Pyrochemical Operations	4/17/85 - 10/24/86	WG Pu, ^{241}Am
320	776	0019	Size Reduction	3/7/85 - 11/11/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
320	776	0025	Drum Repack	3/29/85 - 8/7/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
320	776	0050	Fluidized-Bed Incinerator	7/6/87	WG Pu
320	776	0057	Advanced Size Reduction	10/24/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
320	776	0075	Waste Processing Development	8/8/85 - 8/8/85	WG Pu
320	777	0004	Radioscopy	12/17/85	WG Pu, EU
320	777	0016	Coating Laboratory	8/11/82 - 7/14/86	WG Pu, EU
320	777	0024	Metal Fabrication-Disassembly	7/14/86	WG Pu, EU
320	779	0010	Pyrochemical Technology	9/26/85	WG Pu, ^{241}Am
320	779	0055	Hydride Operations	2/5/80 - 4/24/86	WG Pu
321	707	0022	Metal Fabrication-Machining	10/9/87	WG Pu

Table 15-7. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
321	776	0003	Pyrochemical Operations	11/6/87	WG Pu, ^{241}Am
321	776	0057	Advanced Size Reduction	10/9/87 - 10/9/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
339	371	0011	Operations within Building 371	4/21/87 - 4/21/87	WG Pu, EU, ^{241}Am, DU
339	371	0032	Aqueous Recovery	12/17/86 - 5/12/87	WG Pu, Am^{241}
339	371	0039	Note a	6/23/87 - 6/24/87	WG Pu, EU, ^{241}Am, DU
339	371	0092	Aqueous Recovery	11/5/87 - 7/8/88	WG Pu, ^{241}Am
339	707	0012	Foundry and Casting Operations	4/8/85 - 4/29/88	WG Pu, EU[c]
339	707	0015	Metal Fabrication-Part V	12/17/85 - 11/24/87	WG Pu
339	707	0022	Metal Fabrication-Machining	4/8/85 - 6/23/88	WG Pu, EU[c]
339	707	0031	Metal Fabrication-Assembly	2/3/86 - 5/27/87	WG Pu
339	771	0002	Aqueous Recovery	7/22/85	WG Pu
339	776	0003	Pyrochemical Operations	1/23/86 - 7/11/88	WG Pu, ^{241}Am
339	776	0019	Size Reduction	8/26/80 - 5/23/88	WG Pu, EU, ^{241}Am, DU, ^{233}U
339	776	0025	Drum Repack	4/30/84 - 8/12/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
339	776	0041	Waste Processing/Final Packaging	10/23/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
339	776	0057	Advanced Size Reduction	12/17/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
339	777	0016	Coating Laboratory	7/14/86	WG Pu, EU
339	777	0023	Metal Fabrication-Machining	4/8/85 - 6/23/88	WG Pu, EU
339	777	0024	Metal Fabrication-Disassembly	11/27/85 - 7/22/87	WG Pu, EU
339	777	0066	Special Assembly	5/11/87 - 6/3/87	WG Pu, EU, ^{241}Am, DU
339	779	0054	Research and Development	3/7/86 - 3/21/86	WG Pu, EU, ^{241}Am, DU

a. This prefix was assigned to an MBA in Building 371 that is not defined or was redefined after this waste was generated. It was assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

b. Prefix 0045 appears to have been assigned to MBAs in both Buildings 771 and 881 at different times. Prefix 0045 was used for Special Recovery Anion Exchange in Building 771 and Construction Management in Building 881.

c. Isotopes added as indicated by confirmatory radioassay measurements.

WG = weapons grade EU = enriched uranium DU = depleted uranium

15.3.2.8 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the leaded rubber gloves and aprons wastes are summarized in Tables 15-8 and 15-9. The overall yield for leaded rubber gloves and aprons radioassay data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 15-8 and Table 15-9, respectively.

Table 15-8. Overall Radioassay Yield for Leaded Rubber Gloves and Aprons (INW252.001) (IDC 339) [P322].

Total number of:	Number	Percentage of Total
Containers	418	
"*WIPPOK*" containers	401	96%
"Treatment" containers	0	0%
"Deficient / Permanently Rejected" containers	17	4%

The yield and radionuclide and related radioassay information for the tantalum (IDC 320) and lead (IDC 321) wastes are presented in Tables 15-10 and 15-11, respectively. A WSP for the tantalum and lead wastes was not developed during the 3,100 m^3 Project and no drums were characterized or shipped to the WIPP facility. The data for the individual radioassay systems information are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 15-9. Radionuclide and Related Quantities for Leaded Rubber Gloves and Aprons (INW252.001, IDC 339)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	1.872E+00	1.590E+00	2.485E-02	1.269E+01	417
TRU Activity (Ci)	1.773E+00	1.513E+00	2.286E-02	1.261E+01	417
TRU Activity Concentration (nCi/g)	1.931E+04	1.768E+04	3.748E+02	1.986E+05	417
Thermal Power (W)	5.646E-02	4.808E-02	7.242E-04	3.983E-01	417
Thermal Power Density (W/ft^3)	7.686E-03	6.545E-03	9.859E-05	5.423E-02	417
Plutonium Fissile Gram Equivalent (g)	2.087E+01	1.863E+01	2.912E-01	1.879E+02	417
Americium-241 (g)	5.129E-02	4.118E-02	8.565E-04	2.219E-01	411
Plutonium-238 (g)	2.852E-03	2.516E-03	2.246E-05	1.589E-02	417
Plutonium-239 (g)	2.049E+01	1.857E+01	2.885E-01	1.878E+02	417
Plutonium-240 (g)	1.233E+00	1.023E+00	1.807E-02	5.722E+00	417
Plutonium-241 (g)	5.157E-02	4.974E-02	3.561E-04	3.236E-01	417
Plutonium-242 (g)	7.134E-03	6.430E-03	9.698E-05	4.192E-02	417
Uranium-233 (g)	ND	ND	ND	ND	0
Uranium-234 (g)	1.453E-03	1.432E-03	1.741E-05	6.575E-03	71
Uranium-235 (g)	1.352E+00	1.332E+00	1.620E-02	6.116E+00	71
Uranium-238 (g)	ND	ND	ND	ND	0

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr, whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

ND = not detected; g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

Table 15-10. Overall Radioassay Yield for Tantalum and Lead Wastes (IDCs 320 and 321) [P322].

Total number of:	Number	Percentage of Total
Distinct containers	89	
"WIPPOK" containers	5	6%
"Treatment" containers	0	0%
"Deficient / Permanently Rejected" containers[a]	84	94%

Table 15-11. Radionuclide and Related Quantities for Tantalum and Lead Wastes (IDCs 320 and 321)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	3.279E+00	3.929E+00	3.496E-03	1.718E+01	89
TRU Activity (Ci)	3.245E+00	3.898E+00	3.469E-03	1.710E+01	89
TRU Activity Concentration (nCi/g)	7.984E+04	9.541E+04	4.297E+01	4.598E+05	89
Thermal Power (W)	1.030E-01	1.232E-01	1.173E-04	5.411E-01	89
Thermal Power Density (W/ft^3)	1.402E-02	1.677E-02	1.597E-05	7.367E-02	89
Plutonium Fissile Gram Equivalent (g)	3.517E+01	4.553E+01	6.357E-02	2.208E+02[c]	89
Americium-241 (g)	1.660E-01	2.351E-01	1.812E-04	1.780E+00	86
Plutonium-238 (g)	4.100E-03	5.209E-03	1.100E-05	2.674E-02	85
Plutonium-239 (g)	3.607E+01	4.542E+01	9.850E-02	2.205E+02	85
Plutonium-240 (g)	2.154E+00	2.599E+00	5.990E-03	9.991E+00	85
Plutonium-241 (g)	5.696E-02	7.368E-02	1.812E-04	3.022E-01	85
Plutonium-242 (g)	1.526E-02	1.830E-02	4.503E-05	7.511E-02	85
Uranium-233 (g)	2.012E+01	N/A	2.012E+01	2.012E+01	1
Uranium-234 (g)	1.865E-03	3.137E-03	1.212E-05	1.162E-02	17
Uranium-235 (g)	1.808E+00	2.869E+00	2.696E-02	1.026E+01	16
Uranium-238 (g)	9.104E+01	1.236E+02	3.650E+00	1.784E+02	2

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr, whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry10.

b. The standard deviation is the statistical variation of the population for which measurements were available. N/A = Not Applicable. The standard deviation is not applicable for a single measurement.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

15.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be

added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA (ethlyenediaminetetraacetic acid) is an example of chelating compounds. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, P079, U043]. Oxalic acid was also used for americium recovery [P113]. Lead-containing wastes may be contaminated with trace quantities of these complexing agents.

15.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the leaded rubber gloves and aprons waste stream (INW252.001) (IDC 339), the yield of successful RTR examinations was approximately 99% [P323]. Conversely, approximately 1% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition were divided evenly between: absence of prohibited items could not be verified; and layers of confinement exceeded for the assigned shipping category [P323].

The 3,100 m^3 Project for the tantalum and lead wastes (IDCs 320 and 321), had a yield of successful RTR examinations of approximately 92% [P323]. Conversely, approximately 8% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition in decreasing order of occurrence, are: presence of excess free liquids; layers of confinement were exceeded; did not meet the criteria for protection against sharp objects; absence of prohibited items could not be verified; and presence of sealed inner containers greater than 4 liters [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

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16. LIGHT METAL

This waste group consists of light metal generated by the production, recovery, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations. Light metal includes copper and other metals and metal alloys below copper on the periodic table (heavy metals are discussed in Section 15.0, Lead-Containing Waste). The waste was generated in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012, P052]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 16-1 [U092]. This waste was characterized under a CBFO approved waste stream profile (WSP), INW296.001, for containers of waste shipped to the WIPP facility [P213, P222].

Table 16-1. Light Metal Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
480	Unleached Light Non-SS Metal [P024] Light Non-SS Scrap Metal, Not Prepared for Leaching [P014] Metal Scrap (Non-SS) [C063] Light Non-SS Metal, Not Prepared for Leach [C063] Non-Leached Light Metal [P063] Light Metal [P001]	December 1972 – May-1988
481	Leached Non-SS Metal [P024] Light Non-SS Scrap Metal Prepared for Leaching [P014] Metal Leached (Non-SS) [C063] Light Non-SS Metal Prepared for Leach [C063] Leached Light Metal [P063]	May 1980 – October 1984

Item Description Code 480, Light Metal: This waste consists of light metal generated by the plutonium production, recovery, treatment, laboratory, and maintenance operations in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 [P012, P052]. Light metal includes iron, copper, aluminum, brass, bronze, galvanized metal, stainless steel, carbon steel, and other metal alloys. The metals consist of mechanical and electrical parts, tools, containers, scrap metals, piping, wire, cable, gauges, valves, foil, planchets, batteries, and a variety of other metal items [P052]. The metals may be contaminated with residual amounts of solvents, acids, bases, and other reagents used in the processes where they were generated [P083]. Solvent-contaminated metals were not sorted from nonsolvent-contaminated metals [P114]. Beryllium, pyrophoric metals, and heavy non-SS metal are excluded from IDC 480 [P032]. The waste may also contain limited amounts of combustible wastes [P024].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the light metals wastes are listed in Tables 16-2 and 16-4 for IDCs 480 and 481, respectively [P222]. Typical waste material parameters, including typical packaging materials for the wastes as identified for the 3,100 m^3 Project are presented in Tables 16-3 and 16-5 [P222].

Item Description Code 481, Leached Light Metal: This waste consists of light metal that was washed with hot water in Building 776 to remove radioactive surface contamination. Leached light metal consists of the same metals in IDC 480 and originated from the same buildings and processes as IDC 480 [P014, P024].

Table 16-2. Items Identified by RTR for Unleached Light Metals Waste (IDC 480) During the 3,100 m^3 Project [P222].

Item	Comment
Miscellaneous Cellulosics	Items such as wipes, paper, cardboard roll ends, wood, and coveralls were identified.
Miscellaneous Glass Items	Small glass containers and Raschig rings were identified during RTR examinations.
Miscellaneous Items—Lead	Lead-containing items include leaded rubber gloves, lead tape, leaded rubber apron, lead shielding, and lead sheeting.
Rubber Gaskets	Described in EGG-WM-6503 [P015].
Inorganic Liquid	Small quantities of free liquids were detected in several drums and assigned to other inorganic materials by RTR. The RTR also identified the presence of 4 pints of heavy liquid (paint). The drum was dispositioned as ***Treatment.*** Containers with liquids exceeding the WIPP waste acceptance criteria (WAC) were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.
Light ballast	Waste light ballasts generated prior to January 1, 1979 must be assumed to contain PCBs. All containers were screened for light ballasts. Any container identified with light ballasts was not shipped to WIPP.
Pressurized containers	Several drums contained pressurized containers. Pressurized containers and sealed containers >4 liters do not meet the WIPP WAC. Containers with items prohibited by the WIPP WAC were not shipped to WIPP.
Volrath Cans	RTR examinations indicated Volrath cans were present in some waste containers.
Miscellaneous Plastic Items	Plastic can include surgical gloves, bags, containers, tubing, piping, handles, sleeving, clamshell containers, 90-mil liner lids, and poly sheeting.
Batteries	The RTR examination for several drums indicated that they contained batteries. Batteries may exhibit a toxicity characteristic for lead and/or mercury.
Lead Cell Batteries	Contents of lead cell batteries cannot be verified by real-time radioscopy (RTR) and were dispositioned as *Treatment*. Batteries may exhibit a toxicity characteristic for lead and/or mercury.
Sealed container >4 L	Drums with sealed containers greater than 4 liters were dispositioned as *Treatment*. Pressurized containers and sealed containers >4 liters do not meet the WIPP WAC. Containers with items prohibited by the WIPP WAC were not shipped to WIPP.
Mercury	Mercury was present. The WSPF (INW296.001) discusses fluorescent bulbs containing mercury.

Table 16-2. (continued).

Item	Comment
Light Bulbs	One drum contained 5 light bulbs as other inorganic materials.
Soldering paste	A minor amount of soldering paste was identified during VE and classified as inorganic material. Two MSDSs obtained for soldering paste indicate the ingredients of the paste are neither RCRA-listed nor RCRA characteristics.
Beryllium scrap	Scrap beryllium as Other Metals was identified during VE. The beryllium in this drum was not a discarded commercial chemical project, off-specification species, container residue or spill residue, and therefore is not a hazardous waste.
Sand, blacktop	The RTR examination indicated that a drum contained sand as other inorganic waste material. The RTR also identified 60 pounds of blacktop in another drum.

Table 16-3. Typical Waste Material Parameters for Unleached Light Metal Waste (IDC 480) for the 3,100 m^3 Project [P222].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags, inner container bags, possible poly bottles
Iron Metals/Alloys	Metal waste items
Other Metals	Copper, lead, etc.
Aluminum Metals/Alloys	Aluminum waste items
Other Inorganic Materials	Glassware, Raschig rings
Cellulosics	Cardboard liner, Fibre-Pak, wipes, tape
Plastics	Bags, bottles, tubing
Rubber	Rubber gloves

Table 16-4. Items Identified by RTR for Leached Light Metals Waste (IDC 481) During the 3,100 m^3 Project [P222].

Item	Comment
Batteries	Batteries may exhibit a toxicity characteristic for lead and/or mercury.
Miscellaneous Items– Lead	Lead sheeting, lead pieces
Volrath cans	RTR examination indicated that a Volrath can was present in the waste.
Inorganic liquid	RTR examination indicated liquid greater than one inch. The drum was dispositioned as Treatment. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.

Table 16-4. (continued).

Item	Comment
Miscellaneous plastic items	The RTR examination indicated drums with poly bottles as plastic waste material.
Pressurized containers	RTR examination indicated that pressurized containers were present in some drums. Pressurized containers do not meet the WIPP WAC. Containers with items prohibited by the WIPP WAC were not shipped to WIPP.
Miscellaneous cellulosics	Several drums contained "wood handles." One filter was identified as cellulosics.
Glass	Drums have contained small glass containers.
Light Ballast	The RTR examination identified a light ballast as Iron-Based Metals/Alloys. Due to suspect PCBs, the drums were dispositioned as *Treatment*. All containers were screened for light ballasts. Any containers with light ballasts were not shipped to WIPP.

Table 16-5. Typical Waste Material Parameters for Leached Light Metal Waste (IDC 481) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags, inner container bags, possible poly bottles
Iron Metals/Alloys	Metal waste items
Other Metals	Copper, lead, etc.
Aluminum Metals/Alloys	Aluminum waste items
Other Inorganic Materials	Glassware, Raschig rings
Cellulosics	Cardboard liner, fibre-pak, wipes, tape
Plastics	Bags, bottles, tubing
Rubber	Rubber gloves

16.1 Waste Generation

Light metal was generated by production, recovery, purification, laboratory, treatment, maintenance, and research and development activities associated with plutonium operations at the site. Process flow diagrams for metal waste generating processes are provided in archived WSRIC information [U091, P060, P061, P062, P070, P077, P078, P079, P081, P082].

16.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the construction of Building 707 in 1972. Building 707 was constructed after the 1969 fire in Building 776 which shut down foundry and machining operations in that building [P053]. The foundry in Building 707 cast molten

plutonium into classified components, subassemblies, and assemblies. Other parts were manufactured by rolling, forming, and machining plutonium ingots also cast in the foundry. Components were assembled using a number of welding and joining techniques in Buildings 707, 777, and 779. Production support operations in Buildings 707 and 777 included a variety of inspection, calibration, measurement, weighing, leak testing, and cleaning activities to assure that the parts met stringent specifications. Rejected plutonium parts, scraps, and turnings were returned to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to Building 771 to be recovered [P052, P053]. Typical light metal generated included chips, turnings, tools, and molds [P083].

Halogenated solvents were used in production operations to clean and degrease plutonium parts and metal. In addition, the solvents were used with cutting oils to cool plutonium parts during machining. Carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloroethylene, and methylene chloride were the primary solvents historically used during plutonium production. Tetrachloroethylene was replaced by 1,1,1-trichloroethane for degreasing during the 1973 time frame [P023, P052]. Several nonhalogenated solvents were also used for cleaning and degreasing, primarily during efforts to reduce use of halogenated solvents. These solvents included isopropyl alcohol, ethanol, and acetone [P052, P067, P053]. Building 777 housed the carbon tetrachloride and 1,1,1-trichloroethane systems that collected and filtered solvents generated during production operations. In addition to parts cleaning and degreasing, solvents were also used to clean plutonium operation glovebox lines [P053].

16.1.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Building 771 housed operations that recovered plutonium from waste materials and other sources [P053]. Plutonium purification was performed primarily in Buildings 371, 771, 776, and 779 [P052].

Recovery operations in Building 771 used acid to dissolve solid materials containing plutonium. The resulting solutions were processed by a series of ion exchange, precipitation, calcination, fluorination, and reduction operations to produce purified plutonium metal to be recycled back into production operations [P053]. During normal glovebox operations, metal tools that were worn or broken were disposed of as light metal waste [P083]. Potassium hydroxide, potassium fluoride, hydrogen peroxide, and nitric, hydrochloric, and hydrofluoric acids were the primary reagents used for plutonium recovery operations [P061, P067, P083, U047].

Plutonium metal from returned parts and metal from other DOE facilities was purified at Rocky Flats. Plutonium-241 decays to americium-241, which decreases the effectiveness of the plutonium parts. Plutonium parts were disassembled in Building 777 [P053, P113]. Beginning in 1967, the molten salt extraction (MSE) process in Building 776 recovered americium from plutonium metal using sodium chloride, potassium chloride, and magnesium chloride [P053]. Americium was separated from the MSE residue salts using potassium hydroxide precipitation followed by an ammonium thiocyanate anion exchange process. In 1975, the process changed to cation exchange followed by anion exchange (no thiocyanate) and then precipitation using oxalic acid [P113, U047]. The process changed again the following year to the salt scrub process that used a magnesium/zinc or a magnesium/aluminum extractant [U047]. The purified plutonium metal from MSE was either sent to the foundry in Building 707 or sent to the electrorefining process in Building 371 or Building 776 if the metal contained other impurities [P053, U047]. Metal chips were generated from disassembly, and stainless steel and aluminum cans were generated from the MSE and electrorefining processes [P083].

Spray leaching (Building 771) and hydride leaching (Building 779) also used acids to remove plutonium surface contamination from uranium metal and other metals or beryllium contamination from plutonium metal. These processes used nitric, hydrochloric, sulfuric, and sulfamic acids [P053, P061, P062].

16.1.3 Laboratory

Buildings 371, 559, and 771 housed the main analytical laboratories at the site. The laboratories' primary functions were to provide analytical support to production activities in addition to supporting recovery, purification, and liquid waste treatment operations. Each of the laboratories used numerous acids, bases, solvents, and other chemical reagents.

Building 371 had an analytical laboratory and a chemical standards laboratory. The chemical standards laboratory prepared standards for various users and inspected standards that had been used in the field. The analytical laboratory analyzed samples from various operations on site [P081]. The types of analyses performed included:

- Total alpha activity
- Isotopic analysis
- X-Ray emission
- X-Ray diffraction
- Plutonium, uranium, and americium content
- Corrosivity
- Ignitability

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process. The types of analyses performed included [P067].

- Emission spectroscopy
- Atomic absorption
- Infrared analysis
- Gallium analysis
- Plutonium assay
- Carbon analysis
- Uranium analysis
- Raschig ring analysis
- Tritium analyses
- Non-routine chemical analysis
- Anion/cation solution analysis
- Isotopic analysis
- Thermal analysis
- Gas analysis
- Spark source mass spectroscopy
- X-ray analysis

Building 771 housed analytical and chemical standards laboratories. The chemical standards laboratory prepared control sample standards for the analytical laboratories in Buildings 371, 559, and 771 [P061]. The analytical laboratory provided analyses in support of plutonium operations. The types of analyses performed included [P061, P067].

- X-Ray fluorescence
- Alpha/gamma scintillation
- Atomic absorption
- Laser fluorimetry
- Spectrophotometry
- Calorimetry
- Gamma spectroscopy
- Titrations

The laboratories generated light metal wastes such as tools, planchets, and metal labware. Silver and lead solder and printed circuit boards containing cadmium, chromium, lead, and silver were also generated [P061]. These wastes may have contacted reagents and solvents used in the laboratories including:

Acids/Bases

- boric [P067]
- hydrochloric [P061, P067, P081]
- hydrofluoric [P061, P067, P081]
- nitric [P061,P067, P081]
- perchloric [P067]
- phosphoric [P067]
- sodium hydroxide [P061, P067, P083]
- sulfamic [P067]
- sulfuric [P067, P083]
- tartaric [P067]

Reagents

- ammonium hydroxide [P083]
- ammonium molybdate [P067]
- ceric ammonium nitrate [P067]
- ceric sulfate [P083]
- ferrous sulfamate [P067]
- ferric chloride [P067]
- potassium bromide [P083]
- potassium chloride [P067]
- sodium fluoride [P067]
- total ionic strength adjusting buffer (contains diaminocyclohexane tetraacetic acid) [P061]
- trioctyl phosphene oxide [P061, P081]

Organic Solvents

- acetone [P083]
- benzene [P053]
- carbon disulfide [P083]
- carbon tetrachloride [P053, P067, P083]
- chloroform [P053, P067, P083]
- cyclohexane [P061]
- ethanol [P083]
- isooctane [P083]
- isopropanol [P083]
- methanol [P083]
- methylene chloride [P053, P083]
- petroleum ether [P083]
- toluene [P083]
- tributyl phosphate [P083]
- 1,1,1-trichloroethane [P083]
- trichloroethene [P083]
- 1,1,2-trichloro-1,2,2-triflouroethane [P067, P083]
- xylene [P083]

16.1.4 Research and Development

Research and Development (R&D) included activities related to production, recovery, and purification as well as "special order" work. Building 779, which was built in 1965, housed many of the R&D operations at the plant. Other areas at the plant supporting R&D included Buildings 559, 771, 776, 777, and 881 [P053].

The purpose of Building 779 was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials, which might be used in plutonium operations. Other activities in Building 779 included developing improvements to the manufacturing process and finding new ways to recover plutonium and associated actinides. Another function was to develop a better understanding of the aging and shelf-life limitations of Rocky Flats products. Most of the materials used and wastes generated in this facility were the same as those in the production and recovery buildings, as

much of the work conducted involved improvement of existing processes [P053]. However, processing of neptunium, curium, and cerium was also conducted [P053, U047].

The plant has conducted special order work for other facilities in the DOE complex, the DOD, or other federal departments or agencies. One example is the introduction of radionuclide tracers into pits destined for off-site test shots. This work took place in the 1960s and well into the 1970s. Materials such as americium-240, plutonium-238, neptunium, curium, and cerium were blended in with the regular component materials for the purpose of studying performance of the different weapon components based on post-test distribution of the rare tracers. These tracer materials were kept separate from the regular production material streams, and special recovery operations in Building 771 specialized in recovering these more exotic materials [C072, P053].

From approximately 1959 to the mid-1970s, Rocky Flats was involved in "Project Plowshare." The mission of the program was to develop technology for using nuclear explosives for peaceful applications such as excavation and uncovering of deep mineral deposits. Materials used in the manufacturing of these components were the same as those used in the production buildings [P053].

16.1.5 Waste Treatment

Waste processing at Rocky Flats included both liquid and solid process wastes. Liquid waste treatment operations had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building 771. Radionuclides were removed by precipitation, and the resulting slurry filtered. The solids removed from filters were combined with cement or other solidifying agents. The aqueous waste from this first stage went through a second precipitation [P053]. These processes used sodium hydroxide, ferric sulfate, magnesium sulfate, and calcium chloride [P109]. See Section 23.0, Solidified Aqueous Sludge Building 774, for a detailed description of these processes.

Around 1965, an evaporator was installed in Building 774 to treat liquids from the second stage treatment and from the solar ponds. The concentrate from the evaporator was introduced into a steam-heated double-drum drier, which produced a salt waste. The Building 774 evaporator was taken out in 1979, and the liquids from the second stage treatment and solar ponds were, from that point forward, transferred to Building 374 for additional treatment [P053].

Building 774 also processed organic liquid wastes. Plutonium-contaminated organic liquids were generated from plutonium machining [P053]. The spent organic liquid was filtered and then mixed with a solidifying agent. The process was later changed to a one step process in which the organic liquid was mixed with Envirostone (gypsum cement) and allowed to set up [P109]. See Section 25.0, Solidified Organic Waste for a detailed description of these processes.

Treatment of solid transuranic wastes was conducted in Buildings 771 and 776. Building 771 processed wastes containing plutonium above the EDL while Building 776 processed wastes below the EDL.

Operations in Building 771 processed wastes including Raschig rings, HEPA filters, and sludges from the filter plenum and from process piping. Filters were disassembled to remove plutonium-contaminated dust. Process piping removed from service was cut up and discarded as light metal waste after it was cleaned of built-up sludge. Sludge from the process piping and from the filter plenum was dissolved in nitric acid to recover plutonium. Until 1984, plutonium was recovered from Raschig rings by nitric acid leaching [P061].

Size reduction in Building 776 removed materials from drums and sorted them in an airlock vault. Materials such as light metals, filters, glass, combustibles, and Raschig rings were then put into containers with like materials [P067]. Light metal above the EDL was washed with hot water in an attempt to remove radioactive surface contamination, and then reassayed [C053, C082, P024]. The metals were washed by hand from 1971 to 1973, and a ball-mill washer was used from 1974 until the process was discontinued in 1989 [P024, P052]. If washing reduced the assay to below the EDL, the metal was discarded as IDC 481 [C053, P024].

Advanced size reduction operations in Building 776 disassembled or cut plutonium-contaminated gloveboxes and miscellaneous large equipment into sizes that could be packaged in approved containers [P067, P110].

The fluidized-bed incinerator in Building 776 received low-level plutonium-contaminated combustible solid and liquid wastes [P052, P067]. Building 771 also housed an incinerator for processing combustible wastes [P061, U047]. If drums of the solid combustible wastes contained any metal, the metal was removed prior to feeding the combustibles to the incinerator [P061, P067]. See Section 14.0, Incinerator Waste, for a detailed description of the incineration processes.

16.1.6 Maintenance

Routine and non-routine maintenance at Rocky Flats included utilities, change-out of oils and Raschig rings, equipment parts replacement, strip-out operations and other general maintenance and cleanup activities.

Utility systems included HVAC systems, fume scrubbers, and process vacuum systems. The HVAC systems contain air supply units for filtering incoming air and plenums for filtering exhaust air [P061, P067, P081]. KW detergent was used for periodic maintenance inside and outside the plenums [P083]. Scrubbers housed in Buildings 371, 559, 771, and 779 used potassium or sodium hydroxide to neutralize acid fumes from various process off-gas streams and glovebox exhaust streams. Process vacuum systems provide an absolute pressure at a vacuum header which serves as a means to transfer fluids on demand by valving arrangements [P061, P067, P081]. Light metal parts and tools were generated from maintenance of motors, fans, and associated systems and circuits [P061, P081].

Oils and Raschig rings are used in numerous processes and require periodic change out. During oil changes, oil filters (possibly terne-plated) were replaced and discarded as light metal waste. During Raschig ring removal, broken bolts, part covers, tools, and other light metals were discarded as waste. Other general maintenance activities, generating metal waste included repair of gloveboxes, tanks, valves, pumps, and piping [P061, P067, P083, P109].

Production, recovery, purification, treatment, R&D, and laboratory operations required various types of machinery, instruments, and other equipment. Parts from the equipment were routinely changed due to normal wear and tear. The replaced parts were then discarded as light metal waste. Parts from Building 374 liquid waste treatment operations may have been contaminated with sludges containing cadmium and lead [P052, P083].

Another maintenance activity that may have generated light metal was the strip-out of glovebox lines, process piping, valves, and associated systems. Strip-out activities were performed when a glovebox line was scheduled to be replaced or during renovation. Solvents such as trichloroethylene or 1,1,1-trichloroethane may have been used during this type of operation for decontamination [P067, P108]. Light metal such as piping from strip-out operations may be contaminated with sludge containing chromium and lead [P052].

Light metal waste such as ducting and equipment may have also originated from cleanup of the 1969 fire which spread through combustible materials in several hundred inter-connected gloveboxes in Building 776 [P024, P053].

Other incidents that may have generated light metal resulting from strip-out activities included:

- the 1974 control valve release in Building 707 which allowed radioactive particulates to escape from an exhaust stack on the roof and into Module K [P053] and

- the tritium release in which tritium-contaminated plutonium was processed from April 9, 1973 through April 25, 1973 in Building 779 causing a tritium release to the atmosphere, as well as elevated tritium levels in surface waters, process wastes, equipment, gloveboxes, and exhaust plenums [P053].

16.2 Waste Packaging

Light metal was placed directly into a lined 55-gallon drum or bagged out of the glovebox line in up to three plastic bags. Some metal may also have been packaged in half-gallon or 1-gallon polyethylene bottles within the plastic bags. After removal from the glovebox, the waste was placed in the drum or in Fibre-Paks, which were then placed in the drum. Prior to packaging, sharp edges were taped or wrapped with paper wipes to prevent puncturing the liners [P012, P015, P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner bag or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A PVC O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners for puncture protection [P012, P063, P064]. Lead drum liners placed between the drum and rigid liner were also used in some instances [P001, P016, P024, P043]. When a drum was full, the drum bags were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

During the 3,100 m^3 Project a number of combinations of drum bags, poly bags, and O-ring bags were identified by RTR examination. Any combination of these plastic bags, provided that 5 layers of containment were not exceeded, did not impact acceptability of the drum for shipment to WIPP. Drums that exceeded the TRUPACT-allowed containment layers were flagged for treatment in TRIPS [P222].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024]. During RTR examinations of containers of this waste, quantities of absorbent were identified that varied significantly from expected quantities, and some drums contained no absorbent. In addition, Oil-Dri® and vermiculite may have been used in some drums outside the expected time periods [P222].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. VE of light metal containers identified a variety of combustible, glass, concrete, lead, and plastic items including wipes, surgical gloves, paper,

Raschig rings, beakers, vials, fluorescent bulbs, leaded gloves, lead tape, scrap lead, rubber gaskets, plastic bags, containers, and tubing. Other items identified included tantalum crucibles, asbestos tie-wraps, aerosol cans, and light ballasts [P009, P015, P016, P017, P021, P022, P033, U011, U015]. Acceptable knowledge confirmation activities have also identified numerous items in a small percentage of the light metal waste containers, including small quantities of liquid, Raschig rings, beakers, vials, rubber gaskets, batteries, light bulbs, lead items (e.g., rubber gloves and aprons, tape, and sheeting), and miscellaneous cellulosic and plastic items [P222].

16.3 Waste Characterization

Light metal was characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, and headspace gas analysis. This section provides a hazardous waste determination based on RCRA and the WIPP WAP requirements for light metal. In compliance with the WIPP WAC, it also discusses the radionuclide contaminants and potential complexing agents contained in the waste. This waste contains at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and is therefore a heterogeneous waste [P141. P213, P222].

Fluorescent light ballasts were identified in light metal waste containers by RTR and VE. The ballasts were assumed to contain greater than 50 ppm PCBs. All containers are being screened for light ballasts. Any container identified with light ballasts was not shipped to WIPP [C198, P222].

16.3.1 Hazardous Waste Determination

The material in this waste group does not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The waste may also exhibit the characteristic of toxicity for cadmium, chromium, lead, mercury, silver, and 1,2-dichloroethane. The waste was mixed with halogenated and nonhalogenated solvents and electroplating wastes, and is therefore an F-listed hazardous waste. There is no evidence that light metal exhibits any other characteristic of hazardous waste [C081, C084]. IDCs 480 and 481 have been characterized similarly due to the fact that the wastes originated from the same process operations [C083]. EPA HWNs applicable to some or the entire light metal waste group are presented by IDC in Table 16-6. These conclusions are supported by the evaluations in Sections 16.3.1.1 and 16.3.1.2.

Table 16-6. Light Metal Waste Characterization.

IDC	Title	EPA HWNs
480	Light Metal	D006, D007, D008, D009, D011, D028, F001–F003, F005–F007, and F009
481	Leached Light Metal	D006, D007, D008, D009, D011, D028, F001–F003, F005–F007, and F009

16.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C, as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials in this waste group are not liquid, and absorbents were added to wastes having the potential of generating free liquids [P012, P015, P024]. Leached light metal (IDC 481) should not exhibit the characteristic of ignitability because ignitable liquids or compressed gases have not been

identified with this waste [P016, P024]. Although light metal waste (IDC 480) has been identified to occasionally contain ignitable liquids or compressed gases (i.e., a container of Dykem® Steel Blue [which has a flash point of <25°C] and an unpunctured aerosol can of WD-40 [which is likely to contain an ignitable propellant] were found in one IDC 480 drum [P015, P091]; and another IDC 480 drum contained an 8 ounce can of xylene and methyl isobutyl ketone (both of which are ignitable liquids [U015]), WIPP-prohibited items (e.g., ignitable liquids, unvented aerosol cans, etc.) were removed prior to shipment. The waste materials are not compressed gases as defined by 49 CFR 173. The waste materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P024]. The materials are not DOT oxidizers as defined in 49 CFR 173. The waste materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, and absorbents were added to wastes having the potential of generating free liquids [P012, P015, P024]. Small amounts of free liquids were identified in some IDC 480 drums. However, analysis of the liquids has shown that the pH does not meet the definition of a corrosive waste [P015]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P015, P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for cadmium, chromium, lead, mercury, silver, and 1,2-dichloroethane.

RTR and VE identified drums of light metal waste containing lead items [P222]. Items in this waste group may also include lead and silver solder; fluorescent bulbs and alkaline batteries which contain mercury; circuit boards containing cadmium, chromium, lead, and silver; and terne-plated oil filters which contain lead. Additionally, light metal wastes from strip-out operations in Building 707 and liquid waste treatment operations in Building 374 may have been contaminated with sludges containing cadmium, chromium, or lead. Light metal may exhibit the characteristic of toxicity for these metals. Therefore, the materials in this waste group are assigned EPA HWNs D006, D007, D008, D009, and D011 since a representative sample of this waste cannot be obtained for verification purposes.

Leaded glass, which contains toxic levels of barium and lead, has been identified in light metal containers at Rocky Flats. RTR and VE have not identified leaded glass in light metal containers stored at INEEL [P222]. EPA HWN D005 will not be assigned to this waste unless leaded glass is identified during RTR or VE.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating light metal. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Light metal wastes may also be contaminated with 1,2-dichloroethane, the source and concentration of which is unknown. Headspace gas sampling results for light metals waste from the INEEL 3,100 m^3 Project confirmed the presence of 1-2,dichloroethane, although the calculated UCL_{90} was less than the PRQL [U060, P213]. EPA HWN D028 was conservatively assigned to the waste based on AK and the initial headspace gas data [P213, P222]. The final statistical evaluation for all headspace gas data for this waste stream is presented in Table 16-7.

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene were used for cleaning and degreasing. Benzene was used in laboratory analysis. Since these compounds were typically used as solvents, the waste is regulated as a listed hazardous waste and not a characteristic waste because these compounds are specifically addressed in the treatment standards for the listed hazardous waste [P080]. Since light metal is characterized as listed hazardous wastes due to spent solvent contamination, the waste is not assigned the EPA HWNs for toxicity due to the presence of these organic compounds.

Table 16-7. Statistical evaluation of all HSG Results for the Light Metals Waste Stream (INW296.001, IDCs 480, 481) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	249	239	59.7	98.4	950	67.8	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	249	1	0.238	0.422	3.20	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	249	31	1.33	11.9	180	4.12	10	F001/F002[d]
1,1-Dichloroethane	249	89	0.792	2.73	31.0	1.17	10	N/A
1,1-Dichloroethylene	243	40	0.447	1.18	15.5	0.690	10	N/A
1,2,4-Trimethylbenzene	249	38	0.257	0.404	3.30	0.342	10	N/A
1,2-Dichloroethane	249	40	0.233	0.347	2.55	0.304	10	D028[d]
1,3,5-Trimethylbenzene	249	27	0.219	0.373	3.25	0.313	10	N/A
Acetone	249	221	17.2	24.9	140	19.3	100	F003[d]
Benzene	249	103	0.407	0.610	4.90	0.485	10	F005[d]
Bromoform	244	0	0.147	0.251	2.00	b	10	N/A
Butanol	249	95	1.38	4.61	61.0	1.99	100	N/A
Carbon tetrachloride	249	84	7.79	54.6	700	15.5	10	F001/F002[c]
Chlorobenzene	249	7	0.188	0.326	2.70	0.366	10	N/A
Chloroform	249	122	1.49	7.86	100	2.41	10	N/A
Cis-1,2-dichloroethylene	244	4	0.209	0.370	3.00	0.512	10	N/A
Cyclohexane	249	20	0.319	1.01	12.0	0.618	10	N/A
Ethyl benzene	249	58	0.456	1.51	20.0	0.713	10	N/A
Ethyl ether	244	0	0.326	0.566	4.35	b	10	N/A
Methanol	249	3	4.81	6.91	74.0	12.3	100	F003[d]
Methyl chloride	73	29	2.13	3.39	16.5	2.96	10	N/A
Methyl ethyl ketone	244	182	9.64	102	1,600	19.4	100	N/A
Methyl isobutyl ketone	249	46	0.647	4.32	67.0	1.47	100	N/A
Methylene chloride	249	104	9.66	127	2,000	25.7	10	F001/F002[c]
Tetrachloroethylene	249	14	0.285	1.04	12.0	0.661	10	F001/F002[d]

Table 16-7. (continued).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
Toluene	249	235	16.9	23.6	130	18.9	10	F005[c]
Trans-1,2-dichloroethylene	97	0	0.290	0.551	4.25	b	10	N/A
Trichloroethylene	249	169	13.1	41.1	500	17.1	10	F001/F002[c]
m&p-Xylene	244	94	0.956	4.62	60.0	1.57	10	F003[d]
o-Xylene	244	66	0.388	1.10	14.0	0.563	10	F003[d]

a. When a measurement is reported as below detection, one-half the analysis method detection limit (MDL) is used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

16.3.1.2 Listed Hazardous Waste. The materials in this waste group are listed hazardous wastes because they were mixed with listed waste as defined in 40 CFR 261, Subpart D as a hazardous waste from non-specific sources (40 CFR 261.31). The materials are not, or were not mixed with, hazardous wastes from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were identified in the AK record as used in production, laboratory, and maintenance operations that generated the wastes. Light metal wastes may be contaminated with residual amounts of these spent solvents. Recent confirmatory headspace gas sampling of light metals waste drums at the INEEL confirmed the presence of 1,1,1-trichlorethane, carbon tetrachloride, methylene chloride, and trichloroethylene with calculated UCL_{90}s greater than their respective PRQLs (Table 16-7) [P213]. This waste stream was assigned EPA HWNs F001 and F002.

Acetone, methanol, and xylene were used in laboratory operations. Acetone may also have been used during production operations. In addition, a small container of xylene and methyl isobutyl ketone was found in a drum of light metals waste (Section 16.3.1.1). Light metals may be contaminated with residual amounts of these spent solvents. Headspace gas sampling results from the INEEL 3,100 m^3 Project confirmed the presence of acetone, methanol, and xylene in many samples, although the calculated UCL_{90}s were less than their respective PRQLs [P213]. However, acetone was detected in 37 of the initial 38 headspace gas samples for the 3,100 m^3 Project and the EPA HWN F003 was conservatively assigned in the WSP for containers shipped to WIPP [P213].

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating light metal wastes. Therefore, this waste group is not an F004-listed hazardous waste.

Benzene, carbon disulfide, and toluene were used in laboratory operations. Light metal from laboratory operations may have been contaminated with residual amounts of these spent solvents. The presence of toluene and benzene was confirmed in headspace gas samples collected at the INEEL for the 3,100 m^3 Project. Toluene was detected in the majority of samples (with a calculated UCL_{90} greater than

the PRQL) and benzene was detected in many samples (with a calculated UCL_{90} less than the PRQL)(Table 16-7) [P213]. This waste stream was assigned the EPA HWN F005.

Headspace analysis performed on samples of light metal (IDCs 480 and 481) obtained at INEEL, as reported in 1995, also had confirmed the presence of F-listed solvents. The detected F-listed compounds in which the UCL_{90} is above the PRQL are as follows [P033]:

- 1,1,1-trichloroethane
- methylene chloride (IDC 480 only)
- trichloroethylene (IDC 480 only).

Additional F-listed solvents were detected in headspace samples of light metal waste (IDC 480) obtained at Rocky Flats. The detected F-listed compounds in which the UCL_{90} is above the PRQL are [U030]:

- 1,1,2-trichloro-1,2,2-trifluoroethane
- carbon tetrachloride
- acetone
- ethyl benzene
- methanol
- methyl isobutyl ketone
- toluene.

Aqueous waste treatment operations in Buildings 374 and 774 treated spent stripping, cleaning, and plating solutions from Building 444 electroplating operations [P052]. The Building 444 electroplating operations utilized cyanide [P067], and therefore the Buildings 374 and 774 wastewater treatment operations received F007 and F009 wastes, and generated an F006 wastewater treatment sludge. Light metal wastes may be contaminated with residual amounts of the electroplating wastes, and the associated EPA HWNs F006, F007, and F009 were assigned to the waste stream.

The materials in this waste group are not hazardous waste from specific sources since the wastes were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous wastes.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

16.3.2 Radionuclides

This section identifies the radioisotopes potentially contained in the waste, as well as the chemical form of radionuclide contaminants and radioassay interferences. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted

uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0. Wastes from some of the processes described below may not be contained in the inventory based on the assigned prefixes. However, as explained in Section 16.3.2.6, it is assumed that repackaged drums could contain waste generated from any process.

16.3.2.1 Plutonium Production. Radionuclide contamination in waste from Building 707 will primarily consist of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers [C171, C174, C184, C185, P053, P164, P167].

Building 777 performed disassembly of site-return parts and fabrication operations including machining, briquetting, assembly, and production support processes (container prefixes 0004, 0023, and 0024) [C184, P052, U059, P079]. Wastes from fabrication operations will be contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations will be contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053]. There is documentation of five drums of IDC 480 containing tritium; however, it is not known if they were generated by this process, and the specific drum numbers and package dates are not known [U019].

Buildings 707 and 777 handled actinides in metal or oxide form only [P060, P079]. The actinide metals will likely have partially or completely oxidized because of the reaction with dry air, and some could possibly have formed a hydroxide layer from reaction with moist air. Radioassay interferences may include beryllium from Part V metal fabrication in Building 707, and calcium fluoride which was sprayed onto graphite molds in Building 707 prior to casting [C184, P060]. Other interfering waste contaminants include aluminum, beryllium, and stainless steel (chromium) which were machined in Building 777 [P079].

16.3.2.2 Plutonium Recovery and Purification. Waste from recovery operations in Building 371 contains weapons-grade plutonium primarily from electrorefining [C184, P067]. A limited amount of the waste could also have been generated from aqueous recovery operations which only ran for a short time in 1982. Aqueous recovery operations were designed for recovering and purifying weapons-grade plutonium [C184, P164].

The feed materials to the recovery and purification processes (container prefixes 0001 and 0002) in Building 771 were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated will be contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Radionuclides from aqueous recovery operations will vary widely in chemical form depending on the specific process from which the waste originated. Because the majority of the aqueous processes were performed within one large MBA (container prefixes 0001 and 0002), the specific process can not be determined. The different actinide forms are plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Wastes from the americium recovery glovebox lines (container prefix 0006) in Building 771, used for extraction of americium from site-return plutonium, contains a significant amount of americium-241 [C184, P053, P164, U059]. The americium was in a chloride, hydroxide, nitrate, oxalate, and oxide chemical form during different steps of the process. Prior to 1975, ammonium thiocyanate was also used [P053].

The Oralloy leach process (container prefix 0074) in Building 771 chemically separated plutonium surface contamination from enriched uranium hemishells using nitric acid. The chemical form of the radionuclides are plutonium nitrate and uranyl nitrate [C184, P061, P163, U059.

Wastes generated from Building 771 filter plenum maintenance were assigned container prefix 0009 [C184, P052]. It was assumed that this waste could contain any of the radioisotopes processed in the building.

Site-return metal and other non-specification plutonium were processed by pyrochemical operations in Building 776 (container prefix 0003) to produce plutonium for use in the foundry [C184, P053, U059]. The molten salt extraction process removed americium-241 from site-return and other non-specification plutonium. Electrorefining was used to purify plutonium metal that did not meet foundry specifications. Since metal was the feed and product to the MSE and electrorefining processes, wastes generated from these processes were contaminated with actinide metals which subsequently will have formed an oxide or hydroxide layer by reaction with dry and moist air. Direct oxide reduction was developed to convert plutonium dioxide to plutonium metal [P163, P175]. MSE residue salts, which contain actinide chlorides, were the feed to the salt scrub process. Metal was the product of this process as well, so the radionuclide contaminants may be in a metal, oxide, and/or hydroxide form. Radioassay interferences may include chloride salts (i.e., sodium, potassium, magnesium, calcium, and zinc) [P163].

Hydride operations in Building 779 (container prefix 0055) recovered plutonium from various substrates by reacting plutonium metal with gaseous hydrogen in an argon-inerted glovebox [P052, U059, P062, P163]. Hydriding produced plutonium metal for use in the foundry or non-specification feed to pyrochemical operations, in addition to plutonium oxides sent for aqueous recovery [C184, P062]. The hydriding process formed plutonium hydride which was converted to plutonium dioxide by oxidizing the material in an air atmosphere [P163].

16.3.2.3 Laboratory. The analytical laboratory in Building 371 (container prefix 0071) provided analytical support for process control and performed analyses on feed materials and residues from recovery operations in Building 371 [P053, U059, P081]. The laboratory also analyzed samples from various operations at the site, but primarily from Building 374 [P081]. The Building 371 chemical standards laboratory prepared standards for various users and inspected standards that were used throughout plant site [P053]. Wastes from these laboratories were contaminated with weapons-grade plutonium and enriched and depleted uranium.

The Building 559 analytical laboratory (container prefix 0029) performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, U059, U073]. The primary mission of this laboratory was analysis of site-return and feed materials, in addition to recovery, purification, and foundry products [P053].

The Building 771 analytical laboratory (container prefix 0037) received samples from recovery operations in the building as well as from the foundry [P067, U059]. The samples included plutonium metal turnings, plutonium oxide, acidic plutonium solutions, and various process residues [P061]. In addition, the analytical laboratory analyzed samples from R&D laboratories in Buildings 771 and 779 (see Section 16.3.2.4) [P067, P061]. The chemical standards laboratory (container prefix 0038) prepared uranium, plutonium, and americium nitrates used as control standards for the Buildings 371, 559, and 771 analytical laboratories [P067, P061]. The laboratory also produced nondestructive assay standards used at drum counters and fluoride standards for chemical operations [P061].

The metallography laboratory (container prefix 0021) in Building 777 prepared and examined metallographic specimens in support of R&D operations (plutonium metallography, nuclear and

nonnuclear joining, quality engineering, and product physical chemistry) and, therefore, may contain any of the radionuclides used during R&D activities (see Section 16.3.2.4) [C184, U059, P079]. The Building 777 tritium surveillance laboratory analyzed solid, liquid, and gas samples from throughout the plant site for tritium content [U078].

Because the laboratories supported all phases of weapons production, the chemical form of the radionuclide contaminants and radioassay interferences varied widely depending on the type of sample analyzed.

16.3.2.4 Research and Development. Projects using transuranic radionuclides were done in Buildings 771, 776, 777, 779, and 881. Most of the documentation pertaining to R&D activities did not specify locations in which the work was performed, and unless otherwise noted, it was assumed that any of the radioisotopes could have been handled in the R&D areas of any of these buildings. In addition to weapons-grade plutonium, americium-241, and enriched and depleted uranium, the following radioisotopes were processed during R&D activities [C134, C137, C185, P053, P164, P167, P189, P190, P194, P195, P198, P200, U064]:

- americium-240
- curium-244
- neptunium-237
- plutonium-238, -240, -241, and -242
- low NGS plutonium (≈3% Pu-240)
- power grade plutonium (up to 20% Pu-240 and 1% Pu-241)
- thorium-228
- uranium-233, -235, -236, and –238.

A summary of the projects and time periods that these and other radionuclides were used is presented in Section 3.0.

In Building 771, special recovery anion exchange (container prefix 0045) separated plutonium from other materials that were not suitable for the regular recovery processes [C154, P052, P061]. Chemical technology (container prefix 0042) conducted aqueous R&D activities while plutonium metallurgy operations (container prefix 0078) performed alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C184, U059, P061]. These processes may have used numerous radioisotopes.

A pilot-scale fluidized-bed incinerator (container prefix 0075) was developed in Building 776 to treat low-level waste [C184, U059]. The waste fed to the incinerator was contaminated with low levels of plutonium [P024].

The coatings laboratory (container prefix 0016) in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium [P052, U059, P079]. This research and development facility supported production processes [P052, P079]. The special weapons area (container prefix 0066) in Building 777 was a research and development facility where war reserve and other specially fabricated parts were assembled. [U059, P079]. The process

was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

Pyrochemical technology (container prefixes 0010 and 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations [P067, U059, P062]. These processes included direct oxide reduction, molten salt extraction, electrorefining, salt scrub for MSE, salt scrub for electrorefining, pyrochemical salt recycle, anode alloy, and pyroredox [C182, P062]. Most of the materials used in Building 779 were the same as those in the weapons-production areas and, therefore, were contaminated primarily with weapons-grade plutonium and enriched uranium [P053]. However, other R&D activities in the building may have used a variety of other radionuclides [C171, C184].

16.3.2.5 Liquid Waste Treatment. Aqueous waste treatment operations in Buildings 374 and 774 received wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. Other radionuclides may also be found in the waste streams from R&D, analytical, and special order work [P164]. Radionuclide contaminants are removed from the aqueous wastes by precipitation using sodium hydroxide and, therefore, will be primarily in the form of hydroxides [P163]. Radioassay interferences may include magnesium sulfate and calcium chloride reagents used in the process [P106, P163].

Building 774 also processed organic liquid wastes. Organic wastes are comprised of a variety of oils and solvents. Most of the oils were from spent lathe coolant used in the plutonium machining area and lubricating oils used in machines throughout the plant [P164]. The majority of the transuranic organic liquids were oils and solvents from plutonium machining and degreasing operations in Buildings 707 and 777 and, therefore, were contaminated with actinide metals and oxides [P052]. A more detailed discussion of the wastes treated in these buildings is provided in Sections 22.0 through 25.0.

16.3.2.6 Size Reduction/Repackaging/Solid Waste Treatment. Repack operations (container prefix 0076) in Building 371 involved the repackaging of residues for off-site shipment to other DOE facilities and the repackaging of wastes and residues for on-site storage [P081, U059]. Residues and wastes repacked for off-site shipment included plutonium oxides, incinerator ash, molten salt, electrorefining salt, cell scrape out, and anode heels. Wastes and residues were received from either the stacker/retriever (container prefix 0043) in Building 371 or from one of several 10- and 55-gallon drum storage areas within Building 371 [P081, U059].

The SRV in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (container prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (container prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, U077]. Size reduction included cutting up gloveboxes or ducting, and crushing HEPA filters. Solid waste treatment activities included washing leaded gloves and scrap metal with hot water in a ball-mill washer to recover plutonium [C053, P067, P164].

16.3.2.7 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC [P327]. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239,

-240, and –241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay includes high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities are calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P222].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 16-8. The user of this document can use this table to determine the building or area of generation for containers in the INEEL inventory identified by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by item description code (IDC), container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

16.3.2.8 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for light metals wastes are summarized in Tables 16-9 and 16-10. The overall yield for light metals radioassay data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 16-9 and Table 16-10, respectively. The data for the individual radioassay systems information are contained in EDF-3374, “Radioassay Data Collected During 3100 Cubic Meter Project” [P322].

Table 16-8. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
480	371	0017	Note a	1/3/73 - 2/16/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[e]
480	371	0017	Aqueous Recovery	8/6/82 - 1/24/84	WG Pu, ^{241}Am
480	371	0030	Note b	3/18/82 - 2/16/83	WG Pu, EU, ^{241}Am, DU
480	371	0034	Aqueous Recovery	1/17/83 - 1/17/83	WG Pu, ^{241}Am
480	371	0036	Note a	5/3/73 - 6/19/80	WG Pu, EU, ^{241}Am, DU, ^{233}U[e]
480	371	0039	Note b	1/10/83 - 5/28/83	WG Pu, EU, ^{241}Am, DU
480	371	0048	Note b	5/21/82 - 1/17/83	WG Pu, EU, ^{241}Am, DU
480	371	0073	Aqueous Recovery	7/27/82 - 12/21/82	WG Pu, ^{241}Am

Table 16-8. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
480	371	0076	Note a	7/25/80	WG Pu, EU, ^{241}Am, DU, ^{233}U[e]
480	371	0076	Repackaging Residues	10/13/81 - 10/13/81	WG Pu, EU, ^{241}Am, DU
480	371	0092	Aqueous Recovery	5/21/82 - 9/23/83	WG Pu, ^{241}Am
480	374	0749	Liquid Waste Treatment	11/11/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	559	0029	Analytical Laboratory	3/26/81 - 8/8/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	707	0012	Foundry and Casting Operations	6/16/80 - 4/23/85	WG Pu, EU[f]
480	707	0015	Metal Fabrication-Part V	12/10/81 - 12/14/82	WG Pu, EU[f]
480	707	0018	Note c	12/19/72 - 12/19/72	WG Pu
480	707	0022	Metal Fabrication-Machining	4/22/82 - 1/15/86	WG Pu
480	707	0028	Note c	10/15/80 - 11/2/82	WG Pu, EU[f], DU[f]
480	707	0031	Metal Fabrication-Assembly	4/23/73 - 2/26/84	WG Pu, EU[f]
480	771	0001	Aqueous Recovery	12/27/72 - 1/6/73	WG Pu
480	771	0002	Aqueous Recovery	1/24/73 - 6/15/84	WG Pu, EU[f], DU[f]
480	771	0005	Aqueous Recovery	10/23/81	WG Pu
480	771	0006	Aqueous Recovery (Americium)	6/19/80	WG Pu, ^{241}Am
480	771	0009	Aqueous Recovery (Filter Plenums)	10/22/80 - 5/7/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	771	0037	Analytical Laboratory	6/19/80 - 8/13/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	771	0037	Analytical Laboratory	2/15/83	WG Pu, EU, ^{241}Am, DU
480	771	0038	Chemical Standards Laboratory	6/19/80 - 11/20/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	771	0042	Chemical Technology	11/11/80 - 2/19/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	771	0074	Oralloy Leach	8/8/80 - 2/19/82	EU, WG Pu
480	771	0078	Plutonium Metallurgy Development	3/24/83 - 6/7/84	WG Pu, EU, ^{241}Am, DU
480	771/881	0045	Note d	6/16/80 - 3/18/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	776	0003	Pyrochemical Operations	2/20/81 - 11/10/86	WG Pu, ^{241}Am
480	776	0019	Size Reduction	7/10/81 - 3/20/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	776	0025	Drum Repack	11/11/80 - 5/16/84	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	776	0026	Size Reduction	6/2/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	776	0041	Waste Processing/Final Packaging	3/14/84 - 6/4/84	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	776	0075	Waste Processing Development	1/8/73 - 7/21/81	WG Pu
480	777	0004	Radioscopy	4/23/82	WG Pu, EU
480	777	0016	Coating Laboratory	6/19/80 - 3/24/83	WG Pu, EU
480	777	0021	Metallography Laboratory	1/19/82 - 2/15/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	777	0023	Metal Fabrication-Machining	6/19/80 - 11/14/84	WG Pu, EU
480	777	0024	Metal Fabrication-Disassembly	10/8/81 - 5/13/88	WG Pu, EU
480	777	0066	Special Assembly	10/6/81 - 4/23/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	777	0066	Special Assembly	6/7/84 - 6/7/84	WG Pu, EU, ^{241}Am, DU
480	779	0052	Pyrochemistry Process Development	9/10/81	WG Pu, ^{241}Am, EU[f]
480	779	0054	Research and Development	6/19/80 - 12/22/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
480	779	0054	Research and Development	2/21/83 - 4/14/83	WG Pu, EU, ^{241}Am, DU
480	779	0055	Hydride Operations	10/23/81 - 6/7/84	WG Pu, EU[f]
480	865	0056	Material Tech.-General Metallurgy	1/9/81 - 4/28/83	WG Pu, EU, ^{241}Am, DU, ^{233}U[e]

Table 16-8. (continued).

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
481	371	0076	Repackaging Residues	4/28/83	WG Pu, EU, ^{241}Am, DU
481	371	0092	Aqueous Recovery	6/21/82 - 4/28/83	WG Pu, ^{241}Am
481	707	0022	Metal Fabrication-Machining	5/12/83	WG Pu
481	707	0031	Metal Fabrication-Assembly	12/21/82 - 10/12/84	WG Pu
481	771	0002	Aqueous Recovery	5/21/82 - 5/21/82	WG Pu
481	776	0019	Size Reduction	5/28/80 - 8/15/84	WG Pu, EU, ^{241}Am, DU, ^{233}U
481	776	0025	Drum Repack	11/11/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
481	776	0026	Size Reduction	9/5/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
481	777	0023	Metal Fabrication-Machining	9/16/81	WG Pu, EU

a. Building 371 was not in operation when this waste was generated.

b. This prefix was assigned to an MBA in Building 371 that is not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

c. This prefix was assigned to an MBA in Building 707 that is not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 707 unless the IDC further defines what radionuclides are in the waste.

d. Prefix 0045 appears to have been assigned to MBAs in both Buildings 771 and 881 at different times. Prefix 0045 was used for Special Recovery Anion Exchange in Building 771 and Construction Management in Building 881.

e. Because the historical information for these prefixes did not definitively identify radionuclides for these container prefixes, all TRU radionuclides (WG Pu, EU, ^{241}Am, DU, and ^{233}U) are listed for these prefixes as a conservative measure.

f. Isotopes added by confirmatory radioassay.

WG = weapons grade EU = enriched uranium DU = depleted uranium

16.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, U043]. Oxalic acid was also used for americium recovery [P113]. Light metal may be contaminated with trace quantities of these complexing agents.

16.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For light metals wastes, the yield of successful RTR examinations was approximately 81% [P323]. Conversely, approximately 19% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: presence of excess free liquids; presence of pressurized containers; PCBs present; did not meet the criteria for protection against sharp objects; absence of prohibited items could not be verified; presence of sealed inner containers greater than 4 liters; unverifiable IDC; and layers of containment were exceeded [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

Table 16-9. Overall Radioassay Yield for Light Metals Wastes [P322].

Total number of:	Number	Percentage of Total
Distinct containers	808	
"WIPPOK" containers	515	64%
"Treatment" containers	49	6%
"Deficient / Permanently Rejected" containers	244	30%

Table 16-10. Radionuclide and Related Quantities for Light Metals Waste[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	1.086E+00	2.329E+00	-2.619E-03	2.304E+01	647
TRU Activity (Ci)	1.086E+00	2.331E+00	-2.627E-03	2.309E+01	647
TRU Activity Concentration (nCi/g)	1.887E+04	4.174E+04	-2.463E+01	4.533E+05	647
Thermal Power (W)	3.333E-02	7.261E-02	-8.222E-05	7.252E-01	665
Thermal Power Density (W/ft^3)	4.535E-03	9.879E-03	-1.119E-05	9.866E-02	665
Plutonium Fissile Gram Equivalent (g)	1.160E+01	2.574E+01	-3.098E-02	2.619E+02	658
Americium-241 (g)	5.765E-02	1.272E-01	-4.595E-05	1.226E+00	550
Plutonium-238 (g)	1.705E-03	3.638E-03	-4.923E-06	2.908E-02	631
Plutonium-239 (g)	1.180E+01	2.583E+01	-3.083E-02	2.605E+02	631
Plutonium-240 (g)	7.323E-01	1.596E+00	-1.927E-03	1.584E+01	631
Plutonium-241 (g)	1.850E-02	4.245E-02	-4.595E-05	4.791E-01	631
Plutonium-242 (g)	3.693E-03	9.401E-03	-8.206E-06	1.191E-01	640
Uranium-233 (g)	3.575E-01	2.409E-01	7.949E-02	5.049E-01	3
Uranium-234 (g)	1.279E-03	5.458E-03	2.042E-06	5.696E-02	143
Uranium-235 (g)	1.127E+00	3.670E+00	3.221E-03	2.848E+01	127
Uranium-238 (g)	5.078E+02	2.527E+03	6.150E-01	1.340E+04	28

a. The absence of ^{137}Cs is verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

c. The negative low values are from the "Deficient / Permanently Rejected" category. These assays are outside the systems capabilities. Since this report is merely summarizing the data stored in TRIPS the values were left in for completeness.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

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17. MISCELLANEOUS CEMENTED WASTE

This waste group includes various sludges, particulates, and heels that were cemented prior to disposal. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 17-1 [U092].

Table 17-1. Miscellaneous Cemented Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
806	Cemented Filter Sludge [P063]	April 1987-March 1988
	Cemented Process Solids [P012]	
	Solidified Process Solids [P001]	
823	Cemented Miscellaneous Sludge [P063]	January 1987-March 1987

Item Description Code 806, Solidified Process Solids: This waste consists of various sludges, particulates, and heels immobilized into a solid monolith with Portland cement [P001, P039, P098]. The sludges may have originated from filter plenums, Nash pumps, laboratories, the plutonium recovery incinerator, or the size reduction facility. Particulates and heels included graphite; incinerator ash, soot, and fire brick; and sand, slag, and crucible wastes. Additional particulate materials included ion-exchange resins, grit blasting media, and salt from clean-out of pyrochemical process lines [P001, P039].

Item Description Code 823, Cemented Miscellaneous Sludge: This waste consists of various wastes immobilized into a solid monolith with Portland cement. It is presumed that the generation source of the materials cemented is the same for both IDC 806 and IDC 823 [P016].

17.1 Waste Generation

Particulate- and sludge-type wastes were immobilized by mixing with Portland cement and water [P001, P016]. Some of the wastes to be immobilized were first washed with water to remove residual materials. Portland cement and water were mixed and the waste to be solidified was added to the mixture. The slurry was poured into a 1-gallon polyethylene container mold. After the mixture cured, the cemented pucks were removed from the molds and placed in a 55-gallon drum [P098]. A brief description of the wastes that were immobilized is presented by IDC in Table 17-2 [P001, P039]. Process flow diagrams for miscellaneous cemented waste generating processes are provided in archived WSRIC information [P060, P061, P062, P070, P077, P078, P079, P081, P082].

Sludge wastes were cemented separately as were resin wastes. Particulate wastes, such as grit, ash, and heel, may have been mixed together prior to immobilization [P098]. Even though the sludges and resins were cemented separately, no documentation was available to determine which drums contain the sludges or resins [C044]. Therefore, it will be assumed that miscellaneous cemented wastes (IDCs 806 and 823) may contain any of the wastes that were immobilized.

Table 17-2. Description of Wastes that were Immobilized with Cement [P001, P039].

IDC	Title	Description
159	Screenings from Oxide	Miscellaneous floor sweepings too large to sift through a screen mesh. May contain fine particles, metal, and glass.
290	Filter Sludge	Sludge from filter plenums and Nash pumps.
291	Dried Lab Waste Fluoride Sludge	A more detailed description for this waste was not identified.
292	Incinerator Sludge	Sludge collected from the recovery incinerator in Building 771 (refer to Section 14.0).
310	Graphite Scarfings and Fines	Graphite particles below EDL produced from mold cleaning and floor sweeping.
311	Graphite Heels	Insoluble components remaining after leaching of graphite materials.
332	Oily Sludge	Sludge that contains oil and is not described by another IDC.
340	Sludge from Size Reduction Area	Sludge recovered from cleanup of equipment and clean-out of filter trap.
369	Leco Heels	Insoluble components remaining after leaching of Leco materials.
372	Grit	Grit blasting media in all forms.
373	Fire brick Heel	Insoluble components remaining after leaching of incinerator fire brick.
378	Fire brick, Pulverized or Fines	Particulate fire brick below EDL.
387	Reburned Sand, Slag, and Crucible Sweepings	Floor sweepings from button break-out, calcined to neutralize reactive metals.
390	Unpulverized Slag	Unpulverized slag (calcium fluoride) from button break-out. May contain calcium metal.
391	Unpulverized Sand and Crucible	Unpulverized magnesium oxide sand and crucible from button break-out. May contain calcium metal.
392	Unpulverized Sand, Slag, and Crucible	Unpulverized magnesium oxide sand and crucible and calcium fluoride slag from button break-out. May contain calcium metal.
393	Sand, Slag, and Crucible Heel	Insoluble components remaining after leaching of sand, slag, and crucible.
394	Sand from Button Break-Out	Magnesium oxide sand from button break-out. May contain calcium metal.
395	Unpulverized Slag and Crucible	Unpulverized magnesium oxide crucible and calcium fluoride slag from button break-out. May contain calcium metal.
396	Pulverized Slag	Slag (IDC 390) that has been pulverized in a jaw crusher and hammermill.
397	Pulverized Sand and Crucible	Sand and crucible (IDC 391) that has been pulverized in a jaw crusher and hammermill.
398	Pulverized Sand, Slag, and Crucible	Sand, slag, and crucible (IDC 392) that has been pulverized in a jaw crusher and hammermill.
399	Pulverized Slag and Crucible	Slag and crucible (IDC 395) that has been pulverized in a jaw crusher and hammermill.
413	Impure Salt from Cell Clean-Out	Salts generated from scraping and cleaning of pyrochemical furnace cells. May contain sodium, potassium, magnesium, and calcium metals [P052].

Table 17-2. (continued).

IDC	Title	Description
420	Pulverized Incinerator Ash	Ash from the recovery incinerator in Building 771 that has been pulverized in a ball mill (refer to Section 14.0).
421	Ash Heel	Insoluble components remaining after leaching of ash (IDC 420) (refer to Section 14.0).
422	Soot	Airborne fly ash material that accumulated in the off-gas system of the recovery incinerator in Building 771 (refer to Section 14.0).
423	Soot Heels	Insoluble components remaining after leaching of soot (IDC 422) (refer to Section 14.0).
425	Fluidized Bed Ash	Ash consisting of a fine powder generated by the fluidized-bed incinerator in Building 776 (refer to Section 14.0).
431	Resin, Leached	Ion-exchange column resin below EDL.

17.2 Waste Packaging

Individual containers of processed material were assayed by the in-line can counter. The solidified pucks were then bagged out of the glovebox, double-bagged, and placed into a 55-gallon drum. The individual assay values for containers solidified in a batch and placed in a drum were totaled to provide an assigned assay value for the drum. The drums may have been assayed on a SGS counter or a PADC to verify the assigned assay value. Drums that had not been PADC assayed and had SGS or in-line can counter assay values of 1 gram or less were assayed by PADC to verify that they were transuranic waste [P016].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. Use of 90-mil rigid polyethylene liners began in 1972. A rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags. A polyvinyl chloride O-ring bag and a polyethylene bag placed inside the rigid liner were used if the drum was attached to a glovebox. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P001, P012, P016, P063, P064].

17.3 Waste Characterization

Miscellaneous cemented wastes were characterized based on knowledge of the material, knowledge of the processes generating the waste, and limited analytical data. A RCRA hazardous waste determination for miscellaneous cemented wastes, as well as radionuclide contaminants and potential complexing agents contained in the waste, is provided in this section. This waste does not meet the CH-WAP criteria for classification as debris, and is classified as a homogeneous solid waste [P141].

17.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The wastes may have been mixed with halogenated and nonhalogenated solvents, and are therefore F-listed hazardous waste. There is no evidence that miscellaneous cemented wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or all of this waste group are presented by IDC in Table 17-3.

The hazardous waste determination for the miscellaneous cemented waste group is based on the characterization of the wastes that were immobilized. Sections 12.0–14.0 and 21.0 of this document provide characterization information for IDCs 292, 310, 372, 391, 392, 393, 420, 422, and 425. Limited analytical data are available for IDC 340 [C042]. Constituent information on the remaining IDCs in Table 17-2 was not available.

Table 17-3. Miscellaneous Cemented Waste Characterization.

IDC	Title	EPA HWNs
806	Solidified Process Solids	D004-D011, F001, F002, and F005
823	Cemented Miscellaneous Sludge	D004-D011, F001, F002, and F005

17.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not a liquid, and liquids were not normally associated with waste [P016]. The wastes were inspected before placement in a drum to ensure there was no free liquid [P001]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change. The absence of pyrophoric materials was verified by the generating supervisor and periodic inspection [P016]. In addition, pyrophoric materials would be rendered innocuous by the solidified cement matrix of this waste [P001]. The materials are not compressed gases, and compressed gases were prohibited by procedural control. The absence of compressed gases was verified by the generating supervisor, periodic inspection, and RTR examination [P001, P016]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, and liquids were not normally associated with this waste [P016]. The wastes were inspected before placement in a drum to ensure there was no free liquid [P001]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P001, P016]. Explosives were not handled or used around radioactive material. Reactive materials would be rendered innocuous by the solidified cement matrix of this waste [P001]. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver metals.

The wastes that were cemented may have been contaminated with any of the toxicity characteristic metals. The purpose of the immobilization was to meet the particulate requirements for waste certification. It is uncertain if immobilization of these wastes removed the toxicity characteristic. Therefore, materials in this waste group were assigned EPA HWNs D004–D011. A representative sample of this waste will need to be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating the wastes that were cemented by this process, nor were they used in the cementation process. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

The immobilized wastes may have been contaminated with organic compounds, such as tetrachloroethylene, trichloroethylene, carbon tetrachloride, and methyl ethyl ketone, which were commonly used at Rocky Flats [P023, P053]. However, these compounds were typically used as solvents and are specifically addressed in the treatment standards for listed hazardous waste [P080]. The wastes are regulated as listed hazardous waste and not characteristic waste.

17.3.1.2 Listed Hazardous Waste. The materials in this waste group may have been mixed with waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31). The wastes are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residue, or spill residue thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, and carbon tetrachloride were used commonly for cleaning and degreasing. Methylene chloride was used primarily for paint removal [P023, P053]. The wastes immobilized by the cementation process may have been contaminated with these spent solvents. Miscellaneous cemented wastes were derived from the treatment of listed hazardous waste and therefore, were assigned EPA HWNs F001 and F002.

Acetone, methanol, and xylene were common solvents used at Rocky Flats. The wastes immobilized by the cementation process may have been contaminated with these spent solvents. However, F003-listed solvents are listed solely due to ignitability. Neither the wastes immobilized by the cementation process nor the cemented waste itself exhibits the characteristic of ignitability and therefore these wastes are not assigned EPA HWN F003.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating the wastes immobilized by the cementation process, nor were these solvents used in the cementation process. Therefore, this waste group is not F004-listed hazardous waste.

Toluene and methyl ethyl ketone were common solvents used at Rocky Flats. The wastes immobilized by the cementation process may have been contaminated with these spent solvents. Miscellaneous cemented wastes were derived from the treatment of a listed hazardous waste and are assigned EPA HWN F005.

The materials in this waste group are not hazardous waste from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

17.3.2 Radionuclides

Radionuclide contamination in IDC 806/823 is based on the generating process for the wastes that were immobilized. Several of the wastes, such as graphite (IDCs 310 and 311), grit (IDC 372), resin (IDC 431), and sand, slag, and crucible (IDCs 387 and 390-399) are contaminated primarily with weapons-grade plutonium. Building 771 incinerator wastes (IDCs 292, 373, 378, and 420-423) and pyrochemical salts (IDC 413) may be contaminated with weapons-grade plutonium, americium-241, and enriched uranium. A more detailed description of the processes generating these wastes is provided in Sections 12.0, 13.0, 14.0, 18.0, 20.0, and 21.0.

Additionally, a single drum of IDC 806 was generated by hydride operations (prefix 0055) in Building 779. The hydriding process recovered plutonium from various substrates [P062, P163, U059]. These processes produced plutonium metal for use in the foundry or non-specification feed to pyrochemical operations, in addition to plutonium oxides sent for aqueous recovery [P062, P163].

The SRV in Building 776 conducted repackaging in an airlock (prefix 0025) [P078, U059]. The repacked containers could have been generated from any of the processes that generated miscellaneous cemented wastes [P078].

Table 17-4. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	Radionuclide contaminants may be in several forms. As specified in Table 17-2, screenings from oxide and fluoride sludge are two of the wastes that may have been solidified. Actinide metals and oxides may be present from sand, slag, and crucible (see Section 21.0), hydroxides, oxides, and chlorides from incinerator wastes (see Section 14.0), and nitrates and chlorides from ion exchange resins (see Section 20.0). Actinides should be relatively well distributed throughout the waste, based on the cementing procedure [P098].
Hydrogen Content	Each solidified "puck" contains 600 ml of water [P098]. Hydrocarbons may be present due to oily sludge (IDC 332) and resin (IDC 431) and as contaminants in other wastes that were cemented (see Table 17-2).
Other Interfering Waste Contaminants	Other interferences may include fluoride sludge (Table 17-2), graphite (Section 12.0), aluminum oxide grit and fire brick (Sections 13.0 and 14.0), magnesium oxide sand and crucible, and calcium fluoride slag (Section 21.0).
Physical Matrix Parameters	Waste and waste contaminants should be relatively well distributed throughout the waste, based on the cementing procedure [P098].

17.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239, -240, and-241, and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227, P322]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high

resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P322]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 17-5. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation can in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 17-5. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
806	371	0011	Note a	4/3/87 - 10/14/87	WG Pu, EU, ^{241}Am-
806	371	0032	Aqueous Recovery	3/22/88	WG Pu, EU, ^{241}Am
806	776	0025	Drum Repack	9/2/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
806	779	0055	Hydride Operations	8/21/87	WG Pu
823	371	0011	Note a	1/23/87 - 3/6/87	WG Pu, EU, ^{241}Am

a. This prefix was assigned to an MBA in Building 371 that was not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

WG = weapons grade EU = enriched uranium DU = depleted uranium

17.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS.

Radioassay data were collected in the 3,100 m^3 Project for a waste stream identified as "Miscellaneous Cemented Sludge." Ninety-eight (98) containers were assayed over the life of the 3,100 m^3 Project for this waste stream from IDCs 432, 806, 820, 822, and 823. The radioassay results are summarized for this group of IDCs in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322]. Since only IDCs 806 and 823 are presented in this section, the data are not repeated here.

17.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant. Wastes fed to the recovery incinerator may have contained EDTA (See Section 14.0). Aluminum nitrate was used as a fluoride complexing agent for leaching of materials including graphite, incinerator ash, and sand, slag, and crucible wastes [P061]. Therefore, trace quantities of these compounds may be present in miscellaneous cemented wastes.

17.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. These wastes were not characterized for shipment to WIPP and a WSP was not developed. For the miscellaneous cemented wastes (IDCs 806 and 823), the yield of successful RTR examinations was 100% for each IDC [P323]. Conversely, none of the containers were dispositioned as *Treatment.*

VE indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

18. PYROCHEMICAL WASTE

This waste group includes spent salts and zinc-magnesium alloy metal generated by production and experimental pyrochemical operations used to recover and purify plutonium metal. The salts were generated by molten salt extraction, direct oxide reduction, and electrorefining processes in Buildings 371, 776, and 779 [P038]. The zinc magnesium metal (one drum) was generated by an experimental salt cleanup project in Building 779 [P024, U092, U059]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 18-1 [U092].

Table 18-1. Pyrochemical Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
409	Molten Salt—30% Unpulverized [P038]	September 1982-January 1986
411	Electrorefining Salt [P012] Electrorefining Salt, Final Disposition [P001]	April 1982-August 1986
412	Gibson Salts [P012]	August 1980
414	Direct Oxide Reduction Salt [P012] Direct Oxide Reduction Salt—Unoxidized Ca [P001]	May 1982 – October 1982
416	Zinc Magnesium Alloy [P012] Zinc Magnesium Alloy Metal [P024]	June 1980

Item Description Code 409, Molten Salt—30% Unpulverized: This waste consists of spent salt generated by the molten salt extraction process used to extract americium contamination from plutonium metal. The MSE process that generated IDC 409 used 30 mole percent of magnesium chloride salt during the extraction. The spent salt is composed primarily of sodium chloride, potassium chloride, residual magnesium chloride, entrained magnesium metal, and various plutonium and americium compounds. IDC 409 consists of unpulverized fused chunks of salt [P038, P139].

Item Description Code 411, Electrorefining Salt: This waste consists of spent salt generated by electrorefining operations used to purify plutonium metal that did not meet foundry specifications. The salt is composed primarily of sodium chloride, potassium chloride, magnesium chloride, entrained magnesium metal, and various plutonium compounds [P139]. The salt is a mixture of chunks, granular, and fine particles [P038]. This salt may also contain sodium and potassium metal produced during electrolysis of the molten salt mixture [P052, P139].

Item Description Code 412, Gibson Salts: This waste consists of a single drum of spent salt generated by an experimental pyroredox process that was being developed to extract impurities from plutonium metal. The salt is composed primarily of sodium chloride, potassium chloride, calcium chloride, zinc chloride, entrained zinc and calcium metal, and various plutonium and americium compounds [P139]. The dry, fused salt chunks may also contain sodium and potassium metal resulting from the reduction of sodium chloride and magnesium chloride by the excess calcium metal [P038, P139].

Item Description Code 414, Direct Oxide Reduction Salt: This waste consists of spent salt generated by the direct oxide reduction process used to reduce plutonium oxide to plutonium metal buttons. The salt is composed primarily of calcium chloride, calcium oxide, entrained calcium metal, calcium metal buttons, and various plutonium compounds [P139]. The salt is in the form of chunks and fines [P038].

Item Description Code 416, Zinc-Magnesium Alloy Metal: This waste consists of single drum of metal billets or ingots generated by a research and development project being developed to cleanup pyrochemical salts. The weight percent of magnesium in the alloy ranged from 10 to 30% [P052]. This IDC was generated during pyroredox development efforts and could consist of zinc/magnesium, calcium/magnesium/zinc, or calcium/zinc alloy [C182].

18.1 Waste Generation

Pyrochemical wastes were generated by molten salt processes associated with plutonium recovery and purification operations in Buildings 371, 776, and 779. With the exception of a drum of zinc-magnesium alloy (IDC 416), the pyrochemical waste consists of spent salts used during molten salt extraction, electrorefining, and direct oxide reduction operations. Electrorefining was conducted in Buildings 371, 776, and 779. Molten salt extraction and direct oxide reduction were performed in Building 776. Building 779 supported technology development and experimental scale operations for the pyrochemical processes [P038]. The zinc-magnesium alloy was generated in Building 779 during an experimental salt cleanup project [P052, U092]. Process flow diagrams for pyrochemical waste generating processes are provided in archived WSRIC information [P062, P078, P081].

18.1.1 Molten Salt Extraction

Molten salt extraction technology was used to remove americium from salvaged plutonium metal. The process that generated IDC 409 was primarily conducted in the twelve stationary furnaces in Building 776. However, these salts were also generated by experimental operations in Building 779 [P038].

Plutonium metal containing unacceptable levels of americium was combined with an equimolar mixture of sodium chloride and potassium chloride with magnesium chloride. The metal and salts were placed in a tantalum crucible. The crucible and contents were placed in a furnace and heated until the mixture was molten. The molten salt and metals were then mixed by stirring. While in the molten state, the magnesium chloride oxidized most of the americium and some of the plutonium. The oxidized actinides migrated from the metal to the salt phase. As the mixture cooled, the extremely dense plutonium metal separated from the salt and settled at the bottom of the crucible. The metal and salt were removed from the crucible and separated. Depending on the purity of the plutonium, it was either sent to the foundry or it was further purified in the electrorefining process [P139]. The spent salt (IDC 409) was sent to Building 771 for plutonium assay. Salt above the EDL was stored on site for recovery. Drums of waste salt below the EDL were sent to Building 776 for inspection and sealing [P024].

18.1.2 Electrorefining

Electrorefining was used to purify plutonium metal from molten salt extraction and other recovery operations that did not meet foundry specifications. The processes that generated IDC 411 were conducted in the tilt-pour furnaces in Building 371 and the stationary furnaces in Buildings 776 and 779 [P038].

Non-specification plutonium metal, cast as an anode, was combined with magnesium chloride and an equimolar mixture of sodium chloride and potassium chloride in a magnesium oxide crucible. The crucible and contents were heated in a furnace until the mixture was molten. A cathode and an anode/stirrer were then lowered into the molten mixture. A current was applied to the anode/stirrer which flowed through the mixture to the cathode. Plutonium ions migrated through the salt to the cathode and were reduced to purified metal. After the cathode and anode were removed, the crucible was allowed to cool before it was removed from the furnace. The crucible was broken and the purified plutonium metal

was separated from the salt and anode heel. The plutonium was analyzed then sent to the foundry for production [P139]. The spent salt was sent to Building 771 for plutonium assay. Salt above the EDL was stored on site for recovery. Drums of waste salt below the EDL were sent to Building 776 for inspection and sealing [P024].

18.1.3 Direct Oxide Reduction

Direct oxide reduction technology was developed to reduce plutonium oxide to metal. The process that generated IDC 414 was conducted on a production scale in Building 776 and development work was done in Building 779 [P038].

Calcined plutonium oxide was placed into a magnesium-oxide crucible with calcium chloride and calcium metal. The crucible and contents were placed in a furnace and heated until the contents were molten. The molten mixture was stirred until the reduction was complete. After the mixture cooled, the contents were removed and the plutonium metal was separated from the salt phase. Depending on the purity of the plutonium, it was either sent to the foundry or it was further purified in the electrorefining process [P139]. The spent salt was sent to the in-line can counter for plutonium assay. Salt above the EDL was stored for recovery. Drums of waste salt below the EDL were sent to Building 776 for inspection and sealing [P024].

18.1.4 Pyroredox

Gibson salts (IDC 412) and zinc-magnesium alloy (IDC 416) were generated during a pyroredox process development effort in Building 779 in the late 1970s [P038, P052]. In general, the pyroredox process was a three-step process to purify plutonium. The first step involved the oxidation of impure plutonium in a calcium chloride/potassium chloride molten salt matrix using zinc chloride as the oxidant. Plutonium metal was reduced out of the resulting plutonium rich salt using calcium metal. The remaining salt was assigned IDC 412. The reduced plutonium contained impurities such as calcium and zinc. A calcium/zinc alloy (IDC 416) was produced when these metals were volatilized and condensed from the plutonium. Different feed materials or reductants (i.e., magnesium) would also produce zinc/magnesium or calcium/magnesium/zinc alloys assigned IDC 416 [C182, C187].

18.2 Waste Packaging

A variety of container and liner configurations were used to package pyrochemical wastes. In general, the salts were placed directly into stainless steel cans or produce cans with rolled seam lids [P001, P038]. Electrorefining salts were also placed in one-gallon paint cans wrapped in lead. Direct oxide reduction salts may be contained in 4-liter Nalgene bottles. The individual packages were assayed by the in-line can counter to determine if the salt was above or below the EDL [P001]. The container was then double-bagged and removed from the glovebox line or placed in another stainless steel can that was double bagged and removed from the glovebox [P012]. Packages removed from the glovebox were either placed into another package such as lead-lined Fiber-Paks [P015], stainless steel containers [P024], or Process Residue Containers (clamshells) [U061] or placed directly into prepared drums [P012].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. A 90-mil rigid polyethylene liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags. A PVC O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. VE of a drum of direct oxide reduction salt (IDC 414) identified ceramic items in the packages [P015].

18.3 Waste Characterization

Pyrochemical wastes were characterized based on knowledge of the material, knowledge of the processes generating the waste, VE, sampling and analysis, and headspace gas analysis. A RCRA hazardous waste determination for pyrochemical wastes as well as radionuclide contaminants and potential complexing agents contained in the waste is provided in this section. Zinc magnesium alloy (IDC 416) contains an estimated 80% or more (by volume), metal debris material that meets the CH-WAP criteria for classification as debris, and was classified as a heterogeneous waste. Pyrochemical salts (IDCs 409, 411, 412, and 414) contain at least 50% (by volume) salts, and are classified as homogeneous solid wastes [P141].

18.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. Pyrochemical wastes were not mixed with listed waste, nor do the wastes exhibit a characteristic of hazardous waste. EPA HWNs applicable to some or the entire pyrochemical waste group are presented by IDC in Table 18-2.

The characterization of pyrochemical salts has changed dramatically over the years. Many of the pyrochemical salts were initially determined to be hazardous for the characteristics of corrosivity (D002), reactivity (D003), and toxicity for chromium (D007). Due to numerous waste and surrogate sampling activities, studies, and regulatory interpretations, it was determined that the pyrochemical salts do not exhibit any characteristics of hazardous waste [C117, C119, P052, P139, U062].

Table 18-2. Pyrochemical Waste Characterization.

IDC	Title	EPA HWNs
409	Molten Salt—30% Unpulverized	None
411	Electrorefining Salt	None
412	Gibson Salts	None
414	Direct Oxide Reduction Salt	None
416	Zinc Magnesium Alloy	None

18.3.1.1 Characteristic Waste. The materials in this waste group do not exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as ignitable waste (40 CFR 261.21), corrosive waste (40 CFR 261.22), reactive waste (40 CFR 261.23), or toxic waste (40 CFR 261.24).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials were generated in furnaces during molten salt recovery and purification

operations and packaged in a dry environment. The materials were dry when packaged and do not contain free liquids [P024]. The absence of free liquids has been confirmed by RTR and VE of the packages [P012, P015, P021]. Due to the hygroscopic nature of some of the salts, it is possible that free liquids could form by absorption of moisture from the atmosphere [P140]. Even if this was to occur, the liquid formed would be aqueous and not ignitible, and the reaction with metals such as sodium and calcium entrained in the salt would not be violent or rapid [P052]. The materials are not capable of causing fire through friction or spontaneous chemical change. The materials are not compressed gases, and inspections will be performed to certify that the drums do not contain compressed gases. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials were dry when packaged and do not contain free liquids [P024]. The absence of free liquids has been confirmed by RTR and VE of the packages [P012, P015, P021]. Gibson salts (IDC 412) contain hygroscopic calcium chloride and zinc chloride salts. As a result, these salts have the potential of producing free liquid. Testing has demonstrated that the pH of a surrogate sample composed of a saturated solution containing these chloride salts was greater than 3. In addition, results of corrosion testing on stainless steel were less than 0.25 inches per year [P052, C117]. The materials in this waste group are therefore not corrosive wastes (D002) [C119].

Reactivity: The materials in this waste group are stable and will not undergo violent chemical change. The salts in this waste group may contain sodium, calcium, magnesium, zinc, and potassium metals. These metals all react with water to a varying degree; however, based on analytical data and regulatory interpretations by the Colorado Department of Public Health and Environment (CDPHE), the metals do not meet the definition of reactivity as defined in 40 CFR 261.23. Testing has demonstrated that the reaction of the pyrochemical salts in water was not violent or rapid [P139, P052, P140]. Even though the reaction of salts containing calcium (IDC 414) in water may be more significant than other pyrochemical salts, CDPHE has clearly stated that the salts do not exhibit the RCRA characteristic of reactivity [C117]. The materials do not contain cyanides or sulfides and are not capable of detonation. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173. Explosives were not handled or used around radioactive material. The absence of explosives and compressed gases was verified by the generating supervisor and periodic inspections [P016, C119]. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group do not meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds.

There is no documentation indicating that this waste group came into contact with any of the toxicity characteristic metals except for chromium, which was a contaminant of the plutonium metal. Thermodynamic calculations performed at Rocky Flats concluded that chromium would be present at insignificant concentrations in the salts, because the chromium alloyed with the plutonium which was removed from the salt after the pyrochemical reactions [P052, U062, C119]. TCLP metals analysis performed on salts at Rocky Flats support the nonhazardous characterization [P052].

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating pyrochemical wastes. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride was used for cleaning the glovebox lines used for pyrochemical operations, but was not used in the process that generated pyrochemical wastes [C123]. Carbon tetrachloride was detected in the headspace of drums containing molten salt extraction (IDC 409) and direct oxide reduction (IDC 414) spent salts [P033]. However, the waste should not contain toxicity characteristic levels of carbon tetrachloride since it was used only for glovebox cleaning and not in pyrochemical operations. There is no documentation indicating the presence or use of any other toxicity characteristic organics in the areas or processes generating pyrochemical wastes. Therefore, this waste group does not exhibit the characteristic of toxicity due to organics (D018-D043).

18.3.1.2 Listed Hazardous Waste. The materials in this waste group are not, or were not mixed with, waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31), as hazardous waste from specific sources (40 CFR 261.32), or as discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33).

Carbon tetrachloride and 1,1,1-trichloroethane were used for cleaning the glovebox lines used for pyrochemical operations, but were not used in the process that generated pyrochemical wastes [C123]. Carbon tetrachloride and 1,1,1-trichloroethane were detected in the headspace of drums containing molten salt extraction (IDC 409) and direct oxide reduction (IDC 414) spent salts [P033]. However, since these compounds were used only for glovebox cleaning and not in pyrochemical operations, pyrochemical wastes are not F001- or F002-listed wastes.

There is no documentation indicating the use of any other F-listed solvents in the areas or processes generating pyrochemical wastes. Therefore, this waste group is not an F003-, F004-, or F005-listed waste.

Although pyrochemical wastes are not F-listed hazardous wastes, headspace analysis performed on samples of pyrochemical salts (IDCs 409, 411, and 414) obtained at INEEL indicated the presence of organic solvents. The detected compounds in which the UCL_{90} was above the PRQL are [P033]:

- 1,1,1-trichloroethane (IDCs 409 and 414 only)
- carbon tetrachloride (IDC 414 only).

The materials in this waste group are not hazardous waste from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The material in this waste group is therefore not a K-listed hazardous waste.

The material in this waste group is not a discarded commercial chemical product, an off-specification species, a container residue, or a spill residue thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

18.3.2 Radionuclides

The radioisotopes potentially contained in the waste are identified in this section. In addition, the matrix and other physical parameters which could affect radioassay are summarized in Table 18-3.

The MSE process removed the americium-241 decay product from site-return metal and other non-specification plutonium [P163]. Mass balance calculations for MSE residues (IDC 409) estimated these salts contain 22.6% plutonium, 46,400 ppm americium, and 200 ppm uranium [P175]. The composition of site-return metal and the isotopic make-up of weapons-grade plutonium and enriched uranium are provided in Section 3.0.

The electrorefining process purified plutonium metal from MSE or other operations for use in the foundry [P163]. Mass balance calculations for electrorefining residues (IDC 411) estimate these salts contain 10% plutonium, 66.5 ppm americium, and 617 ppm uranium [P175].

The direct oxide reduction process produced plutonium metal directly from foundry generated plutonium oxide and, therefore, will only contain impurity levels of americium and uranium [P163]. Mass balance calculations for direct oxide reduction residues (IDC 414) estimate these salts contain 4,540 ppm plutonium, 10.1 ppm americium, and 1.1 ppm uranium [P175].

The experimental pyroredox process was for purification of plutonium metal from MSE residues or other sources of impure plutonium metal. Since MSE residue salts were one of the possible feed sources to this process, the Gibson salts (IDC 412) and magnesium/zinc alloy (IDC 416) may contain plutonium, americium, and uranium [C182]. The levels of americium and uranium are possibly present as impurities only. In addition, impurity levels of neptunium may also be present [P035].

Table 18-3. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	**IDC 409**: Primarily plutonium chloride and americium chloride with trace amounts of uranium chloride [P175]. Plutonium metal beads ranging from 0.1 to 1.0 millimeters have been observed in the salts [P140].
	IDC 411: Primarily plutonium chloride and plutonium metal with trace amounts of uranium metal and americium chloride [P175]. Trace amounts of plutonium oxide, PuOCl, and K_2PuCl_5 were observed in samples of the salts [C186, C187]. Plutonium metal beads ranging from 0.1 to 1.0 millimeters were observed in the salts [P140].
	IDC 412: Gibson salt will contain plutonium chloride, and possibly americium chloride, uranium chloride, and neptunium chloride [P035].
	IDC 414: Primarily plutonium oxide with trace amounts of uranium oxide and americium oxide [P175]. Plutonium metal beads ranging from 0.1 to 1.0 millimeters have been observed in the salts [P140].
	IDC 416: The chemical form should be metal since IDC 416 is a metal alloy.
Hydrogen Content	The primary sources for hydrogen in pyrochemical salt waste include fiberboard, polyvinyl chloride, and polyethylene liners, bags, and bottles (see Section 18.2). In addition, trace amounts of hydrocarbons have been detected in waste samples and headspace gas samples [C187, P033]. Based on studies conducted at Rocky Flats, the pyrochemical salts may hydrate from exposure to water in the atmosphere during processing or storage. The amount of this hydration will vary depending on IDC, time in storage, and the amount of plutonium in the salt [C178, C179]. Observations from recent sampling activities indicate minimal weight gain that could be attributed to hydration during storage [C186].
Other Interfering Waste Contaminants	**IDC 409**: Primarily sodium chloride and potassium chloride, residual magnesium chloride, and entrained magnesium metal [P139, P175].
	IDC 411: Primarily sodium chloride and potassium chloride, residual magnesium chloride and magnesium oxide (from crucibles), and entrained magnesium metal [P139, C186, C187, P175]. Analyses of these salts detected trace amounts of chromium (below TCLP limits) [C186, C187].

Table 18-3. (continued).

Parameter	Results of Evaluation
	IDC 412: Sodium chloride, potassium chloride, calcium chloride, and residual zinc chloride [C182, P139]. May also contain chromium chloride and small amounts of aluminum [P035].
	IDC 414: Calcium chloride and magnesium oxide (from crucibles) [P139, P175].
	IDC 416: X-ray diffraction analysis indicated a magnesium/zinc alloy and trace quantities of sodium chloride, potassium chloride, and magnesium oxide. Analysis also detected trace amounts of cadmium and chromium (below TCLP limits) [C187] [C182].
Physical Matrix Parameters	**IDC 409:** Consists of dry, fused salts in the form of chunks and some dispersible fines. The particle sizes will not be evenly distributed [P035].
	IDC 411: Observed salt particle sizes ranging from greater than 6 inches to very fine dispersible powder. The percentage of the different particle sizes varied from drum to drum and were not evenly distributed [C187, P035].
	IDC 412: Consists of dry, fused salts in the form of chunks and some dispersible fines. The particle sizes were not evenly distributed [P038].
	IDC 414: Consists of salts in the form of chunks and fines. The particle sizes will not be evenly distributed [P035]. Large calcium metal beads may also be present throughout the salt as well as the presence of a calcium button [P139, P140].
	IDC 416: Observed particle sizes ranged from powder, slivers, and chips to large spherical chunks [C187].

18.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227, P322]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P322]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 18-4. The building or area of generation for containers in the INEEL inventory is identified by the

container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 18-4. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
409	771	0001	Aqueous Recovery	9/10/82 - 11/3/82	WG Pu, ^{241}Am, EU
409	776	0003	Pyrochemical Operations	12/6/84 - 1/23/86	WG Pu, EU, ^{241}Am
409	776	0025	Drum Repack	4/30/84 - 3/21/85	WG Pu, EU, ^{241}Am
411	371	0076	Repackaging Residues	1/15/86 - 3/5/86	WG Pu, ^{241}Am, EU
411	771	0001	Aqueous Recovery	4/12/82 - 4/12/82	WG Pu, ^{241}Am, EU
411	776	0025	Drum Repack	8/8/86	WG Pu, EU, ^{241}Am
412	779	0052	Pyrochemistry Process Development	8/29/80	WG Pu, ^{241}Am, EU
414	771	0001	Aqueous Recovery	5/7/82 - 10/15/82	WG Pu
416	779	0054	Research and Development	6/10/80	WG Pu, ^{241}Am, EU

WG = weapons grade EU = enriched uranium

18.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS.

Radioassay data were collected in the 3,100 m^3 Project for the pyrochemical wastes IDCs 409, 411, and 414. Six (6) containers were assayed over the life of the 3,100 m^3 Project for these wastes. The radioassay results are summarized in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

18.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. There is no documentation indicating the presence or use of complexing agents in the areas or processes generating pyrochemical wastes.

18.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. None of the pyrochemical IDCs were candidate waste streams for characterization by the 3,100 m^3 Project and no RTR data was generated [P321].

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19. RASCHIG RINGS

This waste group consists of Raschig rings generated by the production, recovery, laboratory, treatment, and maintenance activities associated with plutonium operations. The wastes were generated in Buildings 371, 559, 707, 771, 776, and 777 [P024, P052, P076]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 19-1 [U092]. The wastes were characterized under a CBFO approved WSP, INW247.001, for containers of waste shipped to the WIPP facility [P214, P223].

Table 19-1. Raschig Ring Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
441	Unleached Raschig Rings [P001]	May 1973 – September 1983
442	Leached Raschig Rings [P001]	May 1980 – June 1988

Item Description Code 441, Unleached Raschig Rings: This waste consists of Raschig rings which are borosilicate glass rings used to maintain subcritical conditions in fissile solution storage tanks that were not safe by dimension. The boron in the rings is a neutron poison, an element that absorbs neutrons. The volume of the ring displaces a proportionate volume of solution and, in combination with the boron, creates a critically safe configuration. When the rings were replaced, they were assayed. If the plutonium content was below the EDL, they were assigned IDC 441 [P052]. In 1989, IDC 443 was created for sorting of solvent-contaminated Raschig rings from non-solvent contaminated Raschig rings [C069].

Typical waste material parameters, including typical packaging materials for the unleached Raschig ring wastes as identified for the 3,100 m^3 Project are presented in Table 19-2 [P223].

Table 19-2. Typical Waste Material Parameters for Unleached Raschig Rings Waste (IDC 441) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags, inner container bags, possible poly bottles
Other Inorganic Materials	Raschig rings, vermiculite, Oil-Dri®
Cellulosics	Cardboard liner, fibre-pak
Other metals	Lead liner

Item Description Code 442, Leached Raschig Rings: This waste consists of Raschig rings (IDC 441) that were contaminated with plutonium above the EDL [P052]. The rings were leached in nitric acid to remove the contamination and repackaged as IDC 442 [P012].

Items identified in containers during INEEL 3,100 m^3 Project examinations of the leached Raschig rings waste (IDC 442) are listed in Table 19-3 [P223]. Typical waste material parameters, including typical packaging materials for the leached Raschig ring wastes as identified for the 3,100 m^3 Project are presented in Table 19-4 [P223].

Table 19-3. Items Identified by RTR for Leached Raschig Rings Waste (IDC 442) During the 3,100 m^3 Project [P223].

Item[a]	Comment
Miscellaneous plastic items	The RTR examination indicated horsetail stubs assigned to the plastic waste material parameter. The horsetails in these drums did not appear to be attached to the packaging configuration. The RTR examinations for several drums indicated that they contained small amounts of plastic waste material.
Inorganic liquid	Free liquid was identified and assigned to other inorganic materials by RTR. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.
Miscellaneous metal items	Miscellaneous metal items include metal bands, Volrath cans, flashlight, and other nonspecific metal items not specifically identified above.
D cell batteries	D-size batteries were identified by RTR examination as iron-based metals/alloys. D-cell batteries may exhibit the toxicity characteristic for mercury.
Sealed container >4 L	A sealed container greater than 4 liters was identified during RTR examination. Sealed containers >4 liters do not meet the WIPP WAC. Containers with items prohibited by the WIPP WAC were not shipped to WIPP.

a. All containers were screened for light ballasts. Containers identified with light ballasts were not shipped to WIPP.

Table 19-4. Typical Waste Material Parameters for Leached Raschig Rings Waste (IDC 442) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bags, drum bags, inner container bags, possible poly bottles
Other Inorganic Materials	Raschig rings, vermiculite, Oil-Dri®
Cellulosics	Cardboard liner, fibre-pak
Other metals	Lead liner

19.1 Waste Generation

Raschig rings were contained in tanks used by plutonium production, recovery, purification, and treatment operations at the site. Over time, Raschig rings would become broken or otherwise damaged and were replaced. The rings were also replaced if the assay of the tank exceeded acceptable limits [P052]. Process flow diagrams for Raschig ring waste generating processes are provided in archived WSRIC information [P060, P061, P070, P078, P079, P081].

19.1.1 Plutonium Production

Plutonium production consisted of operations directly associated with the manufacturing of plutonium metal parts including casting, rolling, forming, machining, and assembly processes. Buildings 707 and 777 were the primary weapons components production facilities at the site after the construction of Building 707 in 1972. Building 707 was constructed after the 1969 fire in Building 776 which shut down foundry and machining operations in that building [P053].

The foundry in Building 707 cast molten plutonium into classified components, subassemblies, and assemblies. Other parts were manufactured by rolling, forming, and machining plutonium ingots also cast in the foundry. Components were assembled using a number of welding and joining techniques in Buildings 707, 777, and 779. Production support operations in Buildings 707 and 777 included a variety of inspection, calibration, measurement, weighing, leak testing, and cleaning activities to assure that the parts met stringent specifications. Rejected plutonium parts, scraps, and turnings were returned to be recast. Small pieces of metal, fines, and sweepings were typically burned to oxide and sent to Building 771 to be recovered [P052].

Halogenated solvents were used in production operations to clean and degrease plutonium parts and metal. In addition, the solvents were used with cutting oils to cool plutonium parts during machining. At one time, Raschig ring-filled storage tanks in Building 707 were used to collect 1,1,1-trichloroethane and carbon tetrachloride. The carbon tetrachloride also contained Freon and various oils. These organic liquids were sent to Building 777 to be filtered [P035, P060].

Building 777 contained two organic solvent collection and filtration systems, which used Raschig ring-filled tanks. The carbon tetrachloride system collected, filtered, and distributed waste carbon tetrachloride for eventual treatment in Building 774, and employed three Raschig ring-filled tanks. Other contaminants which could be in the system included Freon TF (1,1,2-trichloro-1,2,2-trifluoroethane), coolant oils, vacuum pump oil, and sight gauge oil. The 1,1,1-trichloroethane filtration system collected and filtered 1,1,1-trichloroethane from several ultrasonic wash tanks and employed two Raschig ring-filled tanks [P052, P079].

19.1.2 Plutonium Recovery and Purification

Several operations at the plant were responsible for either the purification of non-specification plutonium metal or the recovery of plutonium from production waste and residues. Building 771 housed operations that recovered plutonium from waste materials and other sources [P053]. Plutonium purification was performed primarily in Buildings 371, 771, 776, and 779 [P052].

Recovery operations in Building 771 used acid to dissolve solid materials containing plutonium. The resulting solutions were processed by a series of ion exchange, precipitation, calcination, fluorination, and reduction operations to produce purified plutonium metal to be recycled back into production operations. Potassium hydroxide, potassium fluoride, hydrogen peroxide, and nitric, hydrochloric, and hydrofluoric acids were the primary reagents used for plutonium recovery operations [P053, P061, P067, U047]. Raschig ring-filled tanks containing acid or caustic were used in these processes [P052].

19.1.3 Waste Treatment

Operations in Building 771 processed wastes including Raschig rings, HEPA filters, and sludges from the filter plenum and from process piping. Until 1984, plutonium was recovered from Raschig rings

by acid leaching [P061]. Raschig rings containing plutonium above the EDL were leached with hot nitric acid. After leaching, the rings were rinsed with water and air-dried before packaging [P016].

Size reduction in Building 776 removed materials from drums and sorted them in an airlock vault. Materials such as light metals, filters, glass, combustibles, and Raschig rings were then put into containers with like materials. Water and KW detergent were used to wash the vault floor. The wastewater was filtered and then stored in Raschig ring-filled tanks in Building 776 for eventual treatment [P052, P078].

19.1.4 Laboratory

Building 559 housed the Plutonium Analytical Laboratory responsible for spectrochemical, chemical, and mass spectrometric analyses of samples from plutonium production operations. Uranium, Raschig rings, solutions, and commercial product and gas samples were also analyzed in the laboratory. Plutonium production samples, including metal and oxide, were prepared and subdivided for analysis in the sample cutting process [P067].

New and used Raschig rings were tested at the Building 559 laboratory to ensure integrity and specification compliance. Used Raschig rings were removed as samples from various tanks and were typically contaminated with plutonium, uranium, and occasionally sludge. Neutron absorption, chemical resistance, and durability and strength tests were performed on the rings. Nitric acid and sodium hydroxide were used for chemical compatibility testing. The rings were rinsed and dried before disposal [P076].

19.1.5 Maintenance

The majority of the Raschig ring waste was generated by changing out Raschig rings from production, recovery, purification, and waste treatment process tanks. Raschig ring change out was a routine maintenance operation in which rings were sampled, removed, and replaced.

Process tanks were inspected periodically and the rings were replaced if the assay of the tank exceeded acceptable limits. Change out would also occur when the Raschig rings reached the end of their useful life (about 5 years), or became broken or otherwise damaged. This was determined by sampling and analysis or by VE. The Raschig rings were replaced when the sampling showed wall thinning in the rings due to corrosion, loss of boron in the rings, or buildup of solid material in the tank. Raschig rings were also replaced if rings could no longer be sampled [P014, P035, P052].

During the change out process, the tank was drained and flushed with a compatible solution. For example, tanks containing nitric acid were flushed with nitric acid, tanks containing oil and carbon tetrachloride were flushed with carbon tetrachloride [P024].

Raschig rings were also generated when Raschig ring tanks were removed and replaced with equipment which is safe by geometric design (e.g., annular tanks) [P035].

Utility systems include HVAC systems, fume scrubbers, and process vacuum systems. Scrubbers used potassium or sodium hydroxide to neutralize acid fumes from various process off-gas streams and glovebox exhaust streams. Process vacuum systems provide an absolute pressure at a vacuum header, which serves as a means to transfer fluids on demand by valving arrangements. Scrubber tanks and vacuum traps and receivers contained Raschig rings [P052, P055].

19.2 Waste Packaging

After removal from a tank, Raschig rings were contained in up to three polyvinyl chloride or polyethylene bags which were placed in a Fibre-Pak [P012, P024]. Raschig rings were bagged out of the leaching glovebox line in two plastic bags and were also placed in a Fibre-Pak. Two Fibre-Paks were placed in a prepared 55-gallon drum. Raschig rings from the laboratory were broken into 1/4-inch diameter fragments for analysis. After analysis, the fragments were placed in 4-liter polyethylene bottles, double-bagged out of the glovebox, and placed in a prepared 55-gallon drum [P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. A fiberboard liner and discs may also have been used between the waste packages and the drum liners [P008, P016, P063, P064]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

During the 3,100 m^3 Project it was determined during RTR examinations that Raschig rings waste contained varying combinations of drum bags, poly bags, and O-ring bags as packaging materials. Any combination of plastic packaging did not impact acceptability of a drum for shipment to WIPP provided that four layers of containment were not exceeded for drums assigned TRUCON codes ID 118A, ID 218A, ID 125A, ID 225A or five layers on containment for drums assigned TRUCON codes ID 125B, ID 225B. Drums that exceeded the TRUPACT-allowed containment layers were flagged for treatment in the TRIPS [P223].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024]. Examinations of this waste form during the 3,100 m^3 Project indicate that quantities of absorbent can vary significantly from expected quantities, and some drums may contain no absorbent. In addition, Oil-Dri® and vermiculite may be used in some drums outside of expected time periods [P223].

Acceptable knowledge confirmation activities have identified numerous items in a small percentage of the Raschig ring waste containers, including miscellaneous plastic items (e.g., bags, containers, tubing, piping, and sheeting) [P223].

19.3 Waste Characterization

Raschig rings were characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, waste analysis, and headspace gas analysis. A hazardous waste determination based on RCRA and the WIPP WAP requirements for Raschig rings as well as radionuclide contaminants and potential complexing agents contained in the waste in compliance with the WIPP WAC is provided in this section.

Raschig rings are originally classified as homogeneous wastes in the WIPP Transuranic Waste Baseline Inventory Report [P141]. However, this waste contains at least 50% by volume materials that meet the CH-WAP criteria for classification as debris, and should be classified a heterogeneous waste. The classification for both IDCs was changed to heterogeneous wastes and reassigned to the appropriate

waste matrix code (S5122). This change was included in the WIPP approved WSP form INW247.001 [P214].

19.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes may exhibit the characteristic of toxicity for lead. The wastes were mixed with halogenated-solvents, and are therefore F-listed hazardous wastes. There is no evidence that Raschig rings exhibit any other characteristic of a hazardous waste. EPA HWNs applicable to some or all of the Raschig rings waste group are presented by IDC in Table 19-5.

Table 19-5. Raschig Rings Waste Characterization.

IDC	Title	EPA HWNs
441	Unleached Raschig Rings	D008, F001, and F002
442	Leached Raschig Rings	D008, F001, and F002

19.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, nor do they contain free liquids. In addition, absorbents were added to wastes having the potential of generating free liquids [P009, P012, P014, P015, P017, P022, U005, U011]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P016, P024]. The materials are not compressed gases, nor do the containers contain compressed gases [P012, P014, P015, P017, P022, U005, U011]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials in this waste group are not liquid, and absorbents were added to wastes having the potential of generating free liquids [P009, P012, P014, P015, P017, P022, U005, U011]. Although unleached Raschig rings (IDC 441) removed from tanks that contained acids or bases, could potentially contain corrosive free liquids [U060], absorbents were added to the waste to prevent free liquids. Also, for leached Raschig ring (IDC 442) drums, the rings were rinsed with water after the leaching process. Residual liquid from this rinsing should not have been corrosive, and absorbents were added to the waste to absorb free liquids. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P014, P015, P022, P024, U005, U011]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for lead.

There is no documentation indicating the presence or use of RCRA-regulated metals in the areas or processes generating Raschig rings. In addition, TCLP analysis of unused Raschig rings indicate concentrations of barium, cadmium, chromium, lead, and silver well below the regulated levels [C070, P052]. However, one source indicated Raschig rings are potentially hazardous for lead. Although the exact source of the lead is unclear, EPA HWN D008 was conservatively assigned to this waste group [U060].

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating Raschig rings. This waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride was used for cleaning and degreasing, and was stored in Raschig ring tanks. When the Raschig rings were changed out, carbon tetrachloride was used to flush out the tanks. The waste is regulated as listed hazardous waste and not a characteristic waste for its carbon tetrachloride content because the compound was used as a solvent and is specifically addressed in the treatment standards for listed hazardous wastes [P080]. There is no documentation indicating the presence or use of any other toxicity characteristic organics in the areas or processes generating Raschig rings.

19.3.1.2 Listed Hazardous Waste. The materials in this waste group are listed hazardous wastes because they were mixed with wastes listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31). The materials are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The origin of the listed HWNs assigned to Raschig rings wastes are provided in Table 19-6. The table includes only the HWNs applicable to wastes for which a specific source was identified. The HWNs are not applicable to waste generated from areas other than those listed in the table.

Table 19-6. Origin of Listed HWNs.

IDC	EPA HWNs	Building
441	F001 and F002	Buildings 707 and 777
442	F001 and F002	Buildings 707 and 777

Waste oils containing carbon tetrachloride and 1,1,2-trichloro-1,2,2-trifluoroethane spent solvents and 1,1,1-trichloroethane were used for machining and degreasing of plutonium metal. When the Raschig rings were changed out, these solvents were used to flush out the tanks. Headspace gas sample analyses results at the INEEL confirmed the presence of these F-listed constituents. Only 1,1,1-trichloroethane had a calculated UCL_{90} greater than its PRQL (Table 19-7) [P214]. This waste group was assigned EPA HWNs F001 and F002.

There is no documentation indicating the use of F004- or F005-listed solvents in the areas or processes generating Raschig rings. Therefore, this waste group is not an F004- or F005-listed hazardous waste.

Results of headspace gas analyses previously performed on samples of Raschig rings obtained at INEEL also confirmed the presence of F-listed solvents. The detected F-listed compounds in which the UCL_{90} as above the PRQL were as follows [P033]:

- 1,1,1-trichloroethane
- carbon tetrachloride (IDC 441 only)
- tetrachloroethylene (IDC 441 only)
- trichloroethylene (IDC 441 only)
- methanol (IDC 441 only, 2 samples).

Although methanol was detected in the earlier headspace gas samples, there is no documentation indicating that this compound was used in association with Raschig rings. Reasonable statistical evaluations could not be conducted with just two samples [P214]. The statistical evaluation of the headspace gas sampling results over the entire waste stream sampled by the 3,100 m^3 Project at the INEEL indicated methanol was not present in concentrations warranting assignment of the F003 HWN (Table 19-7). Therefore F003 was not assigned to this waste stream.

The materials in this waste group are not hazardous wastes from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous wastes.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

Table 19-7. Statistical evaluation of all HSG results for the Raschig Ring Waste Stream (INW247.001, IDCs 441, 442) [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	225	224	33.8	44.5	378	37.7	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	225	0	0.095	0.112	1.06	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	225	21	0.151	0.636	8.30	0.335	10	F001/F002[d]
1,1-Dichloroethane	225	73	0.503	2.14	24.8	0.827	10	N/A
1,1-Dichloroethylene	225	22	0.159	0.415	5.50	0.276	10	N/A
1,2,4-Trimethylbenzene	225	17	0.114	0.135	1.10	0.158	10	N/A
1,2-Dichloroethane	225	77	0.188	0.235	1.40	0.223	10	N/A
1,3,5-Trimethylbenzene	225	16	0.098	0.114	1.07	0.136	10	N/A
Acetone	225	213	8.02	9.29	65.0	8.84	100	N/A
Benzene	225	98	0.266	0.462	4.70	0.326	10	N/A
Bromoform	225	0	0.070	0.079	0.710	b	10	N/A

Table 19-7. (continued).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
Butanol	225	42	0.304	0.398	3.70	0.384	100	N/A
Carbon tetrachloride	225	92	2.27	18.8	225	4.80	10	F001/F002[d]
Chlorobenzene	225	17	0.097	0.121	1.20	0.136	10	N/A
Chloroform	225	200	1.25	6.13	75.0	1.80	10	N/A
Cis-1,2-dichloroethylene	225	1	0.097	0.143	1.34	b	10	N/A
Cyclohexane	225	5	0.091	0.137	1.10	0.185	10	N/A
Ethyl benzene	225	35	0.134	0.183	1.80	0.174	10	N/A
Ethyl ether	225	0	0.141	0.196	1.45	b	10	N/A
Methanol	225	22	15.2	33.4	190	24.6	100	N/A
Methyl chloride	76	36	2.36	5.26	30.0	3.51	10	N/A
Methyl ethyl ketone	225	173	1.27	1.86	11.0	1.45	100	N/A
Methyl isobutyl ketone	225	17	0.108	0.119	0.800	0.146	100	N/A
Methylene chloride	225	118	2.07	7.62	82.0	2.97	10	N/A
Tetrachloroethylene	225	19	0.153	0.744	9.60	0.38	10	N/A
Toluene	225	200	1.57	1.67	8.50	1.72	10	N/A
Trans-1,2-dichloroethylene	79	0	0.128	0.208	1.34	b	10	N/A
Trichloroethylene	225	163	3.06	11.0	150	4.17	10	N/A
m&p-Xylene	225	38	0.238	0.356	3.30	0.313	10	N/A
o-Xylene	225	30	0.147	0.203	1.70	0.196	10	N/A

a. When a measurement was reported as below detection, one-half the analysis method detection limit (MDL) was used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

19.3.2 Radionuclides

The radioisotopes potentially contained in the waste, as well as the chemical form of radionuclide contaminants and radioassay interferences are identified in this section. The primary radionuclides processed at Rocky Flats included weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are specified in Section 3.0. Wastes from some of the processes described below may not be contained in the inventory based on the assigned prefixes. However, as explained in Section 19.3.2.5, it was assumed that repackaged drums could contain waste generated from any process.

Radioassay interference in all Raschig rings will be caused by the presence of boron, which is a neutron absorber [P052]. The rings contain 11.8 to 13.8 wt% boron oxide with a $^{10}B/^{11}B$ isotopic ratio of not less than 0.24. The borosilicate type glass used has a density of not less than 2.2 g/cm^3 [P024].

19.3.2.1 Plutonium Production. Radionuclide contamination in waste from Building 707 will primarily consist of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. A small percentage of the waste from Building 707 may also contain americium-240, neptunium-237, and plutonium-238 from blending of these isotopes with weapons-grade plutonium for diagnostic tracers [C171, C174, C184, C185, P053, P164, P167].

Building 777 performed disassembly of site-return parts and fabrication operations including machining, briquetting, assembly, and production support processes (prefixes 0004, 0023, and 0024) [C184, P052, U059, P079]. Wastes from fabrication operations will be contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations will be contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053].

Buildings 707 and 777 handled actinides in metal or oxide form only [P060, P079]. The actinide metals will likely have partially or completely oxidized because of the reaction with dry air, and some could possibly have formed a hydroxide layer from reaction with moist air. Radioassay interferences may include beryllium from Part V metal fabrication in Building 707, and calcium fluoride which was sprayed onto graphite molds in Building 707 prior to casting [C184, P060]. Other interfering waste contaminants include aluminum, beryllium, and stainless steel (chromium) which were machined in Building 777 [P079].

19.3.2.2 Plutonium Recovery and Purification. Waste from recovery operations in Building 371 will contain weapons-grade plutonium primarily from electrorefining [C184, P067]. A limited amount of the waste could also have been generated from aqueous recovery operations which only ran for a short time in 1982. Aqueous recovery operations were designed for recovering and purifying weapons-grade plutonium [C184, P164].

The feed materials to the recovery and purification processes (prefixes 0001 and 0002) in Building 771 were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated will be contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Radionuclides from aqueous recovery operations will vary widely in chemical form depending on the specific process the waste originated, and because the majority of the aqueous processes were performed within one large MBA (prefixes 0001 and 0002), the specific process can not be determined. The different actinide forms are plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Wastes from the americium recovery glovebox lines (prefix 0006) in Building 771, used for extraction of americium from site-return plutonium, will contain a significant amount of americium-241 [C184, P053, P164, U059]. The americium was in a chloride, hydroxide, nitrate, oxalate, and oxide chemical form during different steps of the process. Prior to 1975, ammonium thiocyanate was also used [P053].

The Oralloy leach process (prefix 0074) in Building 771 chemically separated plutonium surface contamination from enriched uranium hemishells using nitric acid. The chemical form of the radionuclides will therefore be plutonium nitrate and uranyl nitrate [C184, P061, P163, U059].

19.3.2.3 Laboratory. The analytical laboratory in Building 371 (container prefix 0071) provided analytical support for process control and performed analyses on feed materials and residues from recovery operations in Building 371 [P053, U059, P081]. The laboratory also analyzed samples from

various operations at the site, but primarily from Building 374 [P081]. The Building 371 chemical standards laboratory prepared standards for various users and inspected standards that were used throughout plant site [P053]. Wastes from these laboratories will be contaminated with weapons-grade plutonium and enriched and depleted uranium.

The Building 559 analytical laboratory (container prefix 0029) performed a variety of analyses, including plutonium, enriched and depleted uranium, americium, neptunium, and tritium content [P053, P067, P076, U059, U073]. The primary mission of this laboratory was analysis of site-return and feed materials, in addition to recovery, purification, and foundry products [P053].

The Building 771 analytical laboratory (container prefix 0037) received samples from recovery operations in the building as well as from the foundry [P067, U059]. The samples included plutonium metal turnings, plutonium oxide, acidic plutonium solutions, and various process residues [P061]. In addition, the analytical laboratory analyzed samples from R&D laboratories in Buildings 771 and 779 (see Section 19.3.2.4) [P067, P061]. The chemical standards laboratory (container prefix 0038) prepared uranium, plutonium, and americium nitrates used as control standards for the Buildings 371, 559, and 771 analytical laboratories [P067, P061]. The laboratory also produced nondestructive assay standards used at drum counters and fluoride standards for chemical operations [P061].

19.3.2.4 Research and Development. Projects using transuranic radionuclides were done in Buildings 771, 776, 777, 779, and 881. Most of the documentation pertaining to R&D activities did not specify locations in which the work was performed, and unless otherwise noted, it was assumed that any of the radioisotopes could have been handled in the R&D areas of any of these buildings. In addition to weapons-grade plutonium, americium-241, and enriched and depleted uranium, the following radioisotopes were processed during R&D activities [C134, C137, C185, P053, P164, P167, P189, P190, P194, P195, P198, P200, U064]:

- americium-240
- curium-244
- neptunium-237
- plutonium-238, -240, -241, and -242
- low NGS plutonium (≈3% Pu-240)
- power grade plutonium (up to 20% Pu-240 and 1% Pu-241)
- thorium-228
- uranium-233, -235, -236, and –238.

A summary of the projects and time periods that these and other radionuclides were used is presented in Section 3.0.

In Building 771, special recovery anion exchange (prefix 0045) separated plutonium from other materials that were not suitable for the regular recovery processes [C154, P052, P061]. Chemical technology (prefix 0042) conducted aqueous R&D activities while plutonium metallurgy operations (prefix 0078) performed alloy preparation, heat treating, rolling, metal and metallurgical testing, and cutting for R&D [C184, U059, P061]. These processes may have used numerous radioisotopes.

The coatings laboratory (prefix 0016) in Building 777 developed various substrates to be coated with uranium or plutonium, including stainless steel, copper, chromium, aluminum, and beryllium [P052, U059, P079]. This research and development facility supported production processes [P052, P079]. The special weapons area (prefix 0066) in Building 777 was a research and development facility which assembled war reserve and other specially fabricated parts [U059, P079]. The process was also responsible for disassembly of surveillance (tracer) parts and drilling of parts for use in analytical testing [P079].

Pyrochemical technology (prefixes 0010 and 0052) in Building 779 involved the extraction and recovery of plutonium and americium in support of production operations [P067, U059, P062]. These processes included direct oxide reduction, molten salt extraction, electrorefining, salt scrub for MSE, salt scrub for electrorefining, pyrochemical salt recycle, anode alloy, and pyroredox [C182, P062]. Most of the materials used in Building 779 were the same as those in the weapons-production areas and, therefore, will be contaminated primarily with weapons-grade plutonium and enriched uranium [P053]. However, other R&D activities in the building may have used a variety of other radionuclides [C171, C184].

19.3.2.5 Size Reduction/Repackaging/Solid Waste Treatment. The SRV in Building 776 conducted solid waste treatment, repackaging, and size reduction operations. The SRV was divided into two sides. One side was the airlock (prefixes 0025, 0040, 0041, and 0057) where repackaging was done. The other side (prefixes 0019 and 0026) was a drybox atmosphere where size reduction and solid waste treatment activities took place [C175, C184, P067, U059]. The repacked containers have the potential to contain contaminated materials from any of the processes within the transuranic waste generating buildings [P067, U077].

19.3.2.6 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239, -240, and-241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 uses its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 is verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P223].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 19-8. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The AK relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by

IDC, container prefix, and building where generated. The generation dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 19-8. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Raschig Ring Wastes Were Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
441	any	0089	Note a	5/23/73 - 5/23/73	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
441	776	0019	Size Reduction	8/29/83 - 9/13/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	371	0017	Note a	11/7/80 - 11/21/80	WG Pu, EU, ^{241}Am, DU, ^{233}U[b]
442	371	0032	Aqueous Recovery	7/8/87	WG Pu
442	707	0022	Metal Fabrication-Machining	1/15/81 - 4/9/84	WG Pu, EU[d], DU[d]
442	771	0002	Aqueous Recovery	2/27/81 - 2/24/84	WG Pu, EU[d], DU[d]
442	771	0005	Aqueous Recovery	5/7/80 - 4/23/82	WG Pu, EU[d], DU[d]
442	771	0042	Chemical Technology	3/13/81 - 3/13/81	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	771	0042	Chemical Technology	3/9/83 - 4/11/84	WG Pu, EU, ^{241}Am, DU
442	771/881	0045	Note c	5/9/88 - 5/16/88	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	776	0003	Pyrochemical Operations	8/22/83 - 8/22/83	WG Pu, ^{241}Am
442	776	0019	Size Reduction	6/22/83 - 8/20/84	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	776	0025	Drum Repack	3/14/85 - 3/29/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	776	0041	Waste Processing/Final Packaging	7/8/82 - 8/3/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	776	0057	Advanced Size Reduction	5/23/88 - 6/6/88	WG Pu, EU, ^{241}Am, DU, ^{233}U
442	777	0023	Metal Fabrication-Machining	3/13/81 - 8/22/83	WG Pu, EU

a. Prefixes from the early 1970s and 1980s were not always associated with a specific building or process. However, this waste stream encompasses all RF buildings and processes that generated Raschig rings transuranic wastes. The characterization brackets the Raschig rings wastes generated in these time periods and identified by these IDCs and container prefixes.

b. Because the historical information for these prefixes did not definitively identify radionuclides for these container prefixes, all TRU radionuclides (WG Pu, EU, ^{241}Am, DU, and ^{233}U) are listed for these prefixes as a conservative measure.

c. Prefix 0045 appears to have been assigned to MBAs in both Buildings 771 and 881 at different times. Prefix 0045 was used for Special Recovery Anion Exchange in Building 771 and Construction Management in Building 881.

d. Isotopes added by confirmatory radioassay.

WG = weapons grade EU = enriched uranium DU = depleted uranium

19.3.2.7 ***Confirmatory Radioassay Data.*** During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN coupled with a gamma spectrometry system was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for Raschig rings wastes are summarized in Tables 19-9 and 19-10. The overall yield for the Raschig rings radioassay data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 19-9 and Table 19-10, respectively. The data for the individual radioassay systems information are contained in EDF-3374, “Radioassay Data Collected During 3100 Cubic Meter Project” [P322].

Table 19-9. Overall Yield for Raschig Rings Waste (INW247.001) [P322].

Total number of:	Number	Percentage of Total
Distinct containers	694	
"*WIPPOK*" containers	577	83%
"Treatment" containers	42	6%
"Deficient / Permanently Rejected" containers	74	11%

Table 19-10. Radionuclide and Related Quantities for Raschig Rings Waste[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	6.478E-01	1.134E+00	-3.346E-03	8.270E+00	661
TRU Activity (Ci)	6.489E-01	1.137E+00	-3.356E-03	8.292E+00	661
TRU Activity Concentration (nCi/g)	1.099E+04	1.794E+04	-3.792E+01	1.623E+05	661
Thermal Power (W)	2.038E-02	3.573E-02	-1.051E-04	2.613E-01	662
Thermal Power Density (W/ft^3)	2.773E-03	4.862E-03	-1.430E-05	3.556E-02	662
Plutonium Fissile Gram Equivalent (g)	7.153E+00	1.253E+01	-3.939E-02	8.772E+01	661
Americium-241 (g)	2.732E-02	4.454E-02	-6.295E-05	3.761E-01	571
Plutonium-238 (g)	1.128E-03	1.968E-03	-6.260E-06	1.394E-02	644
Plutonium-239 (g)	7.282E+00	1.256E+01	-3.921E-02	8.730E+01	644
Plutonium-240 (g)	4.540E-01	7.842E-01	-2.450E-03	5.455E+00	644
Plutonium-241 (g)	1.098E-02	1.885E-02	-5.843E-05	1.301E-01	644
Plutonium-242 (g)	1.999E-03	3.483E-03	-1.043E-05	2.323E-02	655
Uranium-233 (g)	5.642E-02	5.429E-02	2.280E-02	1.672E-01	7
Uranium-234 (g)	3.825E-04	1.169E-03	3.255E-06	5.916E-03	32
Uranium-235 (g)	4.061E-01	1.156E+00	5.771E-03	5.503E+00	28
Uranium-238 (g)	1.251E+00	2.006E-01	9.801E-01	1.457E+00	4

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. This also verified the absence of ^{90}Sr whose presence was predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry

b. The standard deviation is the statistical variation of the population for which measurements were available.

c. The negative low values are from the "Deficient / Permanently Rejected" category. These assays are outside the systems capabilities. Since this report is merely summarizing the data stored in TRIPS the values were left in for completeness.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

19.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P068]. A solution of water and KW was used to clean the size reduction vault in Building 776. The wastewater was stored in Raschig ring tanks [P052, P078]. Raschig rings may contain trace quantities of these complexing agents.

19.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For Raschig rings wastes, the yield of successful RTR examinations was approximately 94% [P323]. Conversely, approximately 6% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: layers of containment were exceeded; unverifiable IDC; absence of prohibited items could not be verified; did not meet the criteria for protection against sharp objects; presence of sealed inner containers greater than 4 liters; and presence of excess free liquids [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

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20. RESIN

This waste group consists of spent anion and cation exchange resins that have been cemented. The majority of this waste was generated by plutonium recovery operations in Building 771 [P012]. Smaller amounts of ion exchange resin were generated from americium recovery and R&D operations in Building 771, and from laboratory analysis. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 20-1 [U092].

Table 20-1. Resin Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
432	Cemented Resin [P001] Resin, Leached and Cemented [P012]	December 1972 – August 1986
822	Cemented Resin [P012]	January 1986-February 1987

Item Description Code 432, Cemented Resin: This waste consists of leached, spent anion and cation exchange resins that were cemented by mixing Portland cement, water, and washed resin into a slurry. The slurry was poured into a polyethylene bottle or metal can [U011, P024].

Item Description Code 822, Cemented Resin: This waste consists of washed, spent anion and cation exchange resins that were coated with cement with a mixer in a metal bowl. The resin was slurried with Portland cement and water. The slurried resin was poured into a polyethylene residue container mold and allowed to solidify [P043, P098].

20.1 Waste Generation

Ion exchange resins were generated by the recovery, purification, laboratory, and research and development activities associated with plutonium operations. Spent ion exchange resins were washed or leached and cemented prior to disposal. Process flow diagrams for resin waste generating processes are provided in archived WSRIC information [P061].

20.1.1 Ion Exchange Processes

Ion exchange processes were important to the plutonium purification processes at Rocky Flats. Anion exchange resin was part of the main plutonium recovery operation in Building 771. Plutonium-contaminated materials were often dissolved in nitric acid and processed through ion exchange. The dissolution process created plutonium nitrate solution. The ion exchange resin contained in a glass cylinder was loaded with plutonium by passing the plutonium nitrate solution through the column. Americium and other impurities passed through the column without being loaded on the resins. Ferrous sulfamate and aluminum nitrate were added to the plutonium nitrate solution to aid in the sorption of the plutonium on the resin. The plutonium was then eluted from the resin by passing a dilute nitric acid solution through the column. The resin was replaced when the efficiency was reduced through repeated use. The ion exchange resin used at Rocky Flats was generally small polystyrene plastic beads in which long-chain organic compounds with an activated group are imbedded [P052, P061].

Four ion exchange processes within Building 771 may have generated resin included in IDCs 432 and 822. These processes were anion exchange for plutonium recovery operations, cation exchange for plutonium purification from chloride solutions, special recovery anion exchange for plutonium and neptunium separation, and ammonium thiocyanate anion/cation exchange for americium purification [P061, P095, P096, P102, P105].

The anion exchange processes used for plutonium recovery operations and special recovery operations operated in a similar manner. The major differences between the two processes were (1) flow rate of the solution; (2) the special recovery process was used to separate plutonium and neptunium from impurities or plutonium from enriched uranium; and, (3) small amounts of hydrofluoric acid and sodium nitrite were used as needed in the special recovery process [P061, P095, P096, P102, P105].

The cation exchange process for plutonium purification used the same general steps as anion exchange, but with a different type of resin. In addition, the plutonium was loaded onto the resin with a hydrochloric acid solution and removed with nitric acid [P052, P061].

Prior to 1975, a combination anion and cation exchange process was used to purify americium from plutonium and other metals as part of the americium recovery process. The americium and plutonium were loaded onto a hydrogen form cation exchange resin with a nitric acid solution. The resin was water washed to remove any residual nitric acid. A weak ammonium thiocyanate solution was trickled through the resin to remove iron and other impurities. A stronger ammonium thiocyanate solution was then trickled through the resin to remove the americium and plutonium. The resin was washed again to remove residual ammonium thiocyanate solution prior to repeating the nitric acid loading process [P113].

The americium and plutonium solution from the initial cation exchange purification was trickled through chloride form anion exchange resin columns. A strong ammonium thiocyanate solution was trickled through the resin to remove cerium, yttrium, and other rare earth metals. Residual ammonium thiocyanate was removed using vacuum. The americium and plutonium were removed with a hydrochloric acid solution. Impurities such as chromium, nickel, lead, and iron remained on the resin. The anion exchange resin was replaced after each use [P113].

The solution from the anion exchange purification was concentrated through use of another cation exchange step. Plutonium and americium were separated in a final anion exchange step. A small amount of nitric acid added to the americium and plutonium solution caused the plutonium to load on the chloride form resin and the purified americium would pass through the column to the next americium recovery step. The plutonium was removed from the column with water and returned to the main plutonium recovery process [P113].

The laboratories located in Buildings 559 and 779 generated small amounts of anion exchange resins. Two processes in Building 559 used anion exchange to prepare plutonium samples for isotopic analysis. Building 779 evaluated ion exchange resins for efficiency in support of Building 771 plutonium recovery operations. All of these three processes operated in a manner similar to Building 771 plutonium recovery operations anion exchange and special recovery anion exchange but on a much smaller scale [P062, P076].

20.1.2 Resin Washing and Cementation

Operating procedures required that the ion exchange resin was to be washed twice with water prior to removal from the glovebox. The washing was performed to remove any residual acid from the resin. Resin was removed from the gloveboxes in six-inch diameter plastic-covered Kraft tubes or polyethylene bottles. The containers were assayed to determine if the resin was waste or if it contained recoverable amounts of plutonium [P024, P096, P102, P105]. Once the resin was determined to be waste, it was sent to Building 371 or 771 for cementation. IDCs 432 and 822 are both cemented resins. IDC 822 replaced IDC 432 in the mid-1980s. The change in IDCs is a reflection of a change in the cementation process, not a change in the processes generating the resins. The two cementation processes are summarized below.

Item Description Code 432, Cemented Resin: Leached, spent anion and cation exchange resins were cemented by mixing 1 liter of Portland cement, 500 milliliters of water, and 1 liter of washed resin into a slurry. The slurry was poured into a polyethylene bottle or metal can. One-half inch of dry Portland cement was added to the bottle before the slurry was added and after the slurry had solidified [U011, P024].

Item Description Code 822, Cemented Resin: Washed, spent anion and cation exchange resins were coated with cement with a mixer in a metal bowl. One liter of resin was slurried with 1,200 milliliters of Portland cement and 600 milliliters of water. The slurried resin was poured into a polyethylene residue container mold and allowed to solidify. Americium resin required lead shielding on the mixer and plastic container [P043, P098].

20.2 Waste Packaging

The bottles or cans of cemented resin (IDC 432) were double-bagged out of the glovebox line in polyvinyl chloride or polyethylene bags [P015, P024]. The cemented blocks of americium resin were placed in lead-wrapped plastic residue containers after solidification and before removal from the glovebox [P098]. The waste was then placed in a prepared 55-gallon drum [P012, P015, P024].

The polyethylene containers of cemented resin (IDC 822) were contained in plastic and then double-bagged out of the glovebox line in polyvinyl chloride or polyethylene bags [P012, P098]. The waste was then placed in a prepared 55-gallon drum [P012, P015, P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might also have been used to line the inner drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P012, P016, P024, P063]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox [P016]. Lead drum liners placed between the drum and rigid liner were usually used for cemented resin from the americium recovery line [P024]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

Waste management and inspection protocol allowed containers of wastes to contain up to 10% of another IDC other than that assigned to the container [P016]. VE of cemented resin containers identified a variety of items including a bag of dry Portland cement, white powder in a 1-gallon paint can, a cloth towel, tools, a grease pencil, and paper [P015, U011].

20.3 Waste Characterization

Resin is characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR reviews of the waste, VE, and headspace analysis. A RCRA hazardous waste determination for resin as well as radionuclide contaminants and potential complexing agents contained in

the waste is provided in this section. This waste contains at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and is therefore a heterogeneous waste [C204].

20.3.1 Hazardous Waste Determination

The material in this waste group does not qualify for any of the exclusions outlined in 40 CFR 260 or 261. Resin wastes may exhibit the characteristic of toxicity for chromium and lead. The wastes were not mixed with listed hazardous waste. There is no evidence that resin wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or the entire resin waste group are presented by IDC in Table 20-2.

Table 20-2. Resin Waste Characterization.

IDC	Title	EPA HWNs
432	Cemented Resin	D007 and D008
822	Cemented Resin	None

20.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23). The origin of the characteristic HWNs assigned to resin is provided in Table 20-3. The table includes only the HWNs that are applicable to waste for which a specific source and time period was identified. The HWNs are not applicable to waste generated from areas other than those listed in the table.

Table 20-3. Origin of Characteristic HWNs.

IDC	EPA HWNs	Building and Date of Generation
432	D007 and D008	Generated in Building 771 before 1975

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not a liquid, nor do they contain free liquids [P015, P021, U011]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change. The materials are not compressed gases, nor do the drums contain compressed gases [P015, P021, U011]. Although nitrates were associated with the anion exchange process, the resin washing and cementation process removed the oxidizer property. The resultant materials are, therefore, not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, nor do they contain free liquids [P015, P021, U011]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P015, P021, U011]. Explosives were not handled or used around radioactive material. The resin from the thiocyanate anion exchange process should not contain reactive levels of cyanide because the resin was

washed with water and nitric acid before and after contact with thiocyanate solution [P113]. The nitric acid would liberate any reactive cyanide at that time. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for chromium and lead metals.

The resin from the ammonium thiocyanate ion exchange process in Building 771, which operated until 1975, retained impurities such as chromium, nickel, lead, and iron [P113]. The resins from the other ion exchange processes were used to selectively remove plutonium or other radionuclides and let other metals pass on in the liquid effluent. Therefore, cemented resin (IDC 432) generated in Building 771 prior to 1975 was assigned EPA HWNs D007 and D008.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating resin. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

There is no documentation indicating toxicity characteristic organics were used in the ion exchange processes generating resin. Headspace analysis detected trichloroethylene and 1,1-dichloroethylene in cemented resin (IDC 432) [P033]. Trichloroethylene was commonly used for cleaning, and could have been used to clean gloveboxes used in the various ion exchange processes [P023, P053]. The source of 1,1-dichloroethylene may be from the radiolysis of 1,1,1-trichloroethane [P151]. Since trichloroethylene and 1,1-dichloroethylene were not used in the ion exchange processes, the resin should not contain toxicity characteristic levels of these compounds. Therefore, this waste group does not exhibit the characteristic of toxicity due to organics (D018-D043).

20.3.1.2 Listed Hazardous Waste.

The materials in this waste group are not, or were not mixed with, a waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31), as hazardous waste from specific sources (40 CFR 261.32), or as discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33).

There is no documentation indicating the presence or use of F003- or F004-listed solvents in the areas or processes generating resin. Therefore, this waste group is not an F003- or F004-listed hazardous waste.

Organic solvents may have been used for cleaning the glovebox lines used in the various ion exchange processes [P023, P053]. However, there is no documentation indicating that listed solvents were used in the processes generating resin. Therefore, this waste group is not an F001-, F002-, or F005-listed hazardous waste.

Although this waste is not an F-listed hazardous waste, headspace analysis performed on samples of resin (IDCs 432 and 822) obtained at INEEL confirms the presence of organic solvents in IDC 432. The detected compounds in which the UCL_{90} is above the PRQL are provided [P033].

- 1,1,1-trichloroethane (IDC 432 only)
- trichloroethylene (IDC 432 only)

- toluene (IDC 432 only).

The materials in this waste group are not hazardous waste from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residue thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

20.3.2 Radionuclides

Radionuclide contamination in anion and cation ion exchange resins from plutonium recovery operations in Buildings 371and 771 consisted primarily of plutonium because americium and other impurities remained in the acid solution while the plutonium loaded onto the resin [P061]. Resin from the americium recovery and purification process was contaminated with higher levels of americium since both plutonium and americium were loaded onto the resins [P113]. Limited amounts of resin were generated in Building 559 and the special recovery area of Building 771and was possibly contaminated with neptunium, plutonium, americium, and uranium-235 [P076, P095, P096].

Buildings 371 and 771 cemented resins in preparation for shipment and, therefore, resins from both buildings potentially could have originated from any ion exchange processes [P024, P067]. Repackaging operations were conducted in the Building 776 SRV, and the repacked containers could potentially contain resins from any of the ion exchange processes [C175, P078].

Table 20-4. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	Actinides from chloride solution were loaded onto the cation exchange resins. Actinides from nitrate solution were loaded onto the anion exchange resin as the hexanitrate complex. After eluting the actinide of interest (i.e., plutonium, americium, uranium, or neptunium), the resin was washed with a dilute nitric acid [P061, P076, P163, P095, P096, P102]. Actinides should be relatively well distributed throughout the waste, based on the cementing procedure [P098].
Hydrogen Content	The resins are a polystyrene and divinylbenzene copolymer [P024, P163]. Headspace gas analysis indicates hydrogen content in IDC 432 from 0.31 to 27.1 vol% [P015]. Hydrocarbons were detected in headspace gas samples of IDC 432 [P033]. Each cemented resin "puck" contains 600 ml of water [P098].
Other Interfering Waste Contaminants	No other interfering contaminants were identified.
Physical Matrix Parameters	Resin density is approximately 0.7 g/cm^3 [P024]. Waste and waste contaminants should be relatively well distributed throughout the waste, based on the cementing procedure [P098].

20.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix.

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 20-5. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The generation dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 20-5. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
432	371	0011	Note a	1/17/86	WG Pu, EU, ^{241}Am
432	371	0032	Aqueous Recovery	11/5/83 - 3/31/86	WG Pu, EU, ^{241}Am
432	771	0001	Aqueous Recovery	12/1/72	WG Pu, EU, ^{241}Am
432	771	0002	Aqueous Recovery	1/25/73 - 4/19/85	WG Pu, EU, ^{241}Am
432	776	0019	Size Reduction	9/8/83 - 10/10/83	WG Pu, EU, ^{241}Am
432	776	0025	Drum Repack	3/14/85 - 8/12/86	WG Pu, EU, ^{241}Am
432	865	0056	Material Tech.-General Metallurgy	12/9/83 - 12/8/84	Unknown
822	371	0011	Note a	1/17/86 - 2/19/87	WG Pu, EU, ^{241}Am
822	371	0032	Aqueous Recovery	2/20/86 - 3/31/86	WG Pu, EU, ^{241}Am

a. This prefix was assigned to an MBA in Building 371 that was not defined or was redefined after this waste was generated. It was assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

WG = weapons grade EU = enriched uranium

20.3.2.2 Confirmatory Radioassay Data.

During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS.

Radioassay data were collected in the 3,100 m^3 Project for a waste stream identified as "Miscellaneous Cemented Sludge." Ninety-eight (98) containers were assayed over the life of the 3,100 m^3 Project for this waste stream from IDCs 432, 806, 820, 822, and 823. Only IDCs 432 and 822 are presented in this section. A presentation of the NDA results for this group would have no value in this document. The radioassay results are summarized in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

20.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

Oxalic acid was used in the americium recovery line. However, it was used for a precipitation process that followed the ion exchange processes, and therefore, should not be contained in resin [P113]. There is no documentation indicating the presence or use of any other complexing agents in the areas or processes generating resin.

20.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. The cemented resin (IDC 432 and IDC 833) wastes were not characterized for shipment to WIPP and a WSP was not developed. For the cemented resin wastes, the yield of successful RTR examinations was 100% for each IDC [P323]. Conversely, none of the containers were dispositioned as *Treatment.*

VE indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

21. SAND, SLAG AND CRUCIBLE

This waste group includes sand, slag, and crucible wastes generated by laboratory operations in Buildings 559 and 771, plutonium recovery operations in Buildings 771 and 776, and research and development activities in Building 779. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 21-1 [U092].

Table 21-1. Sand, Slag, and Crucible Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
368	Magnesium Oxide Ceramic Crucibles, not Leco [C063]	October 1986
370	Leco Crucibles [C063]	October 1980-June 1982
391	Crucible and Sand [C063] Unpulverized Sand and Crucible [C063]	June 1980 – August 1983
392	Sand, Slag, and Crucibles [C063] Unpulverized Sand, Slag, and Crucible [C063]	July 1981
393	Sand, Slag, and Crucible Heels [C063]	August 1980 – May 1986
817	Cemented Sand, Slag, and Crucible Heels [C063]	October 1986-January 1987

Item Description Code 368, Magnesium Oxide Ceramic Crucibles, not Leco: This waste consists of magnesium oxide ceramic crucibles and fragments. The crucible pieces will range from large chunks (2" to 3" in one dimension) to dust. The crucibles may contain residual salts from the pyrochemical processes from which they were generated. The salts may contain metals, such as calcium and magnesium, entrained in the salt matrix [P016, P032, P035, P052].

Item Description Code 370, Leco Crucibles: This waste consists of aluminum silicate-based ceramic crucibles with approximately 0.5% chromium, and ranging from 4-inch long by 3/4-inch square to 1-inch high by 1-inch diameter [P012, P035]. Used Leco crucibles contained a spent accelerator metal (copper, iron, tungsten, or tin). Plutonium and an accelerating metal were fused into the Leco crucible. The crucibles may be intact or in pieces. Leco crucibles were segregated into unused (blank) crucibles and used (fused) crucibles. Only blank crucibles were shipped to INEEL [P024, P035, P052].

Item Description Code 391, Unpulverized Sand and Crucible: This waste consists of magnesium oxide crucibles and limited amounts of magnesium oxide sand [P024]. The crucibles will range from half to three quarters the length and diameter of the original crucible to pieces approximately the size of the larger grains of sand. This waste may also contain small beads of magnesium metal condensed from magnesium metal vapor. The vapor was produced by the action of excess calcium metal on magnesium oxide [P035].

Item Description Code 392, Unpulverized Sand, Slag, and Crucible: This waste consists of magnesium oxide crucibles, calcium fluoride slag, and limited amounts of magnesium oxide sand. The crucibles will range from half to three quarters the length and diameter of the original crucible to pieces approximately the size of the larger grains of sand. The slag consists primarily of calcium fluoride contaminated with uncoalesced plutonium, some residual calcium metal or calcium salt, magnesium metal, and trace amounts of the reduction pyrotechnic initiator (powdered magnesium, sodium peroxide, and potassium iodate) [P035, P061].

Item Description Code 393, Sand, Slag, and Crucible Heels: This waste consists of undissolved or precipitated calcium fluoride (slag) and undissolved magnesium oxide sand and crucible remaining after pulverizing and leaching of sand, slag, and crucible (IDC 392) [P016, P024, P061]. The waste may also contain trace amounts of aluminum nitrate and aluminum fluoride. The actinides remaining in the heel will be in the form of fluorides and oxides; predominantly fluorides [P035].

Item Description Code 817, Cemented Sand, Slag, and Crucible Heels: This waste consists of sand, slag, and crucible heels (IDC 393) mixed with Portland cement and water in 1-gallon molds. The cured "pucks" (IDC 817) were removed from the molds in the form of a solid monolith [P016].

21.1 Waste Generation

The laboratories in Buildings 559 and 771 generated Leco crucibles. Sand, slag, and crucible wastes were generated from plutonium recovery operations in Building 771 and from research and development activities in Building 779. Magnesium oxide ceramic crucibles were generated by pyrochemical recovery operations in Building 776 [P024, P052, P061, P062, P070, P078, U092, U059].

21.1.1 Leco Crucible Generation

The laboratories in Buildings 559 and 771 generated Leco crucible waste (ID 370). Leco crucibles were used for carbon analyses of plutonium metals and oxides. Stainless-steel pins were also heated in the crucibles for calibration purposes [P052].

Samples of metals, oxides, or stainless-steel pins were placed in a Leco crucible with an accelerator metal (typically copper, iron, tungsten, or tin) and heated. The heating caused the carbon in the sample to react, forming carbon dioxide. The carbon dioxide was measured to determine the carbon content of the sample. Figure 21-1 shows the carbon analysis process [P052].

21.1.2 Sand, Slag, and Crucible Generation

A magnesium oxide crucible was placed in a stainless-steel reduction vessel, and the void between the crucible and the vessel was filled with magnesium oxide sand. Plutonium tetrafluoride from the hydrofluorination process was mixed with calcium metal and a pyrotechnic initiator (magnesium metal, sodium peroxide, and potassium iodate) and placed in the crucible. The vessel was sealed, placed in an induction furnace, purged with argon, and heated. The resulting reaction reduced the plutonium tetrafluoride to plutonium metal, and oxidized the calcium metal to form calcium fluoride (slag). The purified plutonium metal "button" was separated from the crucible and reaction by-products [P061]. Unpulverized sand and crucible (IDC 391) was generated when the sand and crucible residues were separated from the slag. Unpulverized sand, slag, and crucible (IDC 393) waste was generated when the crucible and reaction by-products were not separated prior to disposal [P052]. Plutonium metal meeting purity requirements was sent to the foundry in Building 707. The plutonium metal containing unacceptable impurities was sent for electrorefining [U013]. The reduction and button break-out process is illustrated in Figure 21-2 [P052].

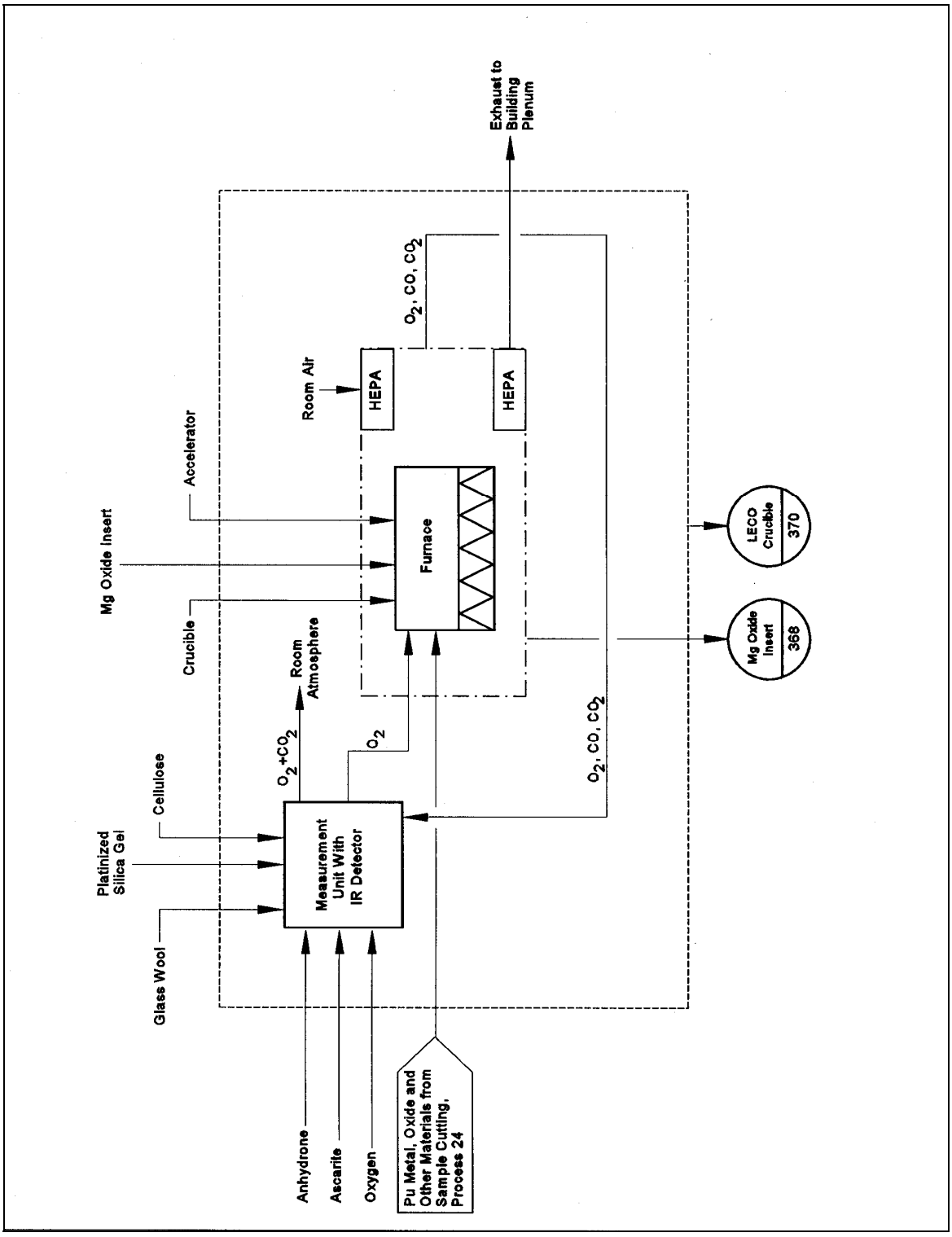

Figure 21-1. Carbon Analysis Process.

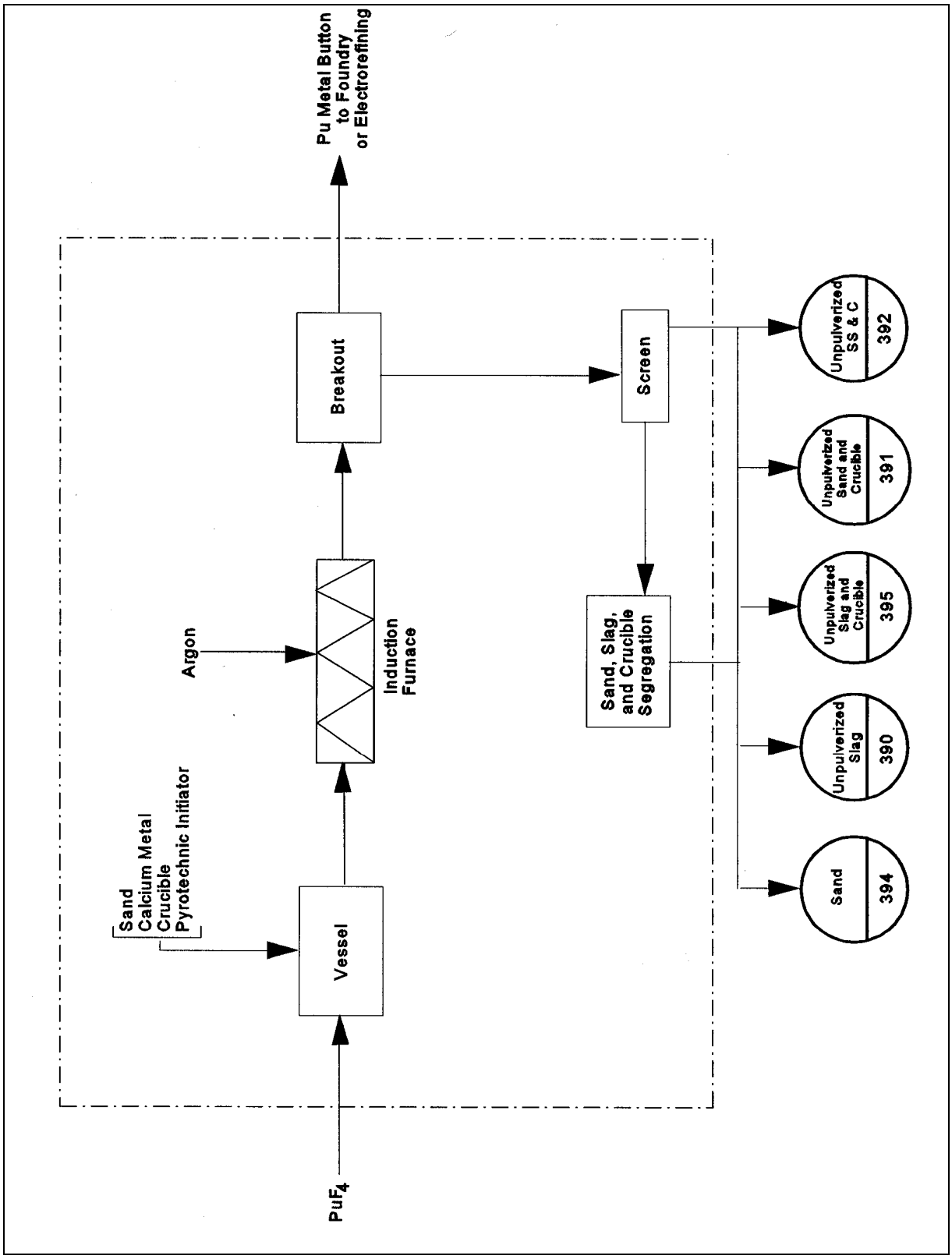

Figure 21-2. Reduction and Button Break-Out Process.

Unpulverized sand, slag, and crucibles from the reduction and button break-out process were pulverized using a jaw crusher and a hammermill and sent to the residue dissolution process for plutonium recovery [P061, P103]. The pulverized sand, slag, and crucibles were leached with heated nitric acid. Aluminum nitrate was added as a fluoride complexing agent to prevent corrosion of downstream process equipment. The plutonium nitrate solution flowed to a R-6 filter for removal of undissolved solids and through a 1-micron filter for final particulate removal. Water was used for washing the undissolved solids on a secondary R-6 filter. The undissolved solids (heels) were dried on a hot plate and then assayed for plutonium content. Heels above the EDL were sent back through the residue dissolution process. Heels (IDC 393) below the EDL were placed in storage [P016]. Figure 21-3 shows the residue dissolution process [P061, P092].

Beginning in 1985, sand, slag, and crucible heels (IDC 393) were immobilized into a solid monolith with Portland cement and water [C050, P016]. Portland cement and water were mixed, and approximately one liter of the heel material was mixed in until completely coated with cement. The heels, cement, and water mixture was poured into a 1-gallon polyethylene container mold and allowed to cure. After being removed from the mold, the solidified puck was placed in a 55-gallon drum. Several pucks were placed in a drum [P016, P098]. The cemented sand, slag, and crucible heels were assigned IDC 817 [P016].

Unpulverized sand and crucible (IDC 391) was also generated during research and development activities in Building 779 [U092]. Documentation pertaining to the specific operation which generated this waste was not identified. However, operations may have been conducted in Building 779 for the development or improvement of the Building 771 recovery processes that generated sand, slag, and crucible wastes. The materials used in the research and development operations are not known, but were likely similar to those used in the recovery processes in Building 771 [C118, P067].

21.1.3 Magnesium Oxide Ceramic Crucible Generation

Pyrochemical operations in Building 776 involved the extraction, recovery, and/or purification of plutonium from plutonium metal, plutonium oxide, or residue salts.

In the electrorefining process, non-specification plutonium metal, cast as an anode, was combined with magnesium chloride and an equimolar mixture of sodium chloride and potassium chloride in a magnesium oxide crucible. The crucible and contents were heated in a furnace until the mixture was molten. A cathode and an anode/stirrer were then lowered into the molten mixture. A current was applied to the anode/stirrer, which flowed through the mixture to the cathode. Plutonium ions migrated through the salt to the cathode and were reduced to purified metal. After the cathode and anode were removed, the crucible was allowed to cool before it was removed from the furnace. The crucible was broken and the purified plutonium metal was separated from the salt and anode heel. The plutonium was analyzed then sent to the foundry for production [P139, P163].

In the direct oxide reduction (DOR) process, calcined plutonium oxide was placed into a magnesium-oxide crucible with calcium chloride and calcium metal. The crucible and contents was placed in a furnace and heated until the contents were molten. The molten mixture was stirred until the reduction was complete. After the mixture cooled, the contents were removed and the plutonium metal was separated from the salt phase. Depending on the purity of the plutonium, it was either sent to the foundry or it was further purified in the electrorefining process [P139, P163].

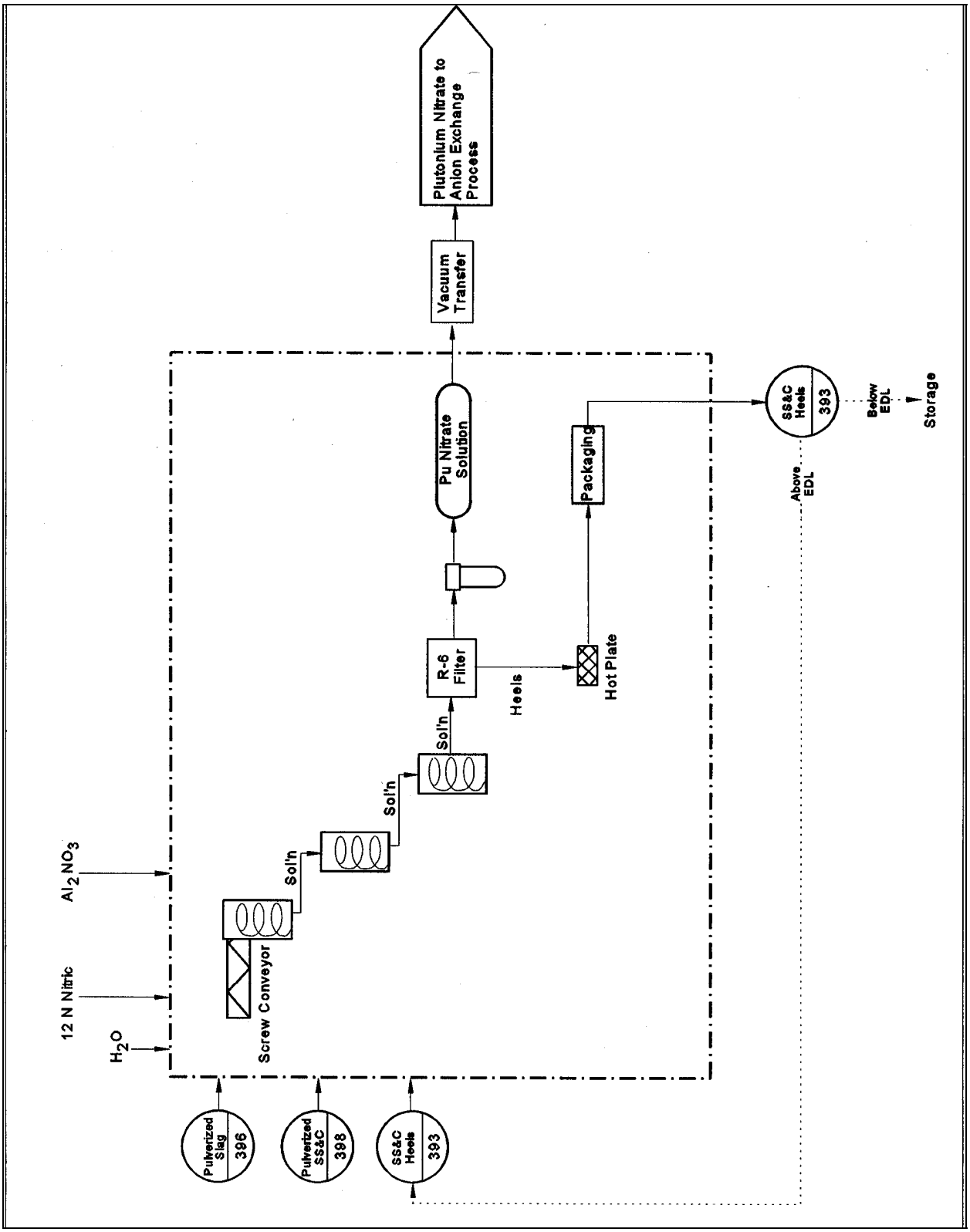

Figure 21-3. Residue Dissolution Process.

The salt scrub process reduced and concentrated actinide ion metals present in residue salts from the molten salt extraction process (described in Section 18.1.1) into a stable non-oxidizing metal alloy. The salts were combined with a reducing agent and alloying agent; the combinations used included: magnesium and aluminum; calcium and gallium; and, calcium and cerium. The crucible and contents was placed in a furnace and heated until the contents were molten. While molten, the plutonium and americium were reduced by the calcium or magnesium and the actinides were taken up in the metal alloy phase. The molten mixture was stirred until the reduction was complete. After the mixture cooled, the contents were removed and the scrub alloy button was separated from the salt phase [P139, P163].

21.2 Waste Packaging

Magnesium oxide crucibles (IDC 368) may have been loaded directly into a drum or removed from the glovebox line contained in two PVC bags or a PVC and a polyethylene bag. The waste may also have been placed in metal cans, polyethylene bottles (up to 4 liters in size), or clamshell containers that were removed from the glovebox line within the two bags. A small amount of Oil-Dri® was added to each bag if the waste was wet [P016, U004].

Leco crucibles (IDC 370) were placed in 1-gallon metal paint cans. Unpulverized sand and crucible (IDC 391) was packaged in 1-gallon paint cans or polyethylene bottles. Sand, slag, and crucible heels (IDC 393) were packaged in 1/2- and 1-gallon polyethylene bottles. Documentation was not identified for the packaging configuration of unpulverized sand, slag, and crucibles (IDC 392). It is assumed that IDC 392 was packaged like IDC 391 because they were generated by the same process [P012, P024].

The paint cans or polyethylene bottles were double-bagged out of the glovebox in PVC or polyethylene bags, which were sealed with tape. Each can or bottle was assayed for plutonium content. The packages were then placed in a 55-gallon drum. Approximately 15 to 25 one-gallon containers and up to 30 half-gallon containers were placed in a drum depending on assay [P012, P024].

Cemented sand, slag, and crucible heels (IDC 817) were bagged out of the glovebox, double-bagged, and placed into a 55-gallon drum [P016].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might have been used to line the inner drum bag. Use of 90-mil rigid polyethylene liners began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags [P008, P012, P016, P024, P063, P064]. A PVC O-ring bag and a polyethylene bag placed inside the rigid liner were used if the drum was attached to a glovebox [P016]. A fiberboard liner and discs may also have been used between the waste and the drum liners [P008, P012, P016, P064]. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag. This procedure was changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

21.3 Waste Characterization

Sand, slag, and crucible wastes have been characterized based on knowledge of the material and knowledge of the processes generating the waste. This section provides a RCRA hazardous waste determination for sand, slag, and crucible as well as radionuclide contaminants and potential complexing agents contained in the waste. Sand, slag, and crucible wastes (IDCs 368, 370, 391, and 392) are at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and are therefore heterogeneous wastes [C204, P141]. Heel and cemented heel (IDCs 393 and 817) is at least 50% (by volume) inorganic particulates, and is classified as a homogeneous waste [P141].

21.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. Sand, slag, and crucible heel wastes may exhibit the characteristic of toxicity for chromium. Magnesium oxide crucibles, Leco crucibles, and sand, slag, and crucible wastes were not mixed with listed hazardous waste, and do not exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or all of the sand, slag, and crucible waste group are presented by IDC in Table 21-2. These conclusions are supported by the evaluation in Sections 21.3.1.1 and 21.3.1.2.

Table 21-2. Sand, Slag, and Crucible Waste Characterization.

IDC	Title	EPA HWNs
368	Magnesium Oxide Crucibles	None
370	Leco Crucibles	None
391	Unpulverized Sand and Crucible	None
392	Unpulverized Sand, Slag, and Crucible	None
393	Sand, Slag, and Crucible Heels	D007
817	Cemented Sand, Slag, and Crucible Heels	D007

21.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and should not contain free liquids because the waste was dry when packaged [P012, P016, P024, P043]. The materials are not capable of causing fire through friction or spontaneous chemical change. Even though magnesium oxide crucible waste (IDC 368) and sand, slag, and crucible wastes (IDCs 391 and 392) may contain metals such as calcium or magnesium, they are not capable of causing fire from absorption of moisture [P052]. The materials are not compressed gases, and compressed gases have not been identified in this waste [P012, P016, P024, P043]. The materials are not DOT oxidizers as defined in 49 CFR 173. Documentation verifying the absence of free liquids and compressed gases in IDC 392 containers was not identified; however, it is assumed that the same procedural controls applied to this waste. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, and should not contain free liquids because the wastes

were dry when packaged [P012, P016, P024, P043]. Documentation verifying the absence of free liquids in IDC 392 containers was not identified; however, it is assumed that the same procedural controls applied to this waste. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group are stable and will not undergo violent chemical change. The materials will not form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. Magnesium oxide crucible waste (IDC 368) and sand, slag, and crucible wastes (IDCs 391 and 392) may contain reactive metals such as calcium or magnesium. Based on regulatory interpretations by the Colorado Department of Public Health and Environment, pyrochemical salts do not meet the definition of reactivity as defined in 40 CFR 261.23. This interpretation is applicable to IDCs 368, 391 and 392 [C117, C119, C199, P052]. Additionally, during DOT water reactivity testing on this waste, violent or explosive reactions were not observed [P052]. The waste materials do not contain cyanides or sulfides and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P016, P024]. Explosives were not handled or used around radioactive material. Documentation concerning the absence of explosives in IDC 392 containers was not identified; however, it is assumed that the same procedural controls applied to this waste. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for chromium metal.

Magnesium oxide crucibles do not contain toxic metals, and toxic metals were not used in the processes generating magnesium oxide crucibles. Therefore, IDC 368 waste does not exhibit the characteristic of toxicity due to metals (D004-D011).

Toxicity characteristic metals were not fired with Leco crucibles. The only source of toxicity characteristic metals was the chromium, which is present in the crucible itself, and the fused stainless-steel on used Leco crucibles. Analysis of non-radioactive Leco crucibles indicates that chromium does not leach. Therefore, Leco crucibles (IDC 370) do not exhibit the characteristic of toxicity for chromium [P052]. TCLP metals analysis of actual Leco crucible waste supports the non-hazardous characterization [P052].

Chromium was a contaminant of plutonium tetrafluoride, which was the feed material for the reduction and button break-out process. Plutonium recovery analysis records of the plutonium metal indicate that the chromium remained with the plutonium metal after the reduction was performed. Therefore, sand, slag, and crucible wastes (IDCs 391 and 392) do not exhibit the characteristic of toxicity for chromium [P052].

Chromium may have been added to sand, slag, and crucible heels from the corrosion of the stainless steel in the dissolution process area. The level of chromium contamination is unknown. Therefore, sand, slag, and crucible heels (IDCs 393 and 817) are assigned EPA HWN D007 [P052]. A representative sample of this waste will be obtained for verification purposes.

There is no documentation indicating the presence or use of pesticides, herbicides, or other organic compounds in the areas or processes generating sand, slag, and crucible. Therefore, this waste group does not exhibit the characteristic of toxicity due to organic compounds (D012-D043).

21.3.1.2 Listed Hazardous Waste. The materials in this waste group are not, or were not mixed with, waste listed in 40 CFR 261, Subpart D as a hazardous waste from non-specific sources (40 CFR 261.31), as hazardous wastes from specific sources (40 CFR 261.32), or as discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

The compounds listed in 40 CFR 261.31 were not used in the processes, which generated this waste, nor were these wastes mixed with any of these compounds. The materials in this waste group are therefore not F-listed hazardous wastes.

The materials in this waste group are not hazardous waste from specific sources because they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

21.3.2 Radionuclides

The radioisotopes potentially contained in the waste are identified in this section. In addition, the matrix and other physical parameters which could affect radioassay are summarized in Table 21-3.

Magnesium oxide crucibles (IDC 368) were generated from pyrochemical processes that produced or recovered plutonium for use in weapons production [P163]. Leco crucibles (IDC 370) were generated from carbon analysis of plutonium metal and oxide samples [P052]. Sand, slag, and crucible (IDCs 391 and 392) were generated during the final step of aqueous plutonium recovery processing where plutonium tetrafluoride was reduced to plutonium metal for use in weapons production. Heels (IDCs 393 and 817) were generated from recovery of plutonium from sand, slag, and crucible wastes [P035, P052]. Therefore, radionuclide contamination will consist of weapons-grade plutonium only. The isotopic composition of weapons-grade plutonium is provided in Section 3.0.

Table 21-3. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	IDC 368: Plutonium metal, oxide, or chloride [P163]. IDC 370: Plutonium metal and oxide [P052]. IDC 391: Plutonium metal and trace amounts of unreacted plutonium fluoride located toward the bottom of the crucible. The sand could contain plutonium metal and fluoride [P035]. IDC 392: Plutonium metal and trace amounts of unreacted plutonium fluoride located toward the bottom of the crucible. The mid-section of the crucible will primarily contain the calcium fluoride slag, which will be contaminated with plutonium metal. The sand could contain plutonium metal and fluoride [P035]. IDCs 393/817: Plutonium fluoride and oxide; predominantly fluoride [P035].
Hydrogen Content	The primary sources for hydrogen in this waste includes fiberboard, polyvinyl chloride, and polyethylene liners, bags, and bottles (see Section 21.2). Analysis of IDC 398 (pulverized IDC 392) indicates trace amounts of hydrocarbons (less than 10 ppm) which may have been produced from the degradation of the

Table 21-3. (continued).

Parameter	Results of Evaluation
	plastic packaging material [C186]. IDC 393 may contain an appreciable amount of moisture because there were no controls on the moisture content of the dried heels [C181]. IDC 368 from DOR will have calcium chloride adhering to the surface of the crucible. Since calcium fluoride is deliquescent, it could adsorb sufficient moisture to cause the crucible to exceed 10 wt% water [C180].
Other Interfering Waste Contaminants	IDC 368: The crucible is a magnesium oxide ceramic material that may contain residual chloride-based salts with metals (e.g., calcium and magnesium) entrained in the salt matrix [P035]. IDC 370: Leco crucibles are an aluminum silicate-based ceramic with approximately 0.5% chromium. The waste may also contain stainless-steel which was melted in the crucible for calibration purposes [P035]. IDC 391: The sand and crucible are composed of magnesium oxide. The waste may also contain small beads of magnesium metal [P035]. IDC 392: The sand and crucible are composed of magnesium oxide. The waste may also contain small beads of magnesium metal. The calcium fluoride slag will contain trace amounts of the pyrotechnic initiator (powdered magnesium and potassium iodate) [P035]. IDC 393/817: Undissolved or precipitated calcium fluoride (slag) and undissolved magnesium oxide sand and crucible remaining after the waste had been pulverized and leached. The waste may also contain trace amounts of aluminum nitrate and aluminum fluoride [P035].
Physical Matrix Parameters	IDC 391: The small beads of magnesium metal will be located in the free board area of the crucible [P035]. IDC 392: The small beads of magnesium metal will be located in the free board area of the crucible, and the slag and pyrotechnic initiator will be located in the mid-section of the crucible [P035].

21.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides are quantified and reported in accordance with Appendix A of the (CH-WAC), Sections 3.1.4, 3.3.1, and 3.7.1. INEEL bases most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239, -240, and –241; and uranium-233, -235, and –238. Default values for mass isotopic ratios for the plutonium isotopes are obtained from 2,556 high-resolution gamma spectrometric measurements of RFP wastes. [P227, P322]. Decision criteria for using default versus measured values are specific to the assay system. Determination of plutonium-242 uses its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay includes high resolution gamma spectrometry and the data from these measurements are reviewed to confirm the applicability of the default mass isotopic values [P322]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, requires a documented disposition as an anomaly. Default isotopic values are used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 are based on the individual gamma spectrometric measurements. The uranium-234 activities are calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, are not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 is verified during radioassay using the

661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence is predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 21-4. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number in this table. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 21-4. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
368	776	0003	Pyrochemical Operations	10/17/86	WG Pu, ^{241}Am
370	559	0029	Analytical Laboratory	1/12/81	WG Pu
370	707	0028	Note a	10/22/80 - 6/21/82	prefix/IDC conflict
391	771	0001	Aqueous Recovery	12/8/82 - 8/30/83	WG Pu
391	779	0054	Research and Development	6/10/80	WG Pu
392	776	0040	Waste Processing/Final Packaging	7/10/81	WG Pu
393	771	0001	Aqueous Recovery	8/26/80 - 10/2/85	WG Pu
393	771	0002	Aqueous Recovery	6/12/84	WG Pu
393	776	0040	Waste Processing/Final Packaging	5/9/86	WG Pu
393	779	0010[c]	Pyrochemical Technology	5/1/84 - 7/22/85	WG Pu
817	371	0011	Note b	10/22/86 - 1/6/87	WG Pu

a. This prefix was assigned to an MBA in Building 707 that is not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 707 unless the IDC further defines what radionuclides are in the waste.

b. This prefix was assigned to an MBA in Building 371 that is not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

c. This prefix should be 01. IDC 393 was generated from recovery operations in Building 771. The package dates and the last five digits of these container numbers are in the proper sequence if the prefix is changed to 01.

WG = weapons grade

21.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project, all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the sand, slag, and crucible waste stream are summarized in Table 21-5. Nine (9) containers were assayed over the life of the 3,100 m^3 Project from IDCs 370, 391, and 393. Table 21-5 presents the radionuclide and related radioassay information from all the radioassay systems in use at RWMC for this group of IDCs. The data for the individual radioassay

systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 m^3 Project" [P322].

A presentation of the overall yield results for NDA for this group would have no value in this document due to limitations from the limited number of containers assayed and the lack of complementary RTR examination data for all IDCs included. [P322].

Table 21-5. WIPP reportable quantities for sand, slag, and crucible.[a]

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	9.332E+00	2.643E+00	3.443E+00	1.182E+01	9
TRU Activity (Ci)	9.351E+00	2.646E+00	3.453E+00	1.184E+01	9
TRU Activity Concentration (nCi/g)	1.821E+05	7.253E+04	4.426E+04	2.571E+05	9
Thermal Power (W)	2.942E-01	8.426E-02	1.083E-01	3.704E-01	9
Thermal Power Density (W/ft^3)	4.003E-02	1.146E-02	1.474E-02	5.039E-02	9
Plutonium Fissile Gram Equivalent (g)	1.031E+02	3.727E+01	4.030E+01	1.428E+02	9
Americium-241 (g)	4.740E-01	7.374E-01	9.282E-02	2.142E+00	7
Plutonium-238 (g)	1.191E-02	3.406E-03	6.246E-03	1.590E-02	9
Plutonium-239 (g)	1.023E+02	3.741E+01	3.911E+01	1.419E+02	9
Plutonium-240 (g)	6.217E+00	2.235E+00	2.444E+00	8.601E+00	9
Plutonium-241 (g)	1.849E-01	7.479E-02	5.829E-02	2.611E-01	9
Plutonium-242 (g)	4.523E-02	2.054E-02	1.041E-02	6.529E-02	9
Uranium-233 (g)	8.383E-01	N/A	8.383E-01	8.383E-01	1
Uranium-234 (g)	2.121E-03	N/A	2.121E-03	2.121E-03	1
Uranium-235 (g)	9.992E-01	N/A	9.992E-01	9.992E-01	1
Uranium-238 (g)	2.387E+02	N/A	2.387E+02	2.387E+02	1

a. The absence of ^{137}Cs is verified during radioassay using the 661 keV line as described in the INEEL RWMC EDF-840. This also verifies the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry (see Reference 14).

b. The standard deviation is the statistical variation of the population for which measurements were available. N/A = Not Applicable. The standard deviation is not applicable for a single measurement.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

21.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

Aluminum nitrate was used in the residue dissolution process as a fluoride complexing agent. Trace quantities of this compound may be present in sand slag, and crucible heels (IDCs 393 and 817) [P061].

21.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the sand, slag, and crucible waste stream, RTR examinations were completed on one container each of IDC 391 and IDC 393 wastes. None of the sand, slag, and crucible wastes were characterized for shipment to WIPP and a WSP was not developed.

The yields of successful RTR examinations for IDC 391 and IDC 393 were 0.0% for both IDCs [P323]. The containers from both IDCs were dispositioned as *Treatment.* The reasons for the *Treatment* disposition are: the layers of confinement were exceeded for the assigned shipping category for IDC 391 waste container and the presence of inner containers greater than 4 liters for the IDC 393 waste container [P323].

Visual examination indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

The sand, slag, and crucible RTR yields were separated by IDCs:

- IDC 370
- IDC 391
- IDC 393.

22. SOLIDIFIED AQUEOUS WASTE–BUILDING 374

This waste group consists of aqueous sludges generated by liquid waste treatment operations in Building 374 at the Rocky Flats Plant. Aqueous wastes from numerous buildings and processes at the plant were received in Building 374 where they were treated to remove radioactive and chemical contaminants. Chemical contaminants were removed using evaporation. Radioactive contaminants were removed using neutralization, precipitation, flocculation, and clarification techniques. The slurry containing the radioactive contaminants was filtered producing a moist sludge. The sludge was either (1) dried, (2) mixed with an absorbent material, or (3) dried and mixed with cement and water. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 22-1 [U092]. The Building 374 solidified aqueous waste was characterized under a CBFO approved WSP, INW218.001, for containers of waste shipped to the WIPP facility [P218, P220, P238].

Table 22-1. Solidified Aqueous Waste-Building 374 in the INEEL Accessible Storage Inventory.

IDC	Title	Dates of Generation
007	Dried Sludge [P014] Bldg. 374 Dry Sludge [C063] Wet Sludge-Bldg. 374 [C063]	August 1982 – May 1987
803	Wet Sludge-Cemented [C063] Solidified Sludge Bldg. 374 (DCP) [C031]	April 1986 – December 1986
807[a]	Solidified By-pass Sludge-Bldg. 374 [C031]	March 21, 1987 – July 1, 1988

a. IDC 807 was assigned to cemented incinerator sludge generated from October 23, 1985 to March 21, 1987 (Section 14.0). An overlap of dates of generation was discovered during the 3,100 m^3 Project.

Item Description Code 007, Wet Sludge-Bldg. 374: This waste consists of either a sludge that has been dried in a dryer, or a moist sludge mixed with Portland cement or a diatomite and Portland cement mixture. The dried sludge was produced from January 1981 to October 1982, and may not be included in the INEEL inventory based on the package dates for IDC 007 in storage. The moist sludge was produced from 1982 to 1987 [P052].

Table 22-2 lists items that have been identified in containers during INEEL 3,100 m^3 Project examination of the Building 374 sludge [P238]. Table 22-3 lists the typical waste material parameters for Building 374 sludge (IDC 007) for the 3,100 m^3 Project, including typical packaging materials [P238].

Table 22-2. Items Identified by RTR for Building 374 Sludge (IDC 007) During the 3,100 m^3 Project [P238].

Item[a]	Comment
Inorganic liquids	Free liquid was detected by RTR and assigned to other inorganic materials. Any containers with liquids above the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.
Lead-containing items	The RTR examination identified a leaded rubber glove.

Table 22-2. (continued).

Item[a]	Comment
Metals	RTR identified metal waste material. Metal material, itself, is not a material that is inherently assigned an HWN(s). The metals identified have been evaluated for their potential to carry additional HWNs. No additional HWNs are applicable.
Miscellaneous Plastics	RTR identified drum bags as plastic waste material.

a. All containers were screened for light ballasts. Any container identified with light ballasts was not shipped to the WIPP.

Table 22-3. Typical Waste Material Parameters for Building 374 Sludge (IDC 007) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Diatomite[a]
Inorganic Matrix	Moist sludge layered with cement or cement/diatomite mixture

a. Only the diatomite on top of the drum was expected to be distinguishable from the layered sludge.

Item Description Code 803, Solidified Sludge Bldg. 374 (DCP): This waste consists of sludge dried in a dryer, and mixed with Portland cement and water, which cured to form a solid monolith. IDC 803 was only generated for about a year [P052].

Table 22-4 lists items that have been identified in containers during INEEL 3,100 m^3 Project examination of the Building 374 sludge [P238]. Table 22-5 lists the typical waste material parameters for Building 374 sludge (IDC 803) for the 3,100 m^3 Project, including typical packaging materials [P238].

Table 22-4. Items Identified by RTR for Building 374 Sludge (IDC 803) During the 3,100 m^3 Project [P238].

Item[a]	Comment
Inorganic liquid	A minor amount free liquid was detected and assigned to inorganic matrix by RTR. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria is confirmed using radioscopy and VE.

a. All containers were screened for light ballasts. Any container identified with light ballasts was not shipped to WIPP.

Item Description Code 807, Solidified By-pass Sludge-Bldg. 374: This waste consists of sludge that bypassed the dryer, and was mixed with diatomite and Portland cement. IDC 807 sludge is the same as the IDC 007 sludge generated using the bypass system. IDC 807 was generated from March 1987 to 1991 [P052, U092].

Prior to 1987, IDC 807 was assigned to cemented incinerator sludge from Building 771 (Section 14.0). The overlap of dates of generation was discovered during the 3,100 m^3 Project. It was determined that only one Solidified By-pass Sludge – Bldg 374 container (IDRF074705736) was generated prior to the generation start date shown in Table 22-1 [C010, C063, C114, P043].

Table 22-5. Typical Waste Material Parameters for Building 374 Sludge (IDC 803) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Oil-Dri®[a]
Inorganic Matrix	Cement/Sludge Mixture

a. Only the Oil-Dri® on top of the drum was expected to be distinguishable from the cement/sludge mixture.

Table 22-6 lists items that have been identified in containers during INEEL 3,100 m^3 Project examination of the Building 374 sludge [P238]. Table 22-7 lists the typical waste material parameters for Building 374 sludge (IDC 807) for the 3,100 m^3 Project, including typical packaging materials [P238].

Table 22-6. Items Identified by RTR for Building 374 Sludge (IDC 807) During the 3,100 m^3 Project [P238].

Item[a]	Comment
Inorganic liquid	Free liquid was detected and assigned to inorganic matrix by RTR. The quantity of free liquid did not exceed waste acceptance criteria limits. Containers with liquids exceeding the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.
Lead-containing items	The RTR examination identified a leaded rubber glove.
D-Cell Battery	A battery (other metals) was identified during RTR examination. Because of the minute weight (0.2 lb) of the battery, it is believed to be a common D-cell battery. EPA HWN D009 was applied to drums containing D-cell batteries due to the battery's potential to contain mercury per NMED request. D-cell batteries may exhibit the toxicity characteristic for mercury.
Miscellaneous Plastics	As part of the liquid recovery program, the inner packaging (plastic bagging) was breached to admit Aquaset or vermiculite to the waste to absorb liquid. The breaching of plastic bagging changed the waste type from packaging materials to waste materials

a. All containers were screened for light ballasts. Any container identified with light ballasts was not shipped to WIPP.

Table 22-7. Typical Waste Material Parameters for Building 374 Sludge (IDC 807) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials	Diatomite[a]
Inorganic Matrix	Moist sludge layered with cement diatomite mixture

a. Only the diatomite on top of the O-ring bag was expected to be distinguishable from the layered sludge.

22.1 Waste Generation

Rocky Flats has treated both liquid and solid process wastes. Liquid waste treatment operations have had relatively few process changes over the years. Building 374 went into operation in 1980 as an integral part of the new plutonium recovery facility, Building 371. It was designed to handle primarily the wastes generated by Building 371, but also helped to relieve the demand on Building 774 [P053]. Only aqueous waste that contained plutonium below the EDL was processed in Building 374 [P001]. Aqueous treatment operations included radioactive decontamination, evaporation, acid neutralization, and sludge solidification [P052, P082, P106, P113].

22.1.1 Radioactive Decontamination

Aqueous wastes containing greater than 13,500 pCi/l alpha contamination were treated in the radioactive decontamination process. The wastes were received by pipeline from Buildings 371, 444, 559, 707, 774, 776, 779, 865, 881, 883, and 889 [C087, U049]. The treatment process involved three separate stages of precipitation, flocculation, and clarification.

The first stage feed tank, D-812, received supernatant from the sludge solidification process and basic waste solutions from Building 371. If needed, the pH of the solutions was adjusted to 10.5 or greater with potassium hydroxide. The basic solutions were pumped to a reactor tank where reagents, including magnesium sulfate, calcium chloride, and ferric sulfate, were added, which attracted and combined with the radioactive isotopes. The reactor contents were mixed with an agitator and flowed continuously by gravity to a flocculator tank. A flocculent was added to aid in agglomeration of the precipitate. The contents were mixed with an agitator and continuously overflowed to a clarifier. A rake at the bottom of the clarifier slowly moved the solids to the center where they were drawn off the bottom of the tank into the feed tanks, D824 A and B, for the sludge solidification process [P004, P106, P113].

The first-stage clarifier liquids flowed over a weir and were pumped to the second-stage feed tank. The second-stage feed tank also received third-stage clarifier effluent, steam condensate and decontamination wastewater from Building 371, wastes from Building 444, and from the 500, 700, and 800 areas [C087, C121, U045, U049, U051]. The second- and third-stage reactors, flocculators, and clarifiers functioned exactly as the first stage [P004, P106, P113]. Figure 22-1 shows the radioactive decontamination process [P052].

22.1.2 Evaporation

The evaporation process concentrated soluble materials from low-level desaltable aqueous wastes. Aqueous wastes were received from Buildings 122, 123, 443, 444, 447, 460, 559, 561, and 566. Clarifier effluent from the radioactive decontamination process, solar pond water, and aqueous wastes from buildings in the 700 and 800 areas were also sent to the evaporator [P052, U045]. The aqueous wastes were pumped to the evaporator where they were continuously circulated and heated by steam producing a concentrated salt brine and steam. The steam was condensed for use by the boiler plant and cooling tower. The salt brine was dried, using a spray drier, and immobilized with cement [P153]. Periodically, a nitric and phosphoric acid descaling solution was used to flush the evaporator heat exchangers. This solution was then sent to the sludge immobilization process [P106]. The evaporation process is shown in Figure 22-1 [P052].

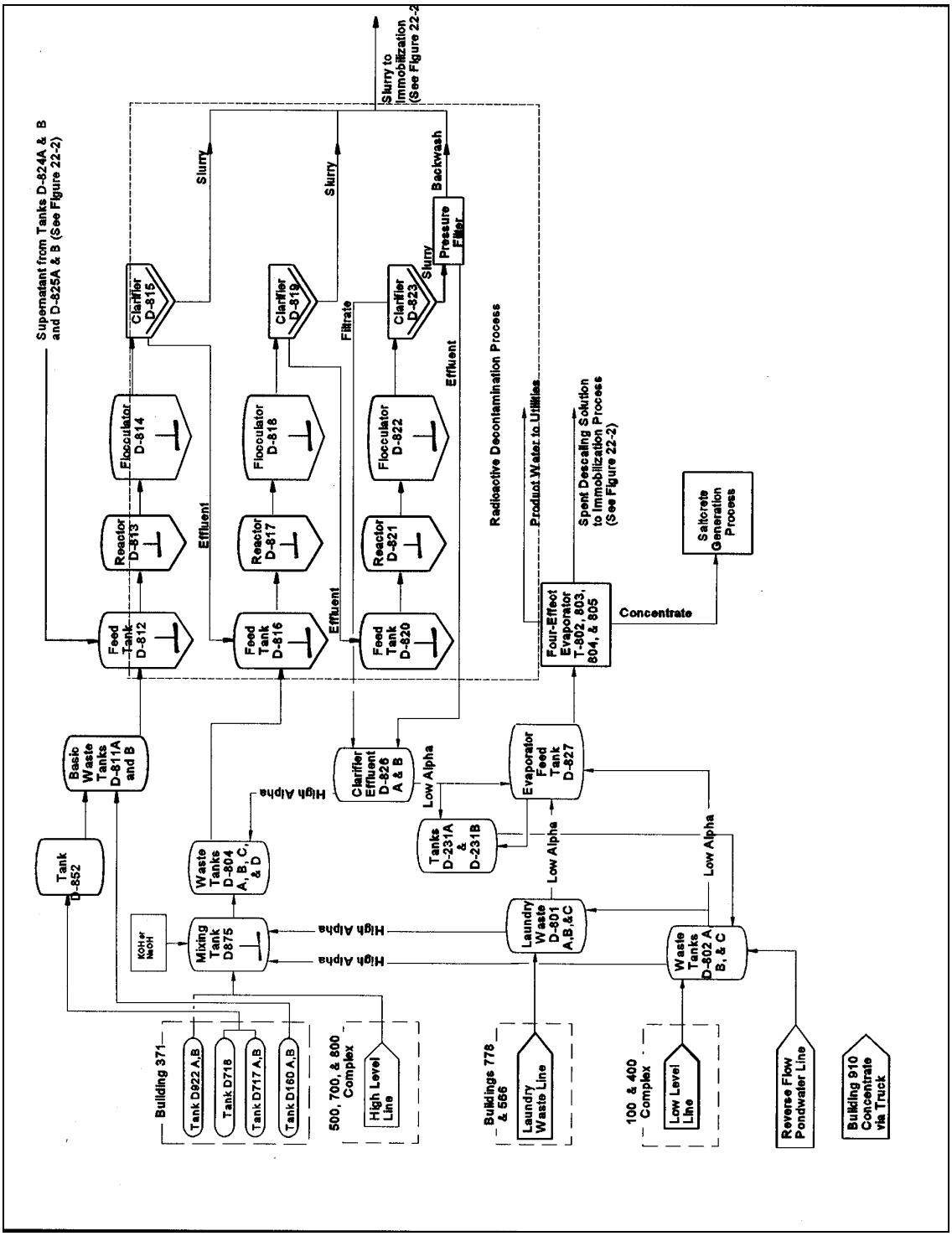

Figure 22-1. Building 374 Radioactive Decontamination and Evaporation Processes.

22.1.3 Acid Neutralization

Nitric acid wastes from plutonium recovery operations in Building 371 were received in Building 374 by pipeline. Acid wastes were also received as packaged materials in 55-gallon drums from Buildings 123, 444, 460, 559, 774, 865, 881, and 883 [U045]. The acid wastes were continuously mixed by an agitator in Tank D-808, and by circulation through a heat exchanger. The heat exchanger removed heat generated during the process. As the liquid circulated, a pH analyzer regulated the amount of neutralization solution containing 46% potassium hydroxide that was fed to the tank to maintain a pH of 12.5 [C121, P106, P113]. Neutralized acid waste was piped to Tanks D-824 A and B for eventual treatment by the sludge solidification process [P106, P113]. The acid neutralization process is shown in Figure 22-2 [P052].

22.1.4 Sludge Solidification

Liquid wastes treated by the acid neutralization, radioactive decontamination, and evaporation processes were transferred to the sludge solidification process. The waste streams that were treated in the sludge solidification process are described in Table 22-8 [P052, P106].

Table 22-8. Waste Streams Treated in the Sludge Solidification Process.

Waste Streams	Source Buildings	Contaminants
Tank D-808: Packaged Acid Wastes and Building 371 Nitric Acid Wastes	Buildings 123, 371, 444, 460, 559, 774, 865, 881, and 883	Acid Wastes
Tanks D-815, D-819, D-823: Radioactive Decontamination Process Effluent	Buildings 371 and 559, and 700 and 800 Areas	Acids, bases, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver, Trim Sol [P130], Oakite Cleaner [P091], Ox Out 536 [P129], acetone, ethyl alcohol, hexane, methanol, methyl ethyl ketone, methylene chloride, eutectic salts, photo developer [P144, P146, P150], and photo stop bath
Tank D-845: Evaporation Process Descaling Solution (nitric and phosphoric acid)	Buildings 122, 123, 443, 444, 447, 460, 559, 561, 566, 700 and 800 Areas, and Solar Ponds	Radioactive decontamination process effluent contaminants, solar pond water constituents, demineralization salts, water softeners, chemical indicators, 1,1,2-trichloro-1,2,2-trifluoroethane, toluene, penetrant oils, isopropanol, ethylene glycol, Mariko [P128], diamond paste, spent emulsifier [P149], spent developer [P143, P145, P147, P148]

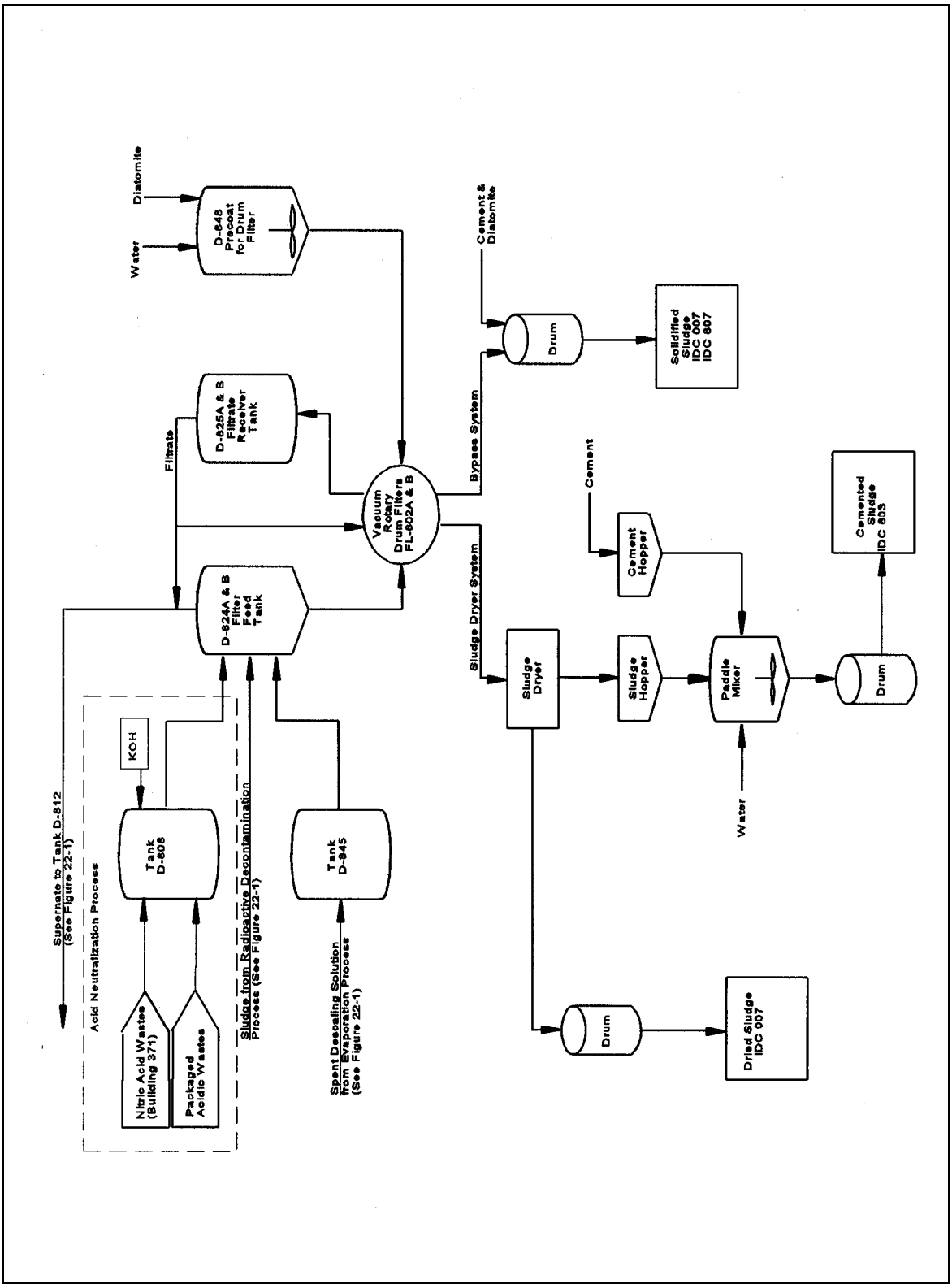

Figure 22-2. Building 374 Acid Neutralization and Sludge Immobilization Processes.

The slurry from radioactive decontamination, spent descaling solution from the evaporator, and wastes from acid neutralization were fed into the filter feed tanks, D-824 A and B. Supernatant from the filter feed tanks was decanted to the radioactive decontamination process. The slurry from the feed tanks was pumped to the radioactively contaminated solids on the surface of the filter media. An advancing blade continuously removed rotary drum vacuum filter. The filter drum was coated with a mixture of diatomite and water or the filtrate. The slurry was fed into the filter pan. The filtrate was drawn through the pre-coat by a vacuum process, leaving the radioactively contaminated solids on the surface of the filter media. An advancing blade continuously removed the sludge and a thin layer of pre-coat. The filtrate from the rotary drum filter was transferred back to the radioactive decontamination process [P047, P106, P113].

The sludge from the rotary drum filter was immobilized using either the sludge dryer system or the bypass system. In the sludge dryer system, the sludge from the vacuum filters was fed to the dryer feed hopper then conveyed through the dryer in heated flights. The dried sludge was transferred directly into a 55-gallon drum. The resulting waste was assigned IDC 007 and consisted of dispersible fines [P052, P106].

The process was modified in October 1982 to bypass the dryer. The bypass system used a series of two conveyor belts to transfer the moist sludge exiting the vacuum filter directly into a 55-gallon drum. Before 1986, cement was placed into the drum in layers with the sludge and tamped down during the metering process. This waste was also assigned IDC 007. After April 1986, diatomite and cement in a 1-to-1 ratio were metered into the drum with the sludge [P013, P015, P016]. IDC 007 was discontinued in 1987 and replaced by IDC 807 [P052]. The process that generated IDC 807 was the same as IDC 007 [P052, P106].

Use of the sludge drier resumed in 1985. The sludge from the vacuum filter was dried in the same manner as the sludge generated prior to October 1982. However, the dried sludge was cemented in the direct cementation process (DCP). The dried sludge overflowed directly into the DCP sludge hopper, and cement and water were mixed in using a paddle mixer. The sludge, cement, and water mixture was deposited into a 55-gallon drum and allowed to solidify [P047, P052, P106]. DCP sludge was assigned IDC 803. Due to mechanical problems, the DCP was only in operation for about a year [P052]. Figure 22-2 illustrates the sludge immobilization processes.

22.2 Waste Packaging

Depending on the type of sludge and waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. A 90-mil rigid polyethylene liner was placed in the empty drum. Either a polyethylene drum bag or a round-bottom polyethylene drum bag was placed inside the rigid liner. A PVC O-ring bag was placed inside the polyethylene liner [P012, P013, P016, P022, P026, P047]. Confirmatory RTR indicated that any combination of these plastic bags were present. Provided that two layers of containment were not exceeded, there was no impact on the acceptability of the drum. Drums that exceeded TRUPACT-allowed containment layers were flagged for treatment in TRIPS.

Sludge generated using the sludge dryer system (IDC 007) was placed directly into lined 55-gallon drums [P052]. Until 1986, sludge generated using the bypass system (IDC 007) was placed into a drum and mixed with cement. The resulting mixture of sludge and cement was tamped down during the metering process. Free liquids have been identified in many of the bypass sludge drums generated during this time period [P013, P015, P016].

For bypass sludge generated after April 1986 (IDC 007/807), one pound of diatomite was placed in the bottom of the rigid liner and another pound inside the polyethylene drum bag. The PVC O-ring bag was placed inside the polyethylene drum bag, and the excess top of the bag was folded down over the outside of the drum. The bag was doubled back up to form a tuck, and two pounds of diatomite were evenly distributed into the tucked portion of the O-ring bag. Two pounds of diatomite were also placed in the bottom of the O-ring bag. Diatomite and Portland cement were metered into the lined drum with the moist sludge. The cement and diatomite mixture was determined to be a better absorbent, and no free liquids or condensation have been found in the drums generated after April 1986 [P016]. A 7-to-1 ratio of sludge to the cement and diatomite mixture was used [C013, C015]. As the drum was filled, the waste was periodically tamped down using a tamping tool. The diatomite in the tucked portion of the O-ring bag capped off the top of the sludge when the bag was twisted and taped closed [P047, P052].

For IDC 803, one liter of Oil-Dri® was placed in the bottom of the O-ring bag. The sludge, cement, and water mixture was placed into the O-ring bag, and the O-ring bag was twisted and taped closed. One liter of Oil-Dri® was placed on top of the O-ring bag inside the polyethylene drum bag [P047].

During characterization for the 3,100 m^3 Project it was observed that several combinations of drum bags, poly bags, and O-ring bags were used to package IDC 007 waste. Any combination of these plastic bags, provided that two layers of containment were not exceeded, did not impact acceptability of the drum. Drums that exceeded TRUPACT-allowed containment layers were flagged for treatment in the TRIPS [P238].

Once a drum was full, the drum bags were twisted and taped closed, and the waste was allowed to cure. The rigid liner was closed with a plastic lid, the drum lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P001, P052].

Acceptable knowledge confirmation activities have identified other items in a small percentage of the sludge waste containers, including small quantities of liquid, lead items, and metal items [P238].

In 2002, the INEEL began a program to recover drums by removing excess residual liquids through absorption. Candidate drums were processed to add Aquaset® or vermiculite to absorb excess liquids. Sufficient Aquaset® or vermiculite was added to each candidate drum to reduce the amount of residual liquid to less than 1% of the container volume [P238].

22.3 Waste Characterization

Building 374 solidified aqueous waste was characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, waste analysis, and headspace gas analysis. This section provides a hazardous waste determination for Building 374 solidified aqueous waste based on RCRA and the WIPP WAP requirements as well as radionuclide contaminants and potential complexing agents contained in the waste in compliance with the WIPP WAC. These wastes are at least 50% (by volume) inorganic solids and are classified as homogeneous waste [P141].

Some IDC 007, 803, and 807 drums may contain residual liquid. Those drums that contained excess liquid at the time of a WAP compliant RTR were marked *Treatment* and were excluded from the inventory destined for WIPP. Only drums that were compliant with the WIPP WAC, i.e., <1% residual liquids, were candidates for WIPP. This candidate inventory was subject to VE to determine the miscertification rate for homogenous solids and to ensure that the RTR methodology results in an acceptable miscertification rate. Some differences between residual liquid estimates made by two compliant RTRs or between a compliant RTR and a VE were expected. These variations resulted from accepted uncertainties inherent in the respective methodologies or from actual changes in the volume of

residual liquid as a result of dynamic conditions such as extremes of heat and cold, drum content matrix characteristics, or drum handling. The presence of excess liquid has been referred to as *dewatering*. This occurrence may have been temporary and/or reversible depending on the above-noted conditions. An investigation into the potential phenomena of sludge dewatering was conducted at the INEEL in response to the observation of suspected dewatering in a single drum in 2001 [P238]. The conclusions of this study were that dewatering could not be confirmed to occur during transport; that the container certification process was WAP compliant with respect to identifying and segregating drums with excess residual liquids; and, that the observations were in accordance with both existing AK and characterization results. Evidence to date indicates that any residual liquids present had a pH less than or equal to 12 [P238]. The EPA HWN D002, therefore, was not assigned to the drums regardless of the presence or absence of excess liquids [P238].

When the VE resulted in an observation of residual liquid in excess of the WAC, this observation was counted as a miscertification and a Nonconformance Report (NCR) was issued. Miscertifications were reported in RWMC-EDF-363 [P303], which was prepared in accordance with MCP-2546 [P238], and reflects the miscertification rate for homogenous solids. An evaluation of previous RTR/VE comparisons concluded that RTR was effective in identifying excess residual liquids and that experience with VE of containers previously examined by RTR validated that effectiveness. This evaluation also concluded that the potential for residual liquids to exist was well established and anticipated when the criteria for residual liquids were established [P238]. Miscertifications that were observed under the described conditions were not indicative of either deficiencies in the AK Record or of difficulties with the RTR methodology. The presence of residual liquids did not affect HWNs or WMCs assigned to the waste [P238].

Furthermore, the observed miscertification rate was well within the WAP requirement. Between the issuance of Revision 5 of the WIPP-WAC and August 19, 2002, 357 containers from the homogenous solids summary category group had undergone VE. Of these, 5 were declared miscertifications due to excess free liquid not detected during RTR. This corresponded to a point estimate miscertification rate of 1.4% with a UCL_{90} of 1.7%. The relevant WAP criterion is that the true miscertification rate for the population be less than 14% with 90% confidence, which was clearly met [P238].

22.3.1 Hazardous Waste Determination

The wastes may exhibit the characteristic of toxicity for cadmium, chromium, lead, mercury, selenium, silver, and hexachlorobenzene. The wastes were derived from the treatment of electroplating wastes and aqueous wastes containing halogenated and nonhalogenated solvents, and are therefore F-listed hazardous wastes. There is no evidence that any of the wastes exhibits any other characteristic of hazardous waste. EPA HWNs applicable to some or all of the Building 374 solidified aqueous waste group are presented by IDC in Table 22-9 [P218, P220].

Table 22-9. Building 374 Solidified Aqueous Waste Characterization.

IDC	Title	EPA HWNs[a]
007	Wet Sludge-Bldg. 374	D006, D007, D008, D009, D010, D011, D032, F001, F002, F005, F006, F007, and F009
803	Solidified Sludge Bldg. 374 (DCP)	D006, D007, D008, D009, D010, D011, D032, F001, F002, F005, F006, F007, and F009
807	Solidified By-pass Sludge Bldg. 374	D006, D007, D008, D009, D010, D011, D032, F001, F002, F005, F006, F007, and F009

a. The EPA HWNs are final per WSP INW218.001.

22.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. These materials are not liquid, but RTR and VE have identified free liquids in some sludge drums. However, the liquids are aqueous and are not ignitable [P013, P015, U060]. These materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change. These materials are not compressed gases, nor do the containers contain compressed gases [P013, P015, P022]. These materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001) [P218, P220].

Corrosivity: The materials in this waste do not meet the definition of corrosivity as defined in 40 CFR 261.22. The waste is not an aqueous liquid. As determined by radioscopy and VE, none of the drums shipped contained 20% by volume, aqueous waste (20% by volume is required in order to measure pH per the prescribed method in 40 CFR 261.22), and therefore, the corrosive characteristic did not apply. It is suspected that bypass sludge (IDC 007) generated before April 1986 may have dewatered. In addition, DCP sludge (IDC 803) may also have dewatered [C121, C242, C243].

After April 1986, a mixture of Portland cement and diatomite was mixed with the sludge (IDCs 007 and 807), which may have helped prevent the waste from dewatering. Visual examination of a few bypass sludge drums (IDC 007) generated after April 1986 did not identify free liquids [P013, P015]. Free liquids were however, identified in four sludge drums (IDC 007) generated prior to this date. Analysis of non-representative waste samples (i.e., free liquids only) indicated a pH range of 7 to 12 [C121, U049, U050]. From Fiscal Years 1995 through 1999, 91 randomly-selected drums were visually examined and 8 were recorded as containing liquid. Measurements of nonrepresentative waste samples for the 8 drums (i.e., free liquids only) indicated that the pH ranged between 8.6 and 11.91 [P238]. Therefore, drums of Building 374 solidified aqueous waste are not corrosive wastes (D002) [P218, P220, P238].

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P013, P015, P022]. Explosives were not handled or used around radioactive material. The waste may contain cyanide from treatment of electroplating wastes. Analysis of bypass sludge indicates a maximum total cyanide concentration 8.2 mg/kg, and a maximum reactive cyanide concentration of 5.36 mg/kg. These cyanide levels will not cause the waste to be reactive [C111, C113]. The materials in this waste group are therefore not reactive wastes (D003) [P218, P220].

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for cadmium, chromium, lead, mercury, selenium, silver, and hexachlorobenzene.

TCLP results from Building 374 bypass sludge samples collected in 1995 are provided in Table 22-10 [C122]. Table 22-11 shows TCLP results for bypass sludge samples obtained in 1989 and

1990 [P052]. The 1995 results indicate that the waste does not contain toxicity characteristic levels of metals. The waste may however, exhibit the characteristic of toxicity for selenium based on the data from 1990. The results from 1989 indicate that the waste may also exhibit the characteristic of toxicity for chromium. Even though the results are only for bypass sludge samples, they may apply to all of the Building 374 sludge wastes since they were derived from the treatment of the same aqueous wastes. In addition to these metals, cadmium, lead, mercury, and silver have been identified as potential contaminants of Building 374 sludge wastes [U060].

An additional 67 solid samples of IDCs 007, 803, and 807 were collected and analyzed between 1996 and 1999. These data are presented in Table 22-12. The results from these samples were confirmatory data used in the 3,100 m^3 Project to characterize the waste for shipment to WIPP. [P238]. The results confirmed the presence of toxicity characteristic metals. However, only chromium and mercury had calculated UCL_{90}s greater than their RTLs. Based on AK and the solid data, EPA HWNs D006, D007, D008, D009, D010, and D011 were assigned to this waste stream [P218, P220, P238].

Table 22-10. TCLP Metals Results for Bypass Sludge from 1995 [C122].

Constituent	TCLP Limit (mg/l)	Sample Size	Concentration (mg/l)
Arsenic	5.0	7	Not detected
Barium	100.0	7	0.10-0.86
Cadmium	1.0	7	Not detected
Chromium	5.0	7	0.24-0.55
Lead	5.0	7	Not detected
Selenium	1.0	7	Not detected-0.12
Silver	5.0	7	Not detected

Table 22-11. TCLP Metals Results for By-pass Sludge from 1989 and 1990 [P052].

Constituent	TCLP Limit (mg/l)	Sample Size	Mean (mg/l)	UCL_{90}
Arsenic[b]	5.0	7	0.6876	0.9085
Barium[b]	100.0	7	0.924	0.1118
Cadmium[e]	1.0	14	0.0448	0.0608
Chromium[a,b]	5.0	7	2.3743	4.1724
Chromium[a,c]	5.0	7	12.260	15.2886
Lead[e]	5.0	14	0.7304	1.1503
Mercury[b]	0.2	6	0.0022	0.0042
Nickel[b]	N/A	7	0.7414	—[d]
Selenium[b]	1.0	7	0.9391	1.3900
Silver[e]	5.0	14	0.7282	0.7414

a. Chromium analyses in 1989 and 1990 used different analytical methods.
b. May 1990 data.
c. November 1989 data.
d. Not calculated in reference number P052.
e. Combined 1989 and 1990 data.

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes that generated the aqueous waste from which Building 374 solidified aqueous waste was derived. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Table 22-12. Statistical Summary of Building 374 Sludge Solids Metals Data From the 3,100 m^3 Project [P218, P220].

Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs Assigned
Arsenic	67	45	3.14	3.84	13.0	4.34	100	N/A
Barium	67	67	49.5	50.7	340	58.6	2,000	N/A
Cadmium	67	66	4.41	6.64	22.0	7.33	20	D006
Chromium	67	67	240	263	1400	301	100	D007
Lead	67	67	36.7	43.8	300	49.6	100	D008
Mercury	67	65	12.6	9.18	64.0	11.2	4	D009
Selenium	67	25	0.746	1.08	3.10	1.20	20	D010
Silver	67	63	77.1	80.8	350	93.0	100	D011

a. The Regulatory Threshold Limit (RTL) used is the TCLP limit (mg/l) for characteristic constituents multiplied by 20 to calculate the RTL for solid samples in mg/kg.

Analytical results for the toxicity characteristic organic compounds detected in Building 374 sludge samples collected during 1988 to 1995 are presented in Table 22-13. Analyses were performed on total or TCLP extracts. Other than the compounds listed in Table 22-13, most of the toxicity characteristic organics were analyzed for but not detected in the TCLP extract [C111, C112, C113, C122, U029].

Table 22-13. Historical Volatile Organic Results for Building 374 Sludge Wastes.

Constituent	TCLP Limit (mg/l)	TCLP Concentrations (mg/kg)	Total Concentration (mg/kg)
Benzene	0.5	0.13 – 0.14	2.0
Carbon tetrachloride	0.5	—[a]	13.0
Chloroform	6.0	—[a]	0.2
Methyl ethyl ketone	200.0	0.042 – 2.9	1.0
Tetrachloroethylene	0.7	—[a]	1.4
Trichloroethylene	0.5	—[a]	16.0

a. TCLP analysis not performed.

Based on these data, the waste may exhibit the characteristic of toxicity for carbon tetrachloride and tetrachloroethylene. However, because these compounds were used as solvents for cleaning and degreasing, the waste is regulated as a listed hazardous waste and not a characteristic waste because these compounds are specifically addressed in the treatment standards for the listed hazardous waste [P080]. Since Building 374 solidified aqueous waste is characterized as a listed hazardous waste due to spent solvent contamination, the waste is not a toxic waste due to the presence of these organic compounds.

Table 22-14 contains data for 67 samples of IDCs 007, 803, and 807 that were collected and analyzed for organic compounds between 1996 and 1999. The analytical results for these samples were used by the 3,100 m^3 Project in the characterization of this waste [P238]. Fifty-six of the samples were analyzed for semi-volatile organic compounds and all 67 samples were analyzed for volatile organic compounds. The results of this sampling indicate the waste should not exhibit the characteristic of toxicity due to the presence of organic compounds. However, because hexachlorobenzene was detected in some of the samples, the EPA HWN D032 was conservatively assigned to the Building 374 solidified aqueous waste group [P220, P238].

Table 22-14. Building 374 Sludge Solid Sample Analysis Results for Organic Compounds [P218, 220].

	Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs Assigned
Volatile	1,1-Dichloroethylene	67	1	0.100	0.494	0.865	b	14	N/A
	1,2-Dichloroethane	67	0	0.068	0.493	0.625	b	10	N/A
	Benzene	67	0	0.087	0.489	0.625	b	10	F005
	Carbon tetrachloride	67	0	0.084	0.489	0.625	b	10	F001
	Chlorobenzene	67	0	0.087	0.489	0.625	b	2,000	N/A
	Chloroform	67	0	0.088	0.489	0.625	b	120	N/A
	Methyl ethyl ketone	67	20	0.515	0.943	2.30	1.03	4,000	F005
	Pyridine	67	1	0.443	0.893	2.50	b	100	N/A
	Tetrachloroethylene	67	4	0.275	0.548	2.05	0.603	10	F001
	Trichloroethylene	67	4	0.753	0.657	4.75	0.808	10	F001
	Vinyl chloride	67	0	0.083	0.490	0.625	b	4	N/A
	1,4-Dichlorobenzene	56	0	0.035	0.067	0.012	b	150	N/A
Semi-volatile	2,4-Dinitrotoluene	56	0	0.048	0.092	0.325	b	2.6	N/A
	Cresols	56	0	0.065	0.117	0.358	b	4,000	N/A
	Hexachlorobenzene	56	2	0.083	0.118	0.500	0.152	2.6	D032
	Hexachloroethane	56	0	0.038	0.073	0.110	b	60	N/A
	Nitrobenzene	56	0	0.033	0.074	0.205	b	40	N/A
	Pentachlorophenol	56	0	0.075	0.153	0.475	b	2,000	N/A

a. RTL – regulatory threshold limit

b. The mean and standard deviation given are values calculated using the method detection limits (after dividing by 2) since all the measurements (or all but one) are below detection. There are no degrees of freedom associated with the t statistic in this case and the UCL_{90} cannot be calculated.

22.3.1.2 Listed Hazardous Waste. The material in this waste group was derived from the treatment of a waste listed in 40 CFR 261, Subpart D as a hazardous waste from non-specific sources (40 CFR 261.31). The waste is not, or was not derived from the treatment of, a hazardous waste from

specific sources (40 CFR 261.32), or a discarded commercial chemical product, an off-specification species, a container residue, or a spill residue thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were commonly used for cleaning and degreasing. Methylene chloride was used primarily for paint removal. The aqueous waste transferred to Building 374 for treatment may have contained small amounts of these spent solvents. Solid sampling organic data (Table 22-14) and INEEL headspace gas sampling results (Table 22-15) from the 3,100 m^3 Project indicate the presence of F001 and F002 organic compounds, although only the UCL_{90} for 1,1,1-trichloroethane was above the PRQL in headspace gas results [P218, P220]. Building 374 solidified aqueous waste was derived from the treatment of a listed hazardous waste and was assigned EPA HWNs F001 and F002.

Table 22-15. Statistical Evaluation of all Building 374 Sludge HSG Data For the 3,100 m^3 Project [P324].

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	1,214	1,208	58.9	448	15,000	75.5	10	F001[c]
1,1,2,2-Tetrachloroethane	1,214	2	0.106	0.196	2.94	0.533	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	1,214	1,157	9.13	79.1	2,600	12.1	10	F001[c]
1,1-Dichloroethane	1,214	453	0.627	2.11	48.0	0.754	10	N/A
1,1-Dichloroethylene	1,214	792	1.16	2.85	51.0	1.29	10	N/A
1,2,4-Trimethylbenzene	1,214	249	0.137	0.232	3.44	0.156	10	N/A
1,2-Dichloroethane	1,214	35	0.132	0.399	11.0	0.220	10	N/A
1,3,5-Trimethylbenzene	1,214	124	0.116	0.208	3.08	0.140	10	N/A
Acetone	1,214	973	2.32	2.51	20.0	2.42	100	N/A[e]
Benzene	1,214	640	0.214	0.326	5.00	0.230	10	F005[d]
Bromoform	1,214	0	0.068	0.127	1.70	b	10	N/A
Butanol	1,214	546.3	0.668	1.05	18.0	0.725	100	N/A[e]
Carbon tetrachloride	1,214	609	8.73	235	7,975	21.0	10	F001[c]
Chlorobenzene	1,214	0	0.107	0.210	3.04	b	10	N/A
Chloroform	1,214	66	0.179	2.29	75.8	0.544	10	N/A
Cis-1,2-dichloroethylene	1,214	0	0.135	0.274	3.71	b	10	N/A
Cyclohexane	1,214	443	0.28	0.467	7.00	0.309	10	N/A
Ethyl benzene	1,214	251	0.340	6.42	224	0.861	10	N/A[e]
Ethyl ether	1,212	0	0.214	0.409	4.95	b	10	N/A
Methanol	1,214	21	6.43	29.0	994	14.8	100	N/A[e]
Methyl chloride	419	246	0.930	1.16	15.0	1.03	10	N/A
Methyl ethyl ketone	1,214	499	0.461	0.69	9.50	0.500	100	F005[d]
Methyl isobutyl ketone	1,214	460	0.177	0.252	3.86	0.192	100	N/A

Table 22-15. (continued).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
Methylene chloride	1,212	657	5.19	13.4	210	5.86	10	F002[d]
Tetrachloroethylene	1,214	269	0.170	0.349	3.00	0.197	10	F001[d]
Toluene	1,214	1,176	3.15	2.32	25.1	3.24	10	F005[d]
Trans-1,2-dichloroethylene	781	1	0.140	0.357	4.99	b	10	N/A
Trichloroethylene	1,213	456	0.687	4.27	120	0.944	10	F001[d]
m&p-Xylene	1,214	556	0.824	18.5	646	1.83	10	N/A[e]
o-Xylene	1,214	155	0.219	2.86	99.4	0.514	10	N/A[e]

a. When a measurement is reported as below detection, one-half the analysis method detection limit (MDL) is used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. The F003 HWN associated with these constituents is not applicable. The F003 HWN was removed from the waste stream because the waste qualifies for the exemption within 40 CFR 261.3(a)(2)(iii).

Acetone, methanol, and xylene were used primarily as solvents in laboratory operations. The aqueous waste transferred to Building 374 for treatment may have contained small amounts of these spent solvents. However, F-listed solvents were not mixed before being discharged into the process waste line. Solvents were also diluted with water and washed into the process waste line at the point of generation. Therefore, the ignitability characteristic was removed at the time of dilution and discharge. Since the F003-listed wastes were rendered non-ignitable prior to subsequent discharge and aggregation within the liquid waste stream destined for sludge generation, this waste qualifies for the exemption in 40 CFR 261.3(a)(2)(iii) for non-hazardous wastewaters. Therefore, this waste is not assigned EPA HWN F003 [P052].

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes that generated the aqueous waste from which Building 374 solidified aqueous waste was derived. Therefore, this waste group is not an F004-listed hazardous waste.

Benzene and toluene were used as solvents in laboratory operations, and methyl ethyl ketone is identified as a contaminant in Table 22-8. The aqueous waste transferred to Building 374 for treatment may have contained small amounts of these spent solvents. Headspace gas sampling results from the 3,100 m^3 Project indicated the presence of benzene, methyl ethyl ketone, and toluene, although the calculated UCL_{90}s were all below the respective PRQLS [P218]. Building 374 solidified aqueous waste was derived from the treatment of a listed hazardous waste and was assigned EPA HWN F005.

Solid waste analysis of Building 374 sludge, reported in 1988, confirmed the presence of F-listed solvents. The analytical results are presented in Table 22-16 [C111, C112, C113, C122, U029]. Methanol was detected in 2 of 5 Phase II solid samples used by the 3,100 m^3 Project in support of the WSP resulting in a UCL_{90} greater than the PRQL [P220, P218]. However, the final statistical evaluation of all headspace gas samples collected during the 3,100 m^3 Project presented in Table 22-15 indicated that, over the entire waste stream, methanol is not present in concentrations that would warrant assignment of the F003 HWN.

Table 22-16. Historical Volatile Organics Results for Solid Samples for Building 374 Sludge Wastes.

Constituent	TCLP Concentrations (mg/kg)	Total Concentrations (mg/kg)
Tetrachloroethene	—[a]	1.4
Trichloroethene	—[a]	16.0
1,1,1-trichloroethane	—[a]	41.1
Methylene chloride	0.56 – 4.0	27.0
Carbon tetrachloride	—[a]	13.0
Total xylenes	—[a]	11.0
Acetone	0.004 – 1.6	—[b]
Ethyl benzene	—[a]	0.3 – 6.0
n-Butyl alcohol	0.065 – 0.17	—[b]
Methanol	6.2	—[b]
Toluene	0.0087 – 1.6	7.0
Methyl ethyl ketone	0.042 –2.9	1.0
Methyl isobutyl ketone	0.051	—[2]
Benzene	0.13 – 0.14	2.0

a. TCLP analysis not performed.
b. Totals analysis not performed

Headspace analysis performed on samples of Building 374 aqueous sludge wastes (IDCs 007, 803, and 807) at INEEL prior to the 3,100 m^3 Project had detected F-listed compounds in which the UCL_{90} was above the PRQL are as follows [P033]:

- methylene chloride (IDC 007 only)
- 1,1,1-trichloroethane (IDC 007 only).

Additional F-listed solvents were detected in headspace samples of sludge (IDCs 803 and 807) obtained at Rocky Flats. The following F-listed compounds were detected in the Rocky Flats' samples with UCL_{90}s above the PRQL [U030].

- 1,1,2-trichloro-1,2,2-trifluoroethane (IDC 803 only)
- methylene chloride (IDC 803 only)
- 1,1,1-trichloroethane (IDC 803 only).

In late 1984 and early 1985, the evaporator in Building 374 began treating spent stripping, cleaning, and plating solutions from electroplating operations in Building 444 [P052]. The Building 444 electroplating operations utilized cyanide, [P067, U045] and therefore the Buildings 374 wastewater treatment operations received F007 and F009 wastes, and generated an F006 wastewater treatment sludge.

The Building 374 sludges were derived from the treatment of spent descaling solution from the evaporator, and were assigned EPA HWNs F006, F007, and F009.

The material in this waste group is not a hazardous waste from specific sources since it was not generated from any of the processes listed in 40 CFR 261.32. The material in this waste group is therefore not a K-listed hazardous waste.

The material in this waste group is not a discarded commercial chemical product, an off-specification species, a container residue, or a spill residue thereof (40 CFR 261.33). The material in this waste group is therefore not a P- or U-listed hazardous waste.

Analytical results for Building 374 sludge samples detected several other organic compounds which are provided in Table 22-17 for informational purposes [C112, U029].

Table 22-17. Historical Organic Results for Building 374 Sludge Wastes.

Constituent	Total Concentrations (mg/kg)
1,2-dichloroethene	5.7
Bis (2-ethylhexyl) phthalate	34.0[a]
Trans-1,3-dichloropropene	24.0
1,1,2,2-tetrachloroethane	26.0
Styrene	10.0

a. Bis (2-ethylhexyl) phthalate was detected in 27 of 48 the solid samples used to characterize the waste for the 3,100 m^3 Project. This compound is a common organic contaminant whose presence is attributable to the presence of plastic packaging material. It is also a common laboratory contaminant and was detected in the laboratory blanks associated with 46 of 56 samples. As a result, the U HWN for this compound was not added to the WSP and the compound was not added to the target analyte list.

22.3.2 Radionuclides

This section identifies the radioisotopes potentially contained in the waste. In addition, Table 22-18 summarizes matrix and other physical parameters which could effect radioassay.

Aqueous waste treatment operations in Building 374 receive wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium [P164]. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are provided in Section 3.0.

Production and production support processes in Buildings 371, 559, 707, 771 (Building 774 effluent), 776, 777, and 779 generated wastes contaminated with weapons-grade plutonium, americium-241, and enriched uranium, which were treated in Building 374. Production and production support processes in Buildings 444, 447, 865, and 883 generated wastes contaminated with depleted uranium which were treated in Building 374 [P053, U053]. Other radionuclides may also be found in Building 374 wastes from R&D, analytical, and special order work [P164]. Processing of most of the "special" radioisotopes, such as curium-244, thorium-232, and uranium-236, was performed until the early- to mid-1970s [C154, P164, P189, P194]. However, these isotopes will not be contained in the sludge waste because Building 374 was not in operation until 1980. Neptunium-237 was processed until

1985 or 1986, and uranium-233 was handled until about 1982 and, therefore, are potentially present in the sludge wastes generated up to these dates [C154, P164, P198, P200]. A more detailed description of plutonium and uranium production operations and R&D operations is provided in Section 3.0.

The Size Reduction Vault in Building 776 conducted repackaging operations (prefixes 0019, 0025, and 0040) [C175, C184, P078, U059]. The package date on these drums is the date in which the waste was repackaged and was originally generated some time prior to this date. Therefore, it is assumed that the repacked IDC 007 sludge containers could potentially contain any of the above radioisotopes. IDC 803 should not contain uranium-233 because this waste was not generated until about 1985.

Table 22-18. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	The sludges were produced by a carrier precipitation process in which ferric sulfate, calcium chloride, magnesium sulfate, and a flocculant were used to form a floc that coprecipitated with the radioactive contaminants [P004, P164]. Based on the generation process, the distribution of actinides in waste should be relatively homogeneous.
Hydrogen Content	Sources of hydrogen may include plastic packaging material (see Section 22.2) and trace amounts of hydrocarbons (see Section 22.3.1). Based on VE, some of the waste is damp or contains free liquid [P013, P015, P022].
Other Interfering Waste Contaminants	Magnesium and chromium were detected in waste samples [C122]. The major anions and cations in Building 774 sludges include aluminum, magnesium, fluoride, and chloride. It could be assumed that these contaminants are in sludges from Building 374 as well because the wastes treated originated from most of the same buildings and processes [P053, P164].
Physical Matrix Parameters	Documentation on the distribution of contaminants was not identified but, based on the generation process, should be relatively homogeneous. Measured sludge density and void space information was not identified.

22.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix.

Activity values of radionuclides are quantified and reported in accordance with Appendix A of the CH-WAC, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL bases most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239, -240, -241; and uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes are obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values are specific to the assay system. Determination of plutonium-242 uses its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay includes high resolution gamma spectrometry and the data from these measurements are reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, requires a documented disposition as an anomaly. Default isotopic values are used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 are based on the individual gamma spectrometric measurements. The uranium-234 activities are calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, are not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 is verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence is predicated on the

presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P238].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 22-19. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number in this table. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 22-19. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
007	374	0747	Liquid Waste Treatment	12/1/82 - 12/22/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
007	374	0747	Liquid Waste Treatment	1/3/83 - 5/8/87	WG Pu, EU, ^{241}Am, DU, ^{233}U[a]
007	774	0744	Liquid Waste Treatment	8/6/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
007	776	0019	Size Reduction	3/11/85 - 2/21/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
007	776	0025	Drum Repack	5/16/84 - 8/5/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
007	776	0040	Waste Processing/Final Packaging	6/13/86 - 6/13/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
803	374	0747	Liquid Waste Treatment	4/10/86 - 12/5/86	WG Pu, EU, ^{241}Am, DU, ^{233}U[a]
803	776	0040	Waste Processing/Final Packaging	6/13/86 - 6/13/86	WG Pu, EU, ^{241}Am, DU, ^{233}U[a]
807	374	0747	Liquid Waste Treatment	3/18/87 - 6/23/88	WG Pu, EU, ^{241}Am, DU
807	776	0025	Drum Repack	9/1/87 - 10/12/87	WG Pu, EU, ^{241}Am, DU, ^{233}U

a. Isotopes added by confirmatory radioassay.

WG = weapons grade DU = depleted uranium EU = enriched uranium

22.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project, all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the Building 374 Sludge waste stream are summarized in Tables 22-20 and 22-21. The overall yield for this radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 22-20 and Table 22-21 present the yield and the radionuclide and related radioassay information, respectively. The data for the individual radioassay systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 m^3 Project" [P322].

Table 22-20. Overall Radioassay Yield for the Building 374 Sludge Waste Stream [P322].

Total number of:	Number	Percentage of Total
Distinct containers	5622	
"*WIPPOK*" containers	4385	78%
"*Treatment*" containers	895	16%
"Deficient / Permanently Rejected" containers	350	6%

Table 22-21. Radionuclide and Related Quantities for the Building 374 Sludge Waste Stream[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	1.867E-01	6.930E-01	3.445E-04	2.567E+01	5252
TRU Activity (Ci)	1.866E-01	6.929E-01	3.452E-04	2.567E+01	5252
TRU Activity Concentration (nCi/g)	9.953E+02	4.014E+03	1.371E+00	1.546E+05	5252
Thermal Power (W)	5.717E-03	2.238E-02	2.578E-07	8.572E-01	5619
Thermal Power Density (W/ft^3)	7.779E-04	3.045E-03	3.510E-08	1.166E-01	5619
Plutonium Fissile Gram Equivalent (g)	8.092E+00	9.699E+00	2.971E-03	1.152E+02	5619
Americium-241 (g)	3.400E-02	1.941E-01	7.451E-06	7.290E+00	4734
Plutonium-238 (g)	1.204E-04	2.568E-04	3.438E-07	5.381E-03	5040
Plutonium-239 (g)	1.060E+00	2.257E+00	4.051E-03	4.804E+01	5040
Plutonium-240 (g)	6.443E-02	1.371E-01	2.464E-04	2.994E+00	5040
Plutonium-241 (g)	1.945E-03	4.016E-03	7.451E-06	8.840E-02	5040
Plutonium-242 (g)	4.757E-04	9.720E-04	1.852E-06	2.210E-02	5040
Uranium-233 (g)	1.415E-01	1.047E-01	3.393E-02	3.387E-01	9
Uranium-234 (g)	2.220E-02	1.611E-01	2.957E-05	8.375E+00	6320
Uranium-235 (g)	6.575E+00	9.644E+00	1.300E-03	1.668E+02	6327
Uranium-238 (g)	5.394E+03	5.002E+04	3.796E-02	2.522E+06	5901

a. The absence of cesium-137 is verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of strontium-90, whose presence is predicated on the presence of cesium-137, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

22.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, P079, U043]. Oxalic acid was also used for americium recovery [P113]. Because complexing agents interfered with the aqueous waste treatment system, wastes sent to Building 374 for treatment should have had only trace quantities of these compounds. Therefore, the solidified aqueous waste should only have trace quantities of complexing agents.

22.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the Building 374 Sludge waste stream, the yield of successful RTR examinations was approximately 74% [P323]. Conversely, approximately 26% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: presence of excess free liquids; layers of confinement were exceeded for the assigned shipping category, and the IDC could not be verified [P323]. An absorbent addition recovery option implemented by the 3,100 m^3 Project increased the RTR yield to approximately 85%. Visual examination indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

23. SOLIDIFIED AQUEOUS WASTE–BUILDING 774

This waste group consists of aqueous sludges generated by liquid waste treatment operations in Building 774 at RFP. Aqueous wastes from numerous buildings and processes at the plant were received in Building 774 where they were treated to remove radioactive and chemical contaminants, and converted to a solid for disposal. A wet sludge containing the contaminants was filtered, followed by the addition of cement or diatomite. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 23-1 [U092]. The Building 774 solidified aqueous sludge wastes were characterized under a CBFO approved WSP, INW216.001 First and Second Stage Sludge Wastes (herein referred to as First/Second Stage Sludge), for containers of waste shipped to the WIPP facility [P217, P219, P226].

Table 23-1. Building 774 Solidified Aqueous Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
001	First Stage Sludge [C063] First Stage Sludge (prefix 0741) [P024] First Stage Sludge–Bldg. 774 [C063] Combined Sludge (prefix 7412) [P024] First and Second Stage Sludge [P014]	December 1972 – September 1988
002	Second Stage Sludge [C063] Second Stage Sludge (prefix 0742) [P024]	August 1971 – February 1985
800	"7412-series" Sludge [P004] Solidified Sludge–Bldg. 774 [C031]	April 1986 – September 1988

Item Description Code 001, First Stage Sludge: This waste consists of immobilized materials generated from first-stage treatment operations in Building 774. Aqueous liquids coming into the process originated from Building 771 recovery operations. The liquids were made basic with sodium hydroxide to precipitate iron, magnesium, etc., which also carried down the relatively small amount of precipitate of plutonium and americium hydrated oxides. The precipitate was filtered to produce a sludge (IDC 001), which was placed in a drum with Portland cement. Beginning in 1979, sludge waste from second-stage treatment was combined with first-stage sludge. The combined sludges were also assigned IDC 001. IDC 001 was discontinued in 1986 when the immobilization process changed, and after which these sludge wastes were assigned IDC 800 [P004, P015, P016, P052, P113].

Table 23-2 lists items that have been identified in containers during INEEL 3,100 m^3 Project examination of the first stage sludge [P226, P323]. Table 23-3 lists the typical waste material parameters for first stage sludge (IDC 001) for the 3,100 m^3 Project, including typical packaging materials [P226].

Table 23-2. Items Identified During RTR of First Stage Sludge (IDC 001) for the 3,100 m^3 Project.

Item[a]	Comment
Free Liquid	Containers with liquids above the WIPP WAC were not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE [P226].

Table 23-2. (continued).

Item[a]	Comment
Miscellaneous Metal Debris	Includes iron based metals/alloys, aluminum based metals/alloys, and other metals. Miscellaneous metals have been evaluated for their potential to carry additional HWNs. No additional HWNs were found applicable to this waste stream.
Miscellaneous Cellulosics	RTR identified cellulosic waste material (filters) and a tape roll.
Lead-Containing Items	The waste was found to contain leaded rubber aprons but not in quantities that would affect the waste matrix code.
Filter	Includes metal alloys and cellulosics. Filter wastes have been evaluated for their potential to carry additional HWNs. No additional HWNs were found applicable to this waste stream.
Miscellaneous Plastics	RTR examination indicated the presence of plastic tubing and polyethylene waste as plastic waste material. In the process of adding absorbent to waste drums as part of the liquid recovery program, the inner packaging (plastic bagging) is breached to admit Aquaset or vermiculite to the waste to absorb liquid. The breaching of plastic bagging changes the waste type from packaging materials to waste materials

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to WIPP.

Table 23-3. Typical Waste Material Parameters for First Stage Sludge (IDC 001) for the 3,100 m^3 Project [P226].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bag
Other Inorganic Materials[a]	Portland cement, vermiculite, Oil-Dri®, Aquaset®
Other Metals	Lead sheets or lead tape
Inorganic Matrix	First Stage Sludge

Item Description Code 002, Second Stage Sludge: This waste consists of immobilized materials generated from second-stage treatment operations in Building 774. The aqueous liquids to be treated originated from first-stage treatment and from numerous buildings on plant site. The liquids were treated in the same manner as the liquids from the first-stage, and the resulting sludge (IDC 002) was placed into a drum with Portland cement. Second-stage sludge generated prior to 1973 may contain miscellaneous debris [P004, P024, P042, P052, P109, P124].

Table 23-4 lists items that have been identified in a small percentage of the containers during INEEL examination of second stage sludge (IDC 002) [P226]. Table 23-5 lists the typical waste material parameters for second stage sludge (IDC 002) for the 3,100 m^3 Project, including typical packaging materials [P226].

Table 23-4. Items Identified During RTR of Second Stage Sludge (IDC 002) for the 3,100 m^3 Project [P226].

Item[a]	Comment
Inorganic Liquid	Containers with liquids above the WIPP WAC were identified but not shipped to WIPP. Compliance with the WAC free liquid criteria was confirmed using radioscopy and VE.
Miscellaneous Metal Debris	Includes iron based metals/alloys, aluminum based metals/alloys, and other metals were found in the waste in small quantities. Miscellaneous metals have been evaluated for their potential to carry additional HWNs. No additional HWNs are applicable.
Miscellaneous Plastics	Miscellaneous plastics found in small quantities in the waste have been evaluated for their potential to carry additional HWNs. No additional HWNs are applicable.

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to WIPP.

Table 23-5. Typical Waste Material Parameters for Second Stage Sludge (IDC 002) for the 3,100 m^3 Project.

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, polyethylene drum bag, plastic bag
Other Inorganic Materials[a]	Portland cement, vermiculite, Oil-Dri®, Aquaset®
Inorganic Matrix	Second Stage Sludge

Item Description Code 800, Solidified Sludge–Bldg. 774: The process that produced solidified sludge from Building 774 (IDC 800) was very similar to IDC 001. The difference between the two IDCs was the immobilization process. For IDC 800, the sludge was co-fed into a drum with a diatomite and Portland cement mixture that formed a solid monolith after curing. IDC 800 was generated from 1986 until March 1991 [P001, P016, P052, P109].

Table 23-6 lists items that have been identified in a small percentage of the containers during INEEL examination of solidified sludge [P226]. Table 23-7 lists the typical waste material parameters for Solidified Sludge (IDC 800) for the 3,100 m^3 Project, including typical packaging materials [P226].

Table 23-6. Items Identified During RTR of Solidified Sludge (IDC 800) for the 3,100 m^3 Project [P226].

Item[a]	Comment
Inorganic Liquid	Containers with liquids above the WIPP WAC were not shipped to the WIPP. Compliance with the WAC free liquids criteria was confirmed using RTR and VE.
Lead-Containing Items	RTR examination identified leaded tape.
Miscellaneous Plastics	RTR identified plastic waste material but not in quantities affecting the waste matrix code or the IDC designation.
Miscellaneous Cellulosics	Filters were found in small quantities in the waste.

a. All containers were screened for light ballasts. Any containers identified with light ballasts were not shipped to WIPP.

Table 23-7. Typical Waste Material Parameters for Solidified Sludge (IDC 800) for the 3,100 m^3 Project [P226].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, polyethylene drum bag, O-ring bag
Other Inorganic Materials[a]	Vermiculite, Aquaset®
Inorganic Matrix	Solidified Sludge–Bldg 774

a. It will not typically be possible to confirm more than 1-7 kg of other inorganic materials since the majority of the Portland cement will be layered throughout the drum. Weights reported by both RTR and VE are expected to include most or all of the Portland cement as Inorganic Matrix.

23.1 Waste Generation

Waste processing at RFP included both liquid and solid process wastes. Liquid waste treatment operations had relatively few process changes over the years. When Building 774 was built in 1952, its primary purpose was to treat radioactive aqueous waste from Building 771. Later, aqueous wastes from numerous buildings on plant site were treated in Building 774. Aqueous treatment operations included neutralization, precipitation, filtration, flocculation, clarification, immobilization, and evaporation [P052, P053, P113]. The evaporation process did not generate aqueous sludge and is not discussed. A flow diagram of the Building 774 aqueous waste treatment system is shown in Figure 23-1 (evaporation not shown) [P052, P077].

23.1.1 First-Stage Treatment

Most aqueous wastes from plutonium recovery operations in Building 771 entered the first-stage of the Building 774 liquid waste processing facility by vacuum transfer through the process waste system. The most common waste streams that entered first-stage treatment were [P061, P113, P124]:

- Plutonium ion exchange column effluent
- Part V waste solutions (nitric, sulfuric, and hydrofluoric acids)
- Americium ion exchange column effluent
- Nitric acid distillate from feed evaporator
- Thiocyanate waste solution
- Water distillate from peroxide precipitation filtrate evaporator
- Caustic scrubber solution
- Steam condensate.

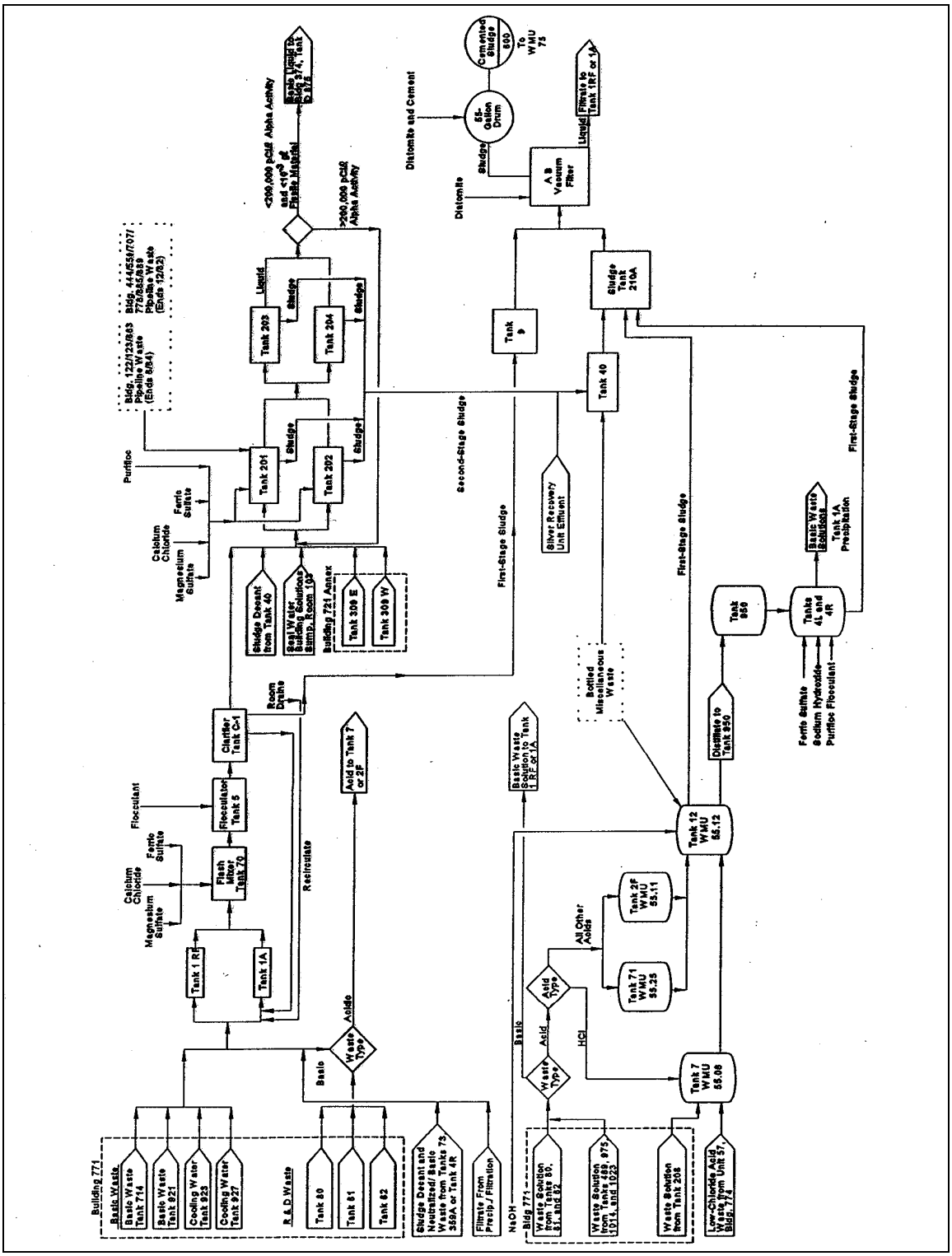

Figure 23-1. Building 774 Aqueous Waste Treatment Process.

The following compounds were used during recovery operations in Building 771 and may be present in aqueous sludges from first-stage treatment [P061, U047]:

- Nitric acid
- Aluminum nitrate
- Calcium fluoride
- Potassium hydroxide
- Ferrous sulfamate
- Sulfuric acid
- Hydrogen peroxide
- Calcium
- Magnesium oxide
- Magnesium
- Sodium peroxide
- Potassium iodate
- Hydrofluoric acid
- Sodium nitrate
- Hydrochloric acid
- Sodium hypochlorite
- Potassium fluoride

There were three first stage treatment processes in Building 774 for treating aqueous wastes that did not contain complexing agents. Complexing agents were handled separately and were not mixed into these aqueous waste streams (see Section 24.0, Solidified Laboratory Waste). These initial treatment processes were for: (1) acids with large quantities of cations in solution; (2) acids or bases with small quantities of cations or solids; and (3) basic or neutral solutions that were relatively free of solids. Treatment techniques consisted of neutralization, precipitation, flocculation, and clarification. Sodium hydroxide, ferric sulfate, calcium chloride, and a flocculating agent (Purifloc A23) [P065] were used in these treatment processes. The high nitrate liquid from the clarifier tank was used as feed for second-stage treatment [P113]. Treatment of the slurry, which resulted from each of these initial treatment processes, is described in Section 23.1.3.

23.1.2 Second-Stage Treatment

Second-stage treatment handled liquids that had been processed through first-stage treatment, decanted liquids from Tank 40 (slurry holding tank), and low-level or nonradioactive aqueous process wastes from numerous buildings on plant site. The building designations for the point of generation and the types of wastes that were transferred to second-stage treatment (by truck or the process waste system) are provided in Table 23-8. Most of the wastes transferred to second-stage treatment by the process waste system were only accepted until August 1984 when the precipitation process in Building 374 went on-line. After that time, only the wastes from Buildings 771 and 774 given in Table 23-8 were transferred to Building 774 second-stage treatment through the process waste system. After August 1984, wastes from the remaining buildings were sent to Building 774 by tanker [P052, P061, P109, P126, U043].

Table 23-8. Waste Streams Feeding Second-Stage Treatment.

Source Buildings	Materials
111	Process liquid waste
122	Medical decontamination washdown
123	Acidic solutions, process waste water, and standards and sample waste
331	Filter sludge and antifreeze solution
334	Ammonium persulfate, copper sulfate, etchants, and cleaners
371	Ammonia hydroxide, potassium hydroxide, and process waste water
443	Lithium chloride solution and water treatment additives
444	Process waste water (acidic), waste plating acid
447	Process waste water

Table 23-8. (continued).

Source Buildings	Materials
460	Process waste water (acidic)
551	35% hydrogen peroxide, high tin content
553	Sulfuric acid, baking soda, calcium chloride
559	Standards, caustic scrubber solution, acid wastes, and process waste water
690	Acid solutions
705	Ox-Out (water, ammonium bifluoride, and nitric acid)
707	Calcium fluoride solution and acid solutions
750	Hydrochloric acid and trisodium phosphate
771	Process waste water (residual chemicals, blowdown water, decon water)
774	Floor washdown and silver recovery effluent
776	Ammonia hydroxide, ethanol, hexane, acid solutions, and process waste water
778	Laundry waste water, Suma cleaner, and rinse water/battery acid
779	Acidic and basic solutions and process waste water
865	Acid solutions, scrubber effluent, polishing solution, and process waste water
881	Acid solutions, standards, samples, ammonium chloride, and process waste water
883	Acid solutions, Ox-Out, and process waste water
886	Ferric chloride, detergents, and process waste water
889	Equipment decontamination water
991	Acidic and basic solutions and water samples

The second-stage process included two separate radioactive decontamination systems: (1) a batch precipitation system used to remove radioactive materials from wastes in which both the radioactive and chemical contaminants exceeded the standards, and (2) a continuous precipitation system used to remove radioactive materials from wastes meeting the standards for chemical, but not radioactive contaminants. Both processes used the ferric hydroxide carrier-precipitation method of decontamination. The treated liquids from the batch process were stored in asphalt-lined ponds or sent to Building 374 for further treatment. Liquids from the continuous process were stored in unlined earthen ponds [P113].

23.1.3 Sludge Treatment

Slurry from first-stage treatment was drawn through a diatomite filter media using a vacuum inside a rotating filter drum. The filter media and trapped solids were continually scraped off the drum filter and fed into a 55-gallon drum [P001]. Portland cement was added to the bottom of the drum prior to placing the sludge in the drum. Portland cement may also have been added on top of the sludge. The sludge was assigned IDC 001 [P016]. Prior to 1979, the slurry from the second-stage was kept separate from the first-stage slurry. Second-stage sludge was assigned IDC 002 [P052].

Beginning in 1979, slurry from first- and second-stage treatment was combined prior to filtration. The sludge was still assigned IDC 001 [P024]. In 1986, the immobilization process changed and IDC 001 was discontinued. The process of pulling the combined slurry through diatomite filter media remained the same [P001]. However, as the sludge was scraped off the drum filter, it was co-fed into a drum with a

diatomite and Portland cement mixture which formed a solid monolith after curing. This waste was assigned IDC 800 and was generated until March 1991 [P016, P052].

23.2 Waste Packaging

Depending on the type of sludge (first-stage, second-stage, or combined) and waste packaging requirements at the time, several types and combinations of bags and liners were used to prepare 55-gallon drums for shipment.

From 1970 to 1972, 3 to 5 pounds of Portland cement were placed in the bottom of an unlined drum. A polyethylene drum bag was then used to line the drum, and another 3 to 5 pounds of cement were placed in the bottom of the bag. A PVC O-ring bag (first-stage sludge) or a plastic bag (second-stage sludge) was put in the drum. The PVC O-ring bag was attached to the glovebox. Approximately 30 pounds of cement were placed in the bottom of the PVC O-ring bag. First-stage sludge was put in the drum and the bag was twisted and taped closed. For second-stage sludge, an additional 3 to 5 pounds of cement were placed at the bottom of the plastic bag. Second-stage sludge was put in the drum in several layers with 3 to 5 pounds of cement between each layer. Another 3 to 5 pounds of cement were placed on the last sludge layer before the bag was twisted and taped closed. Approximately 5 pounds of cement were placed on the top of the PVC O-ring bag (first-stage sludge) or plastic bag (second-stage sludge) inside the polyethylene liner and the liner was twisted and taped closed [P024].

Use of the 90-mil rigid polyethylene liners began in 1972. From 1972 to 1979, the rigid liner was placed in the empty drum with Portland cement being placed in the bottom of the rigid liner. The remaining packaging configuration, including cement layering, was the same as it was before 1972. However, in some cases, second-stage sludge was contained in a single round-bottom polyethylene liner within the rigid liner [P012, P013, P015, P022, P024].

Beginning in 1979, first- and second-stage sludges were combined prior to filtration and subsequent packaging [P024]. As before, the drum was lined with a 90-mil rigid liner with Portland cement placed in the bottom of the liner. The rest of the packaging configuration was the same as it had been for first-stage sludge since 1970. The one exception is that, beginning in 1983, an additional 3 to 5 pound layer of cement may have been placed on top of the sludge inside the O-ring bag before it was closed. Although not required until 1989, a polyethylene round bottom drum liner may have been placed between the rigid liner and O-ring bag as early as 1973 [P012, P013, P015, P016, P022].

During characterization for the 3,100 m^3 Project, several combinations of round bottom drum liner bags, O-ring bags, and poly bags were identified by confirmatory RTR. Any combination of these plastic bags, provided that two layers of containment are not exceeded, did not impact acceptability of the drum. Drums that did exceed TRUPACT-allowed containment layers were flagged for treatment in TRIPS [P226].

Historical AK indicates that first-stage sludge drums may have been lead-lined to reduce radiation levels. Lead-lining may be in the form of lead sheeting used to line the inside of the drum or, after 1972, lead tape may have been used to wrap the outside of the rigid liner. Increased radiation levels are usually associated with high americium concentrations in the sludge [P024]. Confirmatory RTR characterization indicates that lead shielding was present in some drums [P226].

Once the drums were full, and the liners were twisted and taped closed, the drum lids were secured with a bolted ring, and tamper indicating devices were attached to the drums. For IDC 800, the drum was closed after the sludge, diatomite, and cement mixture was allowed to cure [P001, P043].

After drums were inspected, 1 to 2 quarts of Oil-Dri® were placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the rigid liner [P024, P043].

Confirmatory RTR examinations indicated that quantities of absorbent varied from the expected quantities. In addition, some containers contained an absorbent other than that expected or contained no absorbent. In 2002, the INEEL began a program to recover drums by removing excess residual liquids through absorption. Candidate drums were processed to add Aquaset® or vermiculite to absorb excess liquids. Sufficient Aquaset® or vermiculite was added to each candidate drum to reduce the amount of residual liquid to less than 1% of the container volume [P226].

Waste management and inspection protocol at Rocky Flats allowed containers of aqueous sludge waste to contain up to 10% of waste assigned to an IDC other than that assigned to the container [P016]. The other IDCs could have been those for combustibles, concrete, metal, and plastics. Inspection of the containers identified a variety of items including Kimwipes, leaded gloves, rubber gloves, and bottles. Containers of second-stage sludge packaged prior to 1973 may contain items such as electric motors, bottles of chemical wastes (usually liquid), mercury and lithium batteries, and small amounts of contaminated mercury in pint bottles. Radioactive sources may also have been included in containers of second-stage sludge through 1979 [P013, P015, P022, P024]. Acceptable knowledge confirmation activities also identified non-sludge items in a small percentage of the waste containers, including free liquid and small metal items, such as bolts and bars [P226].

23.3 Waste Characterization

Building 774 solidified aqueous wastes are characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, waste analysis, and headspace gas analysis. This section provides a hazardous waste determination for Building 774 solidified aqueous waste based on RCRA and the WIPP WAP requirements. Additional information regarding radionuclide contaminants and potential complexing agents contained in the waste and in compliance with the WIPP WAC, are also presented. These wastes are at least 50% (by volume) inorganic sludges and are classified as homogeneous waste [P141].

Some IDC 001, 002, and 800 drums may contain residual liquid. Those drums that contained excess liquid at the time of a WAP compliant RTR were marked *Treatment* and were excluded from the inventory destined for WIPP. Only drums that were compliant with the WIPP WAC, i.e., <1% residual liquids, were candidates for WIPP. This candidate inventory was subject to VE to determine the miscertification rate for homogenous solids and to ensure that the RTR methodology results in an acceptable miscertification rate. Some differences between residual liquid estimates made by two compliant RTRs or between a compliant RTR and a VE were expected. These variations resulted from accepted uncertainties inherent in the respective methodologies or from actual changes in the volume of residual liquid as a result of dynamic conditions such as extremes of heat and cold, drum content matrix characteristics, or drum handling. The presence of excess liquid has been referred to as *dewatering*. This occurrence may have been temporary and/or reversible depending on the above-noted conditions. An investigation into the potential phenomena of sludge dewatering was conducted at the INEEL in response to the observation of suspected dewatering in a single drum in 2001 [P226]. The conclusions of this study were that dewatering could not be confirmed to occur during transport; that the container certification process was WAP compliant with respect to identifying and segregating drums with excess residual liquids; and, that the observations were in accordance with both existing AK and characterization results. Evidence to date indicates that any residual liquids present had a pH less than or equal to 12 [P226]. The EPA HWN D002, therefore, was not assigned to the drums regardless of the presence or absence of excess liquids [P226].

When the VE resulted in an observation of residual liquid in excess of the WAC, this observation was counted as a miscertification and a Nonconformance Report (NCR) was issued. Miscertifications were reported in RWMC-EDF-363 [P303], which was prepared in accordance with MCP-2546 [P226], and reflected the miscertification rate for homogenous solids. An evaluation of previous RTR/VE comparisons concluded that RTR was effective in identifying excess residual liquids and that experience with VE of containers previously examined by RTR validated that effectiveness. This evaluation also concluded that the potential for residual liquids to exist was well established and anticipated when the criteria for residual liquids were established [P226]. Miscertifications that were observed under the described conditions were not indicative of either deficiencies in the AK Record or of difficulties with the RTR methodology. The presence of residual liquids did not affect HWNs or WMCs assigned to the waste [P226].

Furthermore, the observed miscertification rate was well within the WAP requirement. Between the issuance of Revision 5 of the WIPP-WAC and August 19, 2002, 357 containers from the homogenous solids summary category group had undergone VE. Of these, 5 were declared miscertifications due to excess free liquid not detected during RTR. This corresponded to a point estimate miscertification rate of 1.4% with UCL_{90} of 1.7%. The relevant WAP criterion is that the true miscertification rate for the population be less than 14% with 90% confidence, which was clearly met [P226].

23.3.1 Hazardous Waste Determination

Historical AK indicates that the wastes may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and chloroform. The wastes were derived from the treatment of aqueous electroplating wastes, and aqueous wastes containing small quantities of halogenated and nonhalogenated solvents, and are therefore F-listed hazardous wastes. There is no evidence that any of the wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or all of the Building 774 solidified aqueous waste are presented by IDC in Table 23-9.

Table 23-9. Building 774 Solidified Aqueous Waste Characterization.

IDC	Title	EPA HWNs[a]
001	First-Stage Sludge	D004-D011, D022[b], F001, F002, F005, F006, F007, and F009
002	Second-Stage Sludge	D004-D011, D022[b], F001, F002, F005, F006, F007, and F009
800	Solidified Sludge-Bldg. 774	D004-D011, D022[b], F001, F002, F005, F006, F007, and F009

a. The EPA HWNs are final per WSP INW216.001.

b. The toxicity code for chloroform, D022, was assigned on the basis of headspace gas sampling results. AK and solid sampling results did not indicate that chloroform was present in this waste [U104].

23.3.1.1 Characteristic Waste. Historical AK indicates that the materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as corrosive waste (40 CFR 261.22) and as toxic waste (40 CFR 261.24). Confirmatory information obtained during the 3,100 m^3 Project indicates that the corrosivity characteristic HWN does not apply. The materials do not exhibit the characteristics of ignitability (40 CFR 261.21) or reactivity (40 CFR 261.23). The origin of the characteristic HWNs assigned to IDC 001 is provided in Table 23-10. The table includes only the HWNs that are applicable to waste for which a specific time period was identified. It should be noted that no attempt to delineate between generation dates relative to HWN assignments was made by the 3,100 m^3 Project, which applied HWNs to the entire waste stream intended for disposal at WIPP [P217, P219].

Table 23-10. Dates of Origin for Characteristic HWNs.

IDC	EPA HWNs	Date of Generation
001	D005-D008	Generated before 1979
	D004-D011	Generated after 1979

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. Small amounts of containerized liquid chemical waste were added to the second-stage sludge prior to 1973 (as opposed to piped wastewater); these small quantities of containerized waste were compatible with the first and second stage treatment process [P217. P052, U043, U093]. This waste stream is not liquid, but RTR and VE have identified free liquids in some sludge drums. However, the free liquids are aqueous and are not ignitable [P013, P015, P022, U060]. Only drums with liquids below the WIPP waste acceptance criteria (less than or equal to 1 inch of liquid in internal containers and less than or equal to 0.55 gal (2,082 ml) total volume in the drum) were shipped to WIPP [P217]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P016, P024]. The materials are not compressed gases, nor do the containers contain compressed gases [P013, P015, P022]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001) [P217, P219].

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. Although free liquids have been identified in some sludge drums [P013, P015, P022], RTR and VE determined that none of these drums contained 20% by volume, aqueous waste (20% by volume is required in order to measure pH per the prescribed method in 40 CFR 261.22). Therefore, the corrosive characteristic did not apply [P217, P219, P052]. Also, because the materials are not liquid, the materials do not meet the definition of corrosivity towards steel [P217, P219]. Analysis of several nonrepresentative waste samples (i.e., the free liquids portion only) indicate a pH range of 8 to 12, which is below the 12.5 regulatory threshold [C224]. The materials in this waste group are therefore not corrosive wastes (D002) [P217, P219].

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P013, P015, P022]. Explosives were not handled or used around radioactive material. The waste may contain cyanide from treatment of electroplating wastes, and small amounts of containerized liquid waste [P217]. However, the cyanide concentrations in sludge should be at trace levels and will not cause the waste to be reactive [C065, C200, C203, P124, P217, P219]. Also, the small amounts of liquid chemicals present in internal containers are wastes that are compatible with the sludge [P052, U043, U093]. This waste does not present compatibility hazards due to the chemicals identified either with each other or with the packaging of the waste [P217]. Second-stage sludge generated before 1973 may contain lithium batteries. Lithium metal, which is highly reactive with water, was used as the anode in lithium alkaline batteries. As the battery discharges, the lithium metal is converted to lithium oxide which is not reactive [C202, C208, P024, U060]. The materials in this waste group are therefore not reactive wastes (D003) [P217, P219].

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and nonhalogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for arsenic,

barium, cadmium, chromium, lead, mercury, selenium, and silver. Since these wastes are homogeneous solids, the sludges were randomly sampled and analyzed for the toxicity characteristic contaminants for verification purposes between 1996 and 1999

Aqueous wastes from recovery operations in Building 771 may contain chromium above the regulatory level [P052]. In addition, analytical data for acid solutions from recovery operations indicate barium, cadmium, chromium, and lead above toxicity characteristics levels [P125]. Following plutonium recovery, these solutions were transferred to Building 774 first-stage treatment. Prior to 1979, recovery operations were the only source of waste entering first-stage treatment. Therefore, first-stage sludges (IDC 001) generated before 1979 were assigned EPA HWNs D005-D008.

First- and second-stage sludges were combined starting in 1979. Wastes from the several other sources were sent to second-stage treatment (see Table 23-2). The waste streams entering second-stage treatment contained arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver, or a combination of these metals [P052]. In addition, leaded gloves were identified in some sludge drums, and prior to 1973, bottles of liquid mercury may have been placed into drums containing second-stage sludges.

Historical emission spectroscopy data (sampling and analysis dates unknown) from two Building 774 sludge samples are shown in Table 23-11 [P122]. The data confirm the presence of toxicity characteristic metals, and indicate that the waste could exhibit the characteristic of toxicity for cadmium, chromium, lead, and silver.

Table 23-11. Historical Total Metals Results for Building 774 Aqueous Sludge [P122].

Compound	Total Concentration (ppm)
Arsenic	< 10
Barium	20 to 50
Cadmium	50 to 500
Chromium	5 to 100
Lead	1,000 to 5,000
Mercury	< 5
Silver	200

The results from solid waste sampling performed between 1996 and 1999 at INEEL confirmed that cadmium, chromium, lead, and silver are present in the waste stream with UCL_{90}s greater than the respective RTLs; and that arsenic, barium, mercury, and selenium are also present in the waste stream though at levels that are well below the RTLs. These confirmatory data were used by the 3,100 m^3 Project to characterize the waste for shipment to WIPP and are presented in Tables 23-12 [P219]. The data include samples selected randomly from the entire population of drums [P219]. The results confirmed the presence of toxicity characteristic metals. Based on AK and the solids data, EPA HWNs D004, D005, D006, D007, D008, D009, D010, and D011 were assigned to this waste stream [P217, P219].

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes that generated the aqueous waste from which Building 774 solidified aqueous waste was derived. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Table 23-12. Statistical Summary of First and Second Stage Sludge Solids Metals Data From the 3,100 m^3 Project [P219].

Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	RTL[a] (mg/kg)	Associated EPA HWNs
Arsenic	75	48	147	122	550	100	D004
Barium	75	75	41.4	43.4	290	2,000	D005
Cadmium	75	74	19.1	12.9	130	20	D006
Chromium	75	75	225	198	1,700	100	D007
Lead	75	74	515	244	3,800	100	D008
Mercury	75	32	2.33	1.11	14	4	D009
Selenium	75	7	0.27	0.656	1.5	20	D010
Silver	75	64	147	122	550	100	D011

a. RTL – Regulatory Threshold Limit

Tetrachloroethylene, trichloroethylene, and carbon tetrachloride were used primarily for cleaning and degreasing, and small quantities of these solvents may be present in Building 774 solidified aqueous wastes. These compounds were typically used as solvents. Therefore, the waste is regulated as a listed hazardous waste and not a characteristic waste because these compounds are specifically addressed in the treatment standards for the listed hazardous waste [P080]. Since Building 774 solidified aqueous wastes are characterized as listed hazardous wastes due to spent solvent contamination (refer to Section 23.3.1.2), the toxicity characteristic waste codes are not assigned for these compounds.

Volatile organics analysis of a single sample of Building 774 sludge, reported in 1988, shows a total concentration of 4.4 ppm chlorobenzene which is significantly less than the regulatory level for this compound [U029]. Results from solid and headspace gas sampling and analysis by INEEL used to characterize the sludge wastes for the 3,100 m^3 Project indicated that chlorobenzene was not present in either the headspace gas or the waste itself [P217]. None of the AK references indicate a source for chlorobenzene. Therefore, this waste group does not exhibit the characteristic of toxicity for chlorobenzene (D021).

Historical analytical data from Rocky Flats for a single sample of Building 774 sludge, as reported in 1988, indicates the presence of F-listed solvents. The analytical results are presented in Table 23-13 [U029].

Table 23-13. Total Volatiles Results for Building 774 Aqueous Sludge.

Compound	Total Concentration (ppm)
Methylene Chloride	0.2
Trichloroethylene	0.3
1,1,2-trichloroethane	3.6
Toluene	1.1
Chlorobenzene	4.4
Ethylbenzene	62.0
Total xylenes	96.6

Headspace analysis was performed on samples of Building 774 solidified aqueous wastes (IDCs 001, 002, and 800) obtained at INEEL (as reported in 1995). The detected F-listed compounds in which the UCL_{90} was above the PRQL were [P033]:

- carbon tetrachloride (IDCs 001 and 002 only)
- 1,1,1-trichloroethane (IDCs 001 and 002 only)
- 1,1,2-trichloro-1,2,2-trifluoroethane (IDC 001 only)
- trichloroethylene (IDCs 001 and 002 only).

Additional F-listed solvents were detected in headspace samples of sludge (IDC 800) obtained at Rocky Flats (results queried in 1996). The detected F-listed compounds in which the UCL_{90}s were above the PRQL included [U030]:

- carbon tetrachloride
- toluene
- 1,1,1-trichloroethane.

The initial headspace gas analyses results at INEEL of 41 drums in support of the CBFO approved WSP for this waste stream indicated that three F-listed volatile organic solvents (i.e., 1,1,1-trichloroethane, carbon tetrachloride, and trichloroethylene) and one toxicity constituent (chloroform) had concentrations that exceeded the PRQL at the UCL_{90} [P219]. F001 and F002 were already assigned to this waste stream based upon AK and solid sampling results (Table 23-14). Table 23-14 contains the preliminary data used to determine the number of confirmatory samples required to make a final assignment of HWNs. Table 23-15 contains the solids data associated with the confirmatory sampling and analysis [P219]. Although AK and solid sampling results did not indicate the presence of chloroform in the solid waste, the D022 HWN was assigned to the waste stream as a conservative measure [P217, P219].

23.3.1.2 Listed Hazardous Waste. The materials in this waste group were derived from the treatment of wastes listed in 40 CFR 261, Subpart D as hazardous wastes from non-specific sources (40 CFR 261.31). The wastes were not, or were not derived from the treatment of, a hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, and 1,1,2-trichloro-1,2,2-trifluoroethane were commonly used for cleaning and degreasing. Methylene chloride was used primarily for paint removal. Benzene and toluene were used as solvents primarily in laboratory operations. The aqueous waste transferred to Building 774 second-stage treatment may have contained small quantities of these spent solvents. In addition, the liquid from the vacuum filter was processed back through first-stage treatment.

Table 23-14. Statistical Summary of First and Second Stage Sludge Solids Preliminary Organics Data for the 3,100 m^3 Project [P219].

	Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Volatiles	1,1-Dichloroethylene	73	2	0.386	0.557	3.7	14	N/A
	1,2-Dichloroethane	73	0	0.083	0.508	1.08	10	N/A
	Benzene	73	0	0.083	0.508	1.08	10	F005
	Carbon tetrachloride	73	4	1.69	0.735	15	10	F001/F002
	Chlorobenzene	73	0	0.083	0.508	1.08	2,000	F002
	Chloroform	73	0	0.083	0.508	1.08	120	N/A
	Methyl ethyl ketone	73	8	1.40	1.10	8.5	4,000	F005
	Pyridine	73	6	1.54	1.29	10	100	N/A
	Tetrachloroethylene	73	5	0.335	0.577	2.5	10	F001/F002
	Trichloroethylene	73	15	3.53	1.70	16.9	10	F001/F002
	Vinyl chloride	73	0	0.083	0.508	1.08	4	N/A
Semi-volatiles	1,4-Dichlorobenzene	73	0	0.07	0.087	0.65	150	N/A
	2,4-Dinitrotoluene	74	0	0.866	0.155	7.5	2.6	N/A
	Cresols	74	5	0.7823	0.224	6.75	4,000	N/A
	Hexachlorobenzene	74	0	0.982	0.172	8.5	2.6	D032
	Hexachloroethane	73	0	0.07	0.091	0.6	60	N/A
	Nitrobenzene	74	2	0.881	0.184	7.5	40	N/A
	Pentachlorophenol	74	0	1.09	0.263	9.5	2,000	N/A

a. RTL = Regulatory Threshold Limit

Table 23-15. Statistical Summary of First and Second Stage Sludge Solids Confirmatory Organics Data for the 3,100 m^3 Project [P219].

	Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Volatiles	1,1-Dichloroethylene	7	0	0.008	0.109	0.12	b	14	N/A
	1,2-Dichloroethane	7	0	0.008	0.109	0.12	b	10	N/A
	Benzene	7	0	0.008	0.109	0.12	b	10	F005
	Carbon tetrachloride	7	0	1.77	0.779	4.8	b	10	F001/F002
	Chlorobenzene	7	0	0.008	0.109	0.12	b	2,000	F002
	Chloroform	7	0	0.008	0.109	0.12	b	120	N/A
	Methyl ethyl ketone	7	0	0.381	1.79	2.15	b	4,000	F005
	Pyridine	7	0	0.271	1.26	1.5	b	100	N/A

Table 23-15. (continued).

	Analyte	Total Number of Samples	Number of Samples above MDL	Standard Deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
	Tetrachloroethylene	7	1	0.260	0.210	0.8	b	10	F001/F002
	Trichloroethylene	7	1	0.094	0.147	0.36	b	10	F001/F002
	Vinyl chloride	7	0	0.008	0.109	0.12	b	4	N/A
Semi-volatiles	1,4-Dichlorobenzene	7	0	0	0.120	0.12	b	150	N/A
	2,4-Dinitrotoluene	7	0	0	0.075	0.075	b	2.6	N/A
	Cresols	7	0	0	0.115	0.115	b	4,000	N/A
	Hexachlorobenzene	7	1	0.253	0.206	0.78	b	2.6	D032
	Hexachloroethane	7	0	0	0.120	0.12	b	60	N/A
	Nitrobenzene	7	0	0	0.120	0.12	b	40	N/A
	Pentachlorophenol	7	0	0	0.050	0.05	b	2,000	N/A

a. RTL = Regulatory Threshold Limit

b. The mean and standard deviation presented are the results using the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the upper UCL_{90} cannot be calculated.

The analytical results from confirmatory solid sampling used by the 3,100 m^3 Project at INEEL to characterize the first and second stage sludge wastes did not indicate the presence of VOC or SVOC at concentrations above the RTL/PRQL (Table 23-14, Table 23-15) [P217, P219]. However, the HSG analysis results collected during the 3,100 m^3 Project confirmed the presence of 1,1,1-trichlorethane, carbon tetrachloride, and trichloroethylene with UCL_{90}s greater than their respective PRQLs (Table 23-16) [P324]. Methylene chloride, tetrachloroethylene, and benzene were detected, although all had UCL_{90}s less than their respective PRQLs [P217. P219]. In the original characterization set [P217], 1,1,2-trichloro-1,2,2-trifluoroethane and toluene were present but not in excess of the PRQL and the HWNs for these compounds were assigned based on AK. However, evaluation of HSG data for the entire waste stream, as reflected in Table 23-16, indicated these two compounds at concentration levels such that the UCL_{90}s were greater than the respective PRQLs. Building 774 solidified aqueous wastes were derived from the treatment of a listed hazardous waste and are assigned EPA HWNs F001, F002, and F005.

Acetone, methanol, and xylene were used as solvents primarily in laboratory operations, and the aqueous waste transferred to Building 774 second-stage treatment may have contained small quantities of these spent solvents. However, F-listed solvents were not mixed before being discharged into the process waste line. Solvents were also diluted with water and washed into the process waste line at the point of generation. Therefore, the ignitability characteristic was removed at the time of dilution and discharge [P217, P219]. Since the F003-listed waste was rendered non-ignitable prior to subsequent discharge and aggregation within the liquid waste stream destined for sludge generation, this waste qualifies for the exemption in 40 CFR 261.3(a)(2)(iii) for nonhazardous wastewaters. Confirmatory solid sampling results (Table 23-14, Table 23-15) collected during the 3,100 m^3 Project indicated the presence of methanol in the solid waste, although at levels well below the RTL/PRQL [P217]. The HSG data indicated the presence of acetone, butanol, ethyl benzene, methyl isobutyl ketone, and xylene, although all with UCL_{90}s less than the respective PRQLs [P217]. Therefore, this waste was not assigned EPA HWN F003 [P052, P217].

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes that generated the aqueous waste from which Building 774 solidified aqueous waste was derived. Therefore, this waste group is not an F004-listed hazardous waste.

At one time, Building 774 treated spent stripping, cleaning, and plating solutions from electroplating operations in which cyanides were used. Building 774 solidified aqueous wastes were derived from the treatment of the hazardous electroplating wastes, and therefore are assigned EPA HWNs F006, F007, and F009.

The materials in this waste group are not hazardous wastes from specific sources because they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are therefore not K-listed hazardous waste.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous waste.

Table 23-16. Statistical Evaluation of all First and Second Stage Sludge HSG Data From the 3,100 m^3 Project [P324].

Analyte	Total Number of samples	Number of samples above MDL[a]	Mean (ppmv)	Standard deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	2,637	2,488	86.5	1472	74,000	124	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	2,623	30	0.107	0.291	4.95	0.177	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	2,639	1,325	33.4	380	13,000	46.7	10	F002[c]
1,1-Dichloroethane	2,629	811	2.08	20.8	730	3.02	10	N/A
1,1-Dichloroethylene	2,629	1,244	2.89	22.0	520	3.68	10	N/A
1,2,4-Trimethylbenzene	2,623	766	0.182	0.413	6.50	0.201	10	N/A
1,2-Dichloroethane	2,619	89	0.122	0.303	4.40	0.163	10	N/A
1,3,5-Trimethylbenzene	2,621	500	0.142	0.339	6.00	0.161	10	N/A
Acetone	2,639	2,271	4.24	28.2	990	5.00	100	N/A
Benzene	2,622	2,008	1.51	6.96	190	1.71	10	F005[d]
Bromoform	2,633	3	0.088	0.304	5.00	0.419	10	N/A
Butanol	2,635	1,694	1.57	12.0	600	1.95	100	N/A
Carbon tetrachloride	2,631	1,255	57.0	2047	99,000	131	10	F001[c]
Chlorobenzene	2,618	45	0.130	0.583	24.0	0.243	10	F002[d]
Chloroform	2,626	263	0.741	22.1	1,100	2.49	10	D022[d]
Cis-1,2-dichloroethylene	2,617	145	0.183	0.828	33.0	0.271	10	N/A
Cyclohexane	2,621	1,124	0.364	0.848	18.0	0.397	10	N/A
Ethyl benzene	2,620	1,034	1.02	6.93	150	1.30	10	N/A
Ethyl ether	2,609	2	0.204	0.556	18.0	1.41	10	N/A
Methanol	2,639	139	6.25	10.1	210	7.35	100	N/A

Table 23-16. (continued).

Analyte	Total Number of samples	Number of samples above MDL[a]	Mean (ppmv)	Standard deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
Methyl chloride	169	42	0.626	0.852	9.10	0.797	10	N/A
Methyl ethyl ketone	2,636	863	0.492	1.91	34.5	0.576	100	N/A
Methyl isobutyl ketone	2,638	1,027	0.400	3.12	110	0.525	100	N/A
Methylene chloride	2,619	854	1.71	9.15	170	2.11	10	F001/F002[d]
Tetrachloroethylene	2,628	505	3.40	49.9	1300	6.25	10	F001/F002[d]
Toluene	2,635	2,586	9.39	76.9	1900	11.3	10	F005[c]
Trans-1,2-dichloroethylene	741	13	0.181	0.390	4.13	0.328	10	N/A
Trichloroethylene	2,623	910	20.4	510	2,6000	42.1	10	F001/F002[c]
m&p-Xylene	2,622	1,422	2.83	18.1	440	3.45	10	N/A
o-Xylene	2,621	866	0.498	2.53	49.0	0.609	10	N/A

a. When a measurement is reported as below detection, one-half the analysis method detection limit (MDL) is used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the upper UCL_{90}s cannot be calculated.

c. HWN assigned based on AK and confirmatory HSG analysis.

d. HWN assigned based solely on AK.

e. The F003 HWN associated with these constituents is not applicable. The F003 HWN was removed from the waste stream because the waste qualifies for the exemption within 40 CFR 26.3(a)(2)(iii).

23.3.2 Radionuclides

This section identifies the radioisotopes potentially contained in the waste. In addition, Table 23-17 summarizes matrix and other physical parameters that could affect radioassay.

Table 23.17. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	The sludges were produced by a carrier precipitation process in which ferric sulfate, calcium chloride, magnesium sulfate, and a coagulating agent were used to form a floc that coprecipitated with the radioactive contaminants [P004, P164]. Based on the generation process, the distribution of actinides in waste should be relatively homogeneous. However, as specified in Section 23.2, radioactive sources may have been mixed in second-stage sludges (IDC 002) prior to 1980.
Hydrogen Content	Sources of hydrogen may include plastic packaging material (Section 23.2) and trace amounts of hydrocarbons (Section 23.3.1.2). Based on VE, several of the IDC 800 sludges were damp or contained free liquid [P013]. Nearly all of the IDC 001 and 002 sludges examined were damp and several contained free liquid [P015, P022].

Table 23-17. (continued).

Parameter	Results of Evaluation
Other Interfering Waste Contaminants	Documentation indicates that the major anions and cations included aluminum, magnesium, fluoride, and chloride [P164]. Waste analysis confirmed the presence of aluminum (1%) and magnesium (0.5 and 3%). The analysis also detected boron (10 and 50 ppm), beryllium (100 and 200 ppm), cadmium (50 and 500 ppm), and chromium (5 and 100 ppm) [P122].
Physical Matrix Parameters	Measured sludge density information was not identified; however, average bulk densities were calculated for 13 IDC 001 and 5 IDC 002 sludges. The average density was calculated as 1261 kg/m^3 [C196]. Documentation on the distribution of contaminants was not identified but, based on the generation process, should have been relatively homogeneous.

Aqueous waste treatment operations in Building 774 received wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium [P164]. The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are provided in Section 3.0.

Production and production support processes in Buildings 371, 559, 707, 771, 776, 777, and 779 generated wastes contaminated with weapons-grade plutonium, americium-241, and enriched uranium, which were treated in Building 774. Production and production support processes in Buildings 444, 447, 865, and 883 generated wastes contaminated with depleted uranium, which were treated in Building 774 [P053, U053]. Other radionuclides may also be found in Building 774 wastes from R&D, analytical, and special order work [P164]. Processing of most of the "special" radioisotopes, such as curium-244, thorium-232, and uranium-236, was performed until the early- to mid-1970s [C154, P164, P189, P194]. Neptunium-237 was processed until 1985 or 1986, and uranium-233 was handled until about 1982 [C154, P164, P198, P200]. A more detailed description of plutonium and uranium production operations and R&D operations is provided in Section 3.0.

The Size Reduction Vault in Building 776 conducted repackaging operations (container prefixes 0019, 0025, and 0040) [C175, C184, P078, U059]. The package date on these drums is the date in which the waste was repackaged. The waste was originally generated some time prior to this date. Therefore, it is assumed that the repacked sludge containers could potentially contain any of the above radioisotopes. IDC 800 wastes should not contain uranium-233 because this waste was not generated until 1986.

23.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activities of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241, plutonium-238, -239, -240 -241, uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P226, P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual

gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence is predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P226].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 23-18. The building or area of generation for containers in the INEEL inventory is identified in this table by the container prefix contained in the drum identification number. The acceptable knowledge relating to historical operations and the date of generation may be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 23-18. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
001	774	0741	Liquid Waste Treatment	12/7/72 - 4/25/78	WG Pu, EU, ^{241}Am, DU, ^{233}U
001	774	0742	Liquid Waste Treatment	5/4/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
001	774	0743	Liquid Waste Treatment	5/19/82 - 5/19/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
001	774	0743	Liquid Waste Treatment	1/27/84 - 4/30/86	WG Pu, EU, ^{241}Am, DU, ^{233}U[a]
001	774	0744	Liquid Waste Treatment	6/26/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
001	774	7412	Liquid Waste Treatment	1/25/80 - 12/22/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
001	774	7412	Liquid Waste Treatment	1/3/83 - 9/6/88	WG Pu, EU, ^{241}Am, DU, ^{233}U[a]
001	776	0019	Size Reduction	1/8/85 - 7/17/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
001	776	0025	Drum Repack	11/11/80 - 7/30/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
002	774	0742	Liquid Waste Treatment	8/6/71 - 12/7/83	WG Pu, EU, ^{241}Am, DU, ^{233}U
002	776	0025	Drum Repack	6/5/84 - 2/4/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
800	774	0744	Liquid Waste Treatment	11/19/86 - 3/22/88	WG Pu, EU, ^{241}Am, DU
800	774	7412	Liquid Waste Treatment	4/22/86 - 9/19/88	WG Pu, EU, ^{241}Am, DU, ^{233}U[a]
800	776	0025	Drum Repack	8/31/87 - 10/12/87	WG Pu, EU, ^{241}Am, DU, ^{233}U

a. Isotopes added by confirmatory radioassay.

WG = weapons grade DU = depleted uranium EU = enriched uranium

23.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the First & Second Stage Sludge waste stream are summarized in Tables 23-19 and 23-20. The overall yield for this radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 23-19 and Table 23-20 present the yield and

the radionuclide and related radioassay information, respectively. The data for the individual radioassay systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 23-19. Overall Radioassay Yield for the First and Second Stage Sludge Waste Stream [P322].

Container Status	Total Number of Containers	Percent Yield
Containers examined by radioassay	6,407	N/A
"*WIPPOK*" containers	6,246	97%
"Treatment" containers	9	0.1%
"Deficient / Permanently Rejected" containers	152	2%

Table 23-20. Radionuclide and Related Quantities for the First and Second Stage Sludge Waste Stream[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	6.160E+00	8.264E+00	3.496E-03	1.402E+02	6,388
TRU Activity (Ci)	6.161E+00	8.264E+00	3.469E-03	1.402E+02	6,388
TRU Activity Concentration (nCi/g)	3.458E+04	4.605E+04	1.791E+01	8.355E+05	6,388
Thermal Power (W)	2.050E-01	2.759E-01	1.173E-04	4.686E+00	6,388
Thermal Power Density (W/ft^3)	2.789E-02	3.754E-02	1.597E-05	6.375E-01	6,388
Plutonium Fissile Gram Equivalent (g)	1.017E+01	1.044E+01	1.477E-03	1.669E+02	6,388
Americium-241 (g)	1.672E+00	2.348E+00	2.363E-04	4.030E+01	6,313
Plutonium-238 (g)	6.167E-04	9.778E-04	4.907E-06	1.765E-02	6,333
Plutonium-239 (g)	5.479E+00	8.647E+00	4.395E-02	1.576E+02	6,333
Plutonium-240 (g)	3.332E-01	5.249E-01	2.673E-03	9.549E+00	6,333
Plutonium-241 (g)	1.005E-02	1.586E-02	8.084E-05	2.900E-01	6,333
Plutonium-242 (g)	2.489E-03	3.946E-03	5.060E-06	7.249E-02	6,334
Uranium-233 (g)	1.322E-01	1.147E-01	2.692E-02	4.203E-01	15
Uranium-234 (g)	8.921E-03	1.217E-02	2.768E-05	2.315E-01	6,083
Uranium-235 (g)	4.808E+00	5.880E+00	1.043E-04	1.668E+02	6,214
Uranium-238 (g)	1.651E+03	2.742E+03	8.250E-02	6.855E+04	4,441

a. The absence of ^{137}Cs was verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verified the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry [P240].

b. The standard deviation is the statistical variation of the population for which measurements were available.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

23.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be

added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid are known constituents of KW decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, P079, U043]. Oxalic acid was also used for americium recovery [U047].

Aqueous wastes that were known to contain complexing agents were isolated and prepared separately. Because complexing agents were not compatible with the aqueous waste treatment system, Building 774 solidified aqueous waste should only have trace quantities of complexing agents [P004].

23.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the First and Second Stage Sludge waste stream, the yield of successful RTR examinations was approximately 86% [P323]. Conversely, approximately 14% of the containers were dispositioned as *Treatment* and isolated from the population destined for WIPP. The reasons for the *Treatment* disposition, in decreasing order of occurrence, are: presence of excess free liquids; the absence of prohibited items could not be verified; the IDC could not be verified; and the layers of confinement were exceeded for the assigned shipping category [P323]. All other reasons were less than 1%. An absorbent addition recovery option implemented by the 3,100 m^3 Project increased the RTR yield to approximately 92%. Visual examination indicated that the RTR technique was acceptable for characterization of this waste stream based on a miscertification rate that met the requirements of the program [P321].

24. SOLIDIFIED LABORATORY WASTE

This waste group consists of solidified liquid wastes that were not compatible with the primary aqueous waste treatment system, such as complexing agents, strong acids, and strong bases. The liquids were neutralized and solidified in Building 774 [P012]. The liquid wastes, which were generated in numerous buildings on plant site, were treated to produce IDCs 004 and 802 [U043]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 24-1 [U092].

Although a WSP (INW157.001) was initially planned for the special set ups (IDC 004) and solidified laboratory wastes (IDC 802), it was determined that the solids sampling data was insufficient to support characterization of the waste stream, as required by the WIPP WAP [U107].

Table 24-1. Solidified Laboratory Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
004	Special Setups-Building 774 [P016]	December 1972-November 1986
802	Solidified Laboratory Waste-Building 774 [P016]	June 1986-April 1988

***Item Description Code 004, Special Setups-Building 774*:** This waste consists of liquids primarily from laboratory operations throughout plant site that were neutralized and solidified in Building 774. A mixture of Portland cement and insulation cement was placed in a lined 55-gallon drum. The liquid waste was neutralized and then added to the cement mixture, which cured to form a solid monolith. Some drums may contain polyethylene bottles of solidified waste [P024].

***Item Description Code 802, Solidified Laboratory Waste-Building 774*:** The cementation process for IDC 802 was similar to IDC 004. IDC 802 replaced IDC 004 in approximately 1986 [U092]. The IDC was changed to designate containers of solidified laboratory waste that were certified for disposal [C008].

24.1 Waste Generation

Liquid wastes that were not compatible with the primary aqueous waste treatment system were solidified in Building 774. The liquids, which include complexing agents, strong acids, and strong bases, were generated primarily from the analytical laboratories, research and development laboratories, and maintenance shops [P016, P024]. Specifically, the liquid wastes originated in Buildings 122, 123, 126, 371, 444, 559, 705, 707, 750, 771, 777, 779, 865, 881, 883, 886, and 991 [U043]. The liquids generated in the analytical laboratories in Buildings 371, 559, and 771 were sent to Building 771 for recovery if they contained plutonium above the EDL [P067]. Following recovery, the liquids were transferred to Building 774 where they were immobilized in cement. Liquid wastes from the other buildings and processes were below the EDL and were also solidified in Building 774 [P016, P024]. A process flow diagram for solidified laboratory waste is provided in archived Building 774 WSRIC information [P077].

24.1.1 Neutralization and Solidification Process

Packaged waste received in plastic bottles was entered into the glovebox. The bottles containing acid waste were transferred into Tank T-7, the receiver and neutralizer tank adjacent to the glovebox. After sodium hydroxide was added to Tank T-7, pH paper was used to ensure the acid waste had been neutralized. Liquid wastes that were basic at the time they were received were not neutralized prior to solidification [P070].

A mixture of approximately 250-300 pounds of Portland type I/II cement and 100-150 pounds of insulation cement were placed in a lined 55-gallon drum that was attached to the glovebox [P073]. Approximately 80-100 liters of the basic waste or neutralized liquid waste was added to the cement mixture and placed on a drum roller to ensure mixing of the contents [P024, P073]. The cement mixture in the drum reacted with the waste solution to form a solid monolith [P070].

Periodically, polyethylene bottles were filled with the cement mixture and sent to the small quantity waste generators on plant site for addition of the liquid waste [P024].

24.1.2 Liquid Waste Generation

A setup logbook was used in Building 774 to record the types of waste and generation source of IDCs 004 and 802 The date of treatment, generation location, waste description, and treatment process were entered in the log book [U043]. All wastes with treatment entries indicated as "bottle box" or "setup in bottle box" were those treated by this process. If the entry was "setup" with no indicated treatment process, it was assumed to be included in IDC 004 and 802 except large volumes (>1 drum) of organic liquids. There are numerous entries for less than 10 liters of organic waste treated in the bottle box system. A large volume of organic waste is not compatible with the bottle box solidification system and would most likely have been treated in the solidified organic waste system (see Section 25.0, Solidified Organic Waste).

A description of the liquid wastes treated by this process including generation buildings is presented in Table 24-2 [U043]. Information in parentheses does not appear in the logbook but is provided as clarification.

Table 24-2. Liquid Wastes Included In IDCs 004 and 802.

Generation Building	Waste Description
122	^{239}Pu and ^{55}Fe (assumed to be sources)
123	Anion and cation resin, glass wool, hydrochloric acid, and nitric acid; lab waste; liquid bromine; NH_4Cl; ^{133}Ba (assumed to be a source); enriched uranium, ^{237}Np, ^{90}Sr, and tritium sources; small amount of liquid that apparently had been a standard
126	Isotopes (assumed to be sources)
371	DCHP (dicesium hexachloroplutonate); effluent waste; lab waste
444	Ox-out/5.5% nitric acid (Ox-out is a water solution of nitric acid and ammonium bifluoride [P091]); phosphoric acid; chromic acid; sodium lignosulfonate; Versene (Versene is a trade name EDTA product [P024])
447	Contaminated Turco bath (Turco is a trade name for a series of cleaners with various combinations of acids, complexing agents, and surfactants [P091])
559	5-15% phosphoric acid; basic lab waste; beryllium chloride salts; electroetch solution; inorganic waste; m-phenylenediamine; scrubber waste; tritium scintillation cocktail contains toluene; tritium analytical waste
705	Ox-out (Ox-out is a water solution of nitric acid and ammonium bifluoride [P091])
707	Coolant water; dist. water
750	Absorber – no contamination

Table 24-2. (continued).

Generation Building	Waste Description
771	Acid solution; acrylonitrile; americium oxalate filtrate; basic cyanide waste; basic lab waste; boilout solution; cadmium nitrate; caustic; Cl and SCN waste; citric solution—Am citrate solution; Cl-NO_3 waste; Cl_2 waste HF trapping solvent; cooling water; depleted uranium in nitric acid; distillate water and detergent; ethylene glycol; filter solution; floor sweepings (oxide waste); HCl dissolutions; HF fluoride solution; hydrofluoric, oxalic, and ascorbic acid with stannous chloride; magnesium, potassium, and sodium (assumed to be in solution, the waste volume is reported in liters); metallurgical lab waste; nitrate, borate, chromate, and oxalate; OH filtrate; phosphoric acid, 2-ethoxyethanol, oxalic acid, ethylene glycol, water, and ethyl alcohol; potassium hydroxide; Pu-Cm sludge; slurried cement; SST (assumed to be stainless steel) capsules depleted uranium; tetraphosphoric acid; titanium tetrachloride; U-233 in oil; U-233 plating solution; U-233 filtrate solution; U-238 acid waste; solid cerium; wash solution; waste acid nickel plating; waste etching solution; waste solution; water from compactor; Metex solution (Metex is a trade name for a series of inorganic and organic acids or salts [P119])
777	Dist. water
779	75% sulfuric acid; americium solution; contaminated soil; Cs/Na/K/NaCl salts; depleted uranium; etchant solution; tetraphosphoric; etching solution; perchloric acid; hydrochloric acid solution; low level waste; metal X and B273 (no reference was found to identify the constituents of this material); nitric acid; oil; phosphoric acid and ethylene glycol; plutonium oxide and sodium hydroxide; propylene carbonate; waste solution; water etching solution
865	700 gram picric acid - reacted with Na_2S NaOH $(NH_4)_2S$
865	Aqueous cut-off wheel solution
881	Acid solution Pu, Am, U; aqueous; chlorophenol; ECM (electrochemical milling) sludge; hot waste solution Pu, Np, Am, Th, U; lab waste solution-high in tritium; liquid from vacuum trap; low-level waste Np, U-235, Pu, Am; nitrate and chloride salts; tributyl phosphate; tritiated water; tritium
883	Grinder coolant, machine coolant
886	Kepro developer (Kepro developer contains 1,1,1-trichloroethane [P091])
991	Ox-out containing beryllium (Ox-out is a water solution of nitric acid and ammonium bifluoride [P091])

24.2 Waste Packaging

Solidified laboratory waste was contained in an O-ring bag inside a prepared 55-gallon drum attached to the glovebox [P015, P021]. Approximately 10 to 15 pounds of Portland cement were added on top of the cemented laboratory waste before the O-ring bag was sealed. The solidified waste may also be contained in polyethylene bottles inside the lined 55-gallon drum [P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with a polyethylene drum bag. Three to five pounds of Portland cement were placed in the bottom of the drum

and in the drum bag. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with a polyethylene round bottom drum liner [P016, P024, P063, P064]. Three to five pounds of Portland cement was placed in the bottom of the rigid liner and in the round bottom liner. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

After drums were inspected, one to two quarts of absorbent material (Oil-Dri®) was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024].

24.3 Waste Characterization

Solidified laboratory waste was characterized based on knowledge of the material, knowledge of the processes generating the waste, RTR review of the waste, VE, surrogate waste analysis, and headspace gas analysis. This section provides a RCRA hazardous waste determination for solidified laboratory waste as well as radionuclide contaminants and complexing agents contained in the waste. This waste is at least 50% (by volume) inorganic solids and is classified as a homogeneous waste [P141].

A characterization report was drafted for this waste for the 3,100 m^3 Project which included the results from solids sampling [U107]. The number of samples collected and analyzed were insufficient to fully characterize the waste stream per the WIPP WAP.

24.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes were mixed with halogenated- and non-halogenated-solvents and are therefore listed waste. The wastes do not exhibit any characteristic of hazardous wastes. EPA HWNs applicable to some or all of the solidified laboratory waste group are presented by IDC in Table 24-3 [U092].

Table 24-3. Solidified Laboratory Waste Characterization.

IDC	Title	EPA HWNs
004	Special Setups-Building 774	F001, F002, F003, and F005
802	Solidified Laboratory Waste-Building 774	F001, F002, F003, and F005

24.3.1.1 Characteristic Waste

The materials in this waste group do not exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C, as an ignitable waste (40 CFR 261.21), as a corrosive waste (40 CFR 261.22), as a reactive waste (40 CFR 261.23), or as a toxic waste (40 CFR 261.24).

***Ignitability*:** The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and free liquids are not normally associated with these wastes [P016]. In addition, absorbents were added to wastes having the potential of generating free liquids (i.e., dewatering of cemented wastes) [P015, P021, P024]. Visual examination identified one drum containing 20 milliliters of liquid outside of the rigid liner. The liquid appeared to be water or condensation and would not be ignitable [P015]. The materials are not compressed gases, nor do the wastes contain compressed gases [P012, P013, P015, P016, P021, P024]. Even though oxidizers were added to solidified laboratory waste for treatment, the cementation process would have removed the oxidizer property. Therefore, the resultant materials are not DOT oxidizers as defined in 49 CFR 173. The

materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P016, P024]. The materials in this waste group are therefore not ignitable wastes (D001).

***Corrosivity*:** The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, and free liquids are not normally associated with this waste [P016]. In addition, absorbents were added to wastes having the potential of generating free liquids (i.e., dewatering of cemented wastes) [P015, P021, P024]. Visual examination identified one drum containing 20 milliliters of liquid outside of the rigid liner. The liquid appeared to be water or condensation and would not be corrosive [P015]. The materials in this waste group are therefore not corrosive wastes (D002) [U060].

***Reactivity*:** The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain explosive materials [P012, P013, P015, P016, P021, P024]. Explosives were not handled or used around radioactive material [P012]. Small volumes of cyanide, acrylonitrile (vinyl cyanide), thiocyanate, and sodium sulfide solution were added to the solidified laboratory waste stream on five occasions (11/13/73, 9/11/74, 2/2/78, 2/21/78, and 10/14/80) [U043]. However, due to the solidified matrix of these wastes, if exposed to pH conditions between 2 and 12.5, they should not generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment. The materials in this waste group are therefore not reactive wastes (D003).

***Toxicity*:** The materials in this waste group do not meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and non-halogenated solvents, pesticides, herbicides, and other toxic compounds.

Surrogate laboratory waste was spiked with various concentrations of barium, cadmium, chromium, lead, and silver. Sampling and TCLP analysis of the resultant solidified waste form indicated that the surrogate sample did not exhibit the characteristic of toxicity for these metal compounds [U054]. Although arsenic and mercury were not tested, there is no documentation indicating that these compounds were solidified in the process [U043]. Solids sample data were complied by the 3,100 m^3 Project at the INEEL for this waste group in a yet unpublished document, Characterization of Rocky Flats Plants Special Setups Sludge Waste Stream (IDCs 004, 802) [U107]. The solids data confirmed AK information regarding the absence of contaminant metals and are presented in Table 24-4. This waste group does not exhibit the characteristic of toxicity for metals (D004-D011).

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating the wastes in IDCs 004 and 802. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Carbon tetrachloride and trichloroethylene were used in the laboratory as well as many other operations on plant site. Since these compounds were typically used as solvents, the wastes are regulated as listed hazardous wastes and not as characteristic wastes because these compounds are specifically addressed in the treatment standards for listed hazardous waste [P080]. Because solidified laboratory wastes are characterized as listed hazardous wastes due to spent solvent contamination, the wastes are not toxicity characteristic waste due to the presence of these organic compounds.

Table 24-4. Statistical Summary of Solids Sampling Metals Analyses Data for Solidified Laboratory Waste [U107].

Analyte	Total Number of Samples	Number of Samples above MDL	SD (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Arsenic	8	8	3.44	8.68	14	10.4	100	N/A
Barium	8	8	51.3	249	360	275	2,000	N/A
Cadmium	8	8	1.14	2.29	3.7	2.86	20	N/A
Chromium	8	8	10.6	37.4	60	42.7	100	N/A
Lead	8	8	3.1	8.29	14	9.85	100	N/A
Mercury	8	0	0.036	0.101	0.145	N/A	4	N/A
Selenium	8	2	0.805	1.16	2.9	2.91	20	N/A
Silver	8	7	10.5	5.89	31	11.6	100	N/A

a. RTL = Regulatory Threshold Limit

24.3.1.2 Listed Hazardous Waste. The materials in this waste group are listed hazardous wastes because they were mixed with waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31) The materials are not, or were not mixed with, hazardous waste from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Solvents including carbon tetrachloride and 1,1,2-trichloro-1,2, 2-trifluoroethane were used in laboratory analyses but were separated from the aqueous phase of the wastes prior to treatment [P107]. The aqueous phase was not considered a spent solvent [C085]. Although Kepro developer (containing 1,1,1-trichloroethane) was added to solidified laboratory waste, it was not used for its solvent properties [P091, U043]. Organic compounds such as 1,1,1-trichloroethane, carbon tetrachloride, and trichloroethylene also were commonly used for various cleaning activities on the RFP site [P053]. Maintenance shops also generated liquid wastes that were added to solidified laboratory waste and it is possible that some amount of spent solvent was introduced into the solidification process [P016]. Solidified laboratory wastes were assigned EPA HWNs F001 and F002.

Solvents such as methanol and xylene also were also used in laboratory analyses [P107]. There is no documentation indicating that these solvents were added to solidified laboratory waste. If the solvents were separated from the aqueous phase after analysis, the aqueous phase would not be listed hazardous waste based these spent solvents [C085]. Solidification of aqueous waste containing these solvents has not been verified. Headspace gas analyses of solidified laboratory waste detected these solvents as well as ethyl benzene [P033]. The source of ethyl benzene has not been identified, and it is assumed that ethyl benzene could have been introduced into the solidification process as a spent solvent. F003-listed solvents are listed solely due to ignitability, and even though these wastes do not exhibit that characteristic, these solvents may have been ignitable at the point of generation. This waste group was assigned EPA HWN F003.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating the wastes in IDCs 004 and 802. Therefore, this waste group is not an F004-listed hazardous waste.

Large volumes of organic waste were not compatible with the bottle box solidification system, which produced solidified laboratory waste. However, small amounts (4-8 liters) of organic solvents were added to the waste on several occasions. Spent solvent wastes included electropolishing solution

containing 2-ethoxyethanol from metallography laboratories and scintillation cocktail containing toluene from tritium analysis [U043]. Solidified laboratory wastes were derived from the treatment of these spent solvent wastes, and were assigned EPA HWN F005.

Confirmatory solids sampling and headspace gas data generated during the 3,100 m^3 Project at the INEEL, confirmed the presence of F-listed constituents in the solidified laboratory wastes (Tables 24-5 and 24-6) [U107]. Carbon tetrachloride was the only organic compound detected in solids samples with a UCL_{90} greater than its PRQL. 1,1,1-Trichloroethane and methanol were the only F-listed compounds detected in headspace gas concentrations resulting in a UCL_{90} greater than the PRQLs. Earlier headspace gas analyses performed on samples of solidified laboratory waste obtained at INEEL confirmed the presence of F-listed solvents. The detected F-listed compounds in which the UCL_{90} from the previous sampling was above the PRQL are as follows [P033]:

- 1,1,1-trichloroethane (IDC 004 only)
- carbon tetrachloride (IDC 004 only)
- trichloroethylene (IDC 004 only)
- ethyl benzene (IDC 004 only)
- methanol
- xylene (IDC 004 only).

Table 24-5. Statistical Evaluation of Organic Compound Data from Solid Sample Analyses Generated by the 3,100 m^3 Project for the Solidified Laboratory Wastes (IDCs 004 and 802) [U107].

	Analyte	Total Number of Samples	Number of Samples above MDL	Standard deviation (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Volatiles	1,1-Dichloroethylene	5	0	0.042	0.547	0.6	b	14	N/A
	1,2-Dichloroethane	5	0	0.042	0.547	0.6	b	10	N/A
	Benzene	5	0	0.042	0.547	0.6	b	10	N/A
	Carbon tetrachloride	5	4	8368	6.21	21.5	13.3	10	F001/F002
	Chlorobenzene	5	0	0.042	0.54	0.6	b	2,000	N/A
	Chloroform	5	0	0.042	0.547	0.6	b	120	N/A
	Methyl ethyl ketone	8	0	0.122	1.16	1.43	b	4,000	N/A
	Pyridine	8	0	0.138	1.29	1.48	b	100	N/A
	Tetrachloroethylene	5	0	0.042	0.547	0.6	b	10	N/A
	Trichloroethylene	5	0	0.042	0.547	0.6	b	10	F001/F002
	Vinyl chloride	5	0	0.042	0.547	0.6	b	4	N/A
Semi-Volatiles	1,4-Dichlorobenzene	7	0	0	0.12	0.12	b	150	N/A
	2,4-Dinitrotoluene	7	0	0.003	0.107	0.11	b	2.6	N/A
	Cresols	7	1	0.045	0.123	0.225	b	4,000	N/A
	Hexachlorobenzene	7	0	0.008	0.109	0.115	b	2.6	N/A
	Hexachloroethane	7	0	0.016	0.127	0.14	b	60	N/A
	Nitrobenzene	7	0	0.016	0.127	0.14	b	40	N/A
	Pentachlorophenol	7	0	0.051	0.149	0.19	b	2,000	N/A

a. RTL = regulatory threshold limit

b. The mean and standard deviation calculations used the method detection limits (after dividing by 2) since all measurements (or all but one) were below detection. The UCL_{90} cannot be calculated since there are no degrees of freedom associated with the t statistic.

Table 24-6. Statistical Evaluation of Headspace Gas Analyses of Samples Collected during the 3,100 m^3 Project for the Solidified Laboratory Wastes (IDCs 004 and 802).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	7	4	55.7	134	360	166	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	7	0	0.144	0.220	0.495	b	10	N/A
1,1,2-Trichloro-1,2,2-Trifluoroethane	7	0	0.417	0.640	1.45	b	10	F002[d]
1,1-Dichloroethane	7	4	1.70	3.20	8.80	4.32	10	N/A
1,1-Dichloroethylene	7	2	0.815	0.975	2.35	2.94	10	N/A
1,2,4-Trimethylbenzene	7	3	0.225	0.276	0.65	0.525	10	N/A
1,2-Dichloroethane	7	0	0.263	0.402	0.900	b	10	N/A
1,3,5-Trimethylbenzene	7	3	0.197	0.245	0.600	0.463	10	N/A
Acetone	7	3	2.03	1.52	4.30	3.68	100	N/A
Benzene	7	5	0.541	0.298	0.900	0.746	10	N/A
Bromoform	7	0	0.101	0.155	0.350	b	10	N/A
Butanol	7	6	3.86	4.57	12.0	6.61	100	N/A
Carbon Tetrachloride	7	1	0.245	0.293	0.650	b	10	F001/F002[d]
Chlorobenzene	7	0	0.263	0.402	0.900	b	10	N/A
Chloroform	7	0	0.278	0.426	0.950	b	10	N/A
Cis-1,2-Dichloroethylene	7	0	0.364	0.556	1.25	b	10	N/A
Cyclohexane	7	5	28.5	53.2	140	64.9	10	N/A[e]
Ethyl Benzene	7	4	0.291	0.267	0.700	0.510	10	F003[d]
Ethyl Ether	7	0	0.951	1.46	3.30	b	10	N/A
Methanol	7	6	3,414	2,047	5,500	4,648	100	F003[c]
Methyl Ethyl Ketone	7	3	0.758	0.96	2.30	1.80	100	N/A
Methyl Isobutyl Ketone	7	3	0.432	0.415	0.990	0.885	100	N/A
Methylene Chloride	7	1	0.941	1.27	2.95	b	10	N/A
Tetrachloroethylene	7	0	0.186	0.285	0.650	b	10	N/A
Toluene	7	5	3.12	2.26	7.70	4.67	10	F005[d]
Trichloroethylene	7	3	2.76	2.78	7.90	5.78	10	F001/F002[d]
m&p-Xylene	7	4	0.604	0.518	1.35	1.03	10	F003[d]
o-Xylene	7	3	0.299	0.295	0.750	0.620	10	F003[d]

a. When a measurement is reported as below detection, one-half the analysis method detection limit (MDL) is used Note that the MDL for a given analyte may vary from sample to sample.
b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.
c. HWN assigned based on headspace gas results.
d. HWN assigned based solely on AK.
e. Cyclohexane does not have an EPA HWN However, this compound is an underlying hazardous constituent and target analyte This compound was included in the flammability determination in compliance with the WAP.

The materials in this waste group are not hazardous wastes from specific sources since they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are not K-listed hazardous wastes.

The materials in this waste group are not discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

24.3.2 Radionuclides

This section identifies the radioisotopes potentially contained in the waste. In addition, Table 24-4 summarizes matrix and other physical parameters, which could affect radioassay.

Aqueous waste treatment operations in Building 774 receive wastes from throughout plant site, including processes that generated low-level and non-radioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium The isotopic compositions of weapons-grade plutonium, enriched uranium, and depleted uranium are provided in Section 3.0. The solidified laboratory wastes also contain other radioisotopes that were undesirable in the regular aqueous waste treatment system [P164].

As was specified in Table 24-2, tritium, plutonium, americium, depleted uranium, enriched uranium, uranium-233, iron-55, neptunium-237, barium-133, strontium-90, and curium (no isotope specified) were introduced into the solidification process in liquid received or as sources from various buildings. In addition, one log book entry for waste from Building 126, which is a radioisotope storage area, is simply "isotopes" with no further detail [U043].

The SRV in Building 776 conducted repackaging operations (prefixes 0019 and 0025) [C175, C184, P078, U059]. The package date on these drums is the date in which the waste was repackaged and was originally generated some time prior to this date. Therefore, it is assumed that the repacked containers could potentially contain any of the above radioisotopes. IDC 802 should not contain uranium-233 because uranium-233 was only handled until about 1982, and IDC 802 was not generated until about 1986 [P198]. Table 24-7 is an evaluation of the matrix and expected effects on radioassay.

Table 24-7. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	Radionuclides will primarily be in the form of hydroxides because sodium hydroxide was used to neutralize the waste solution prior to solidification [P070]. Other radionuclide forms may include oxalate, citrate, and oxide (see Table 24-2).
Hydrogen Content	Sources of hydrogen may include plastic packaging material (see Section 24.2) and small amounts of hydrocarbons (see Table 24-2) A few drums may contain free liquid or unhardened sludge [P073].
Other Interfering Waste Contaminants	Radioassay interferences may include bromine, ammonium bifluoride, hydrofluoric acid, chromic acid, beryllium chloride, hydrochloric acid, cadmium nitrate, magnesium, and borate (see Table 24-2).
Physical Matrix Parameters	The distribution of waste contaminants should be relatively homogeneous because after the liquid was added to the cement mixture, it was placed on a drum roller to ensure mixing of the contents [P024].

24.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides were quantified and reported in accordance with Appendix A of the CH-WAC, DOE/WIPP-02-3122, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measure americium-241; plutonium-238, -239, -240, -241; uranium-233, -235, and –238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227, P322]. Decision criteria for using default versus measured values are specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high-resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence is predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 24-8. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number in this table. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The package dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 24-8. Radionuclides of Concern and Package Dates by Container Prefix and Generation Building.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
004	774	0743	Liquid Waste Treatment	4/23/85	WG Pu, EU, ^{241}Am, DU
004	774	0744	Liquid Waste Treatment	12/14/72 - 12/17/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
004	774	0744	Liquid Waste Treatment	2/7/83 - 6/3/86	WG Pu, EU, ^{241}Am, DU
004	776	0019	Size Reduction	9/19/83 - 11/17/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
004	776	0025	Drum Repack	2/4/85 - 8/11/86	WG Pu, EU, ^{241}Am, DU, ^{233}U
802	774	0744	Liquid Waste Treatment	6/19/86 - 4/16/88	WG Pu, EU, ^{241}Am, DU
802	776	0019	Size Reduction	9/3/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
802	776	0025	Drum Repack	9/3/87 - 9/3/87	WG Pu, EU, ^{241}Am, DU, ^{233}U

WG = weapons grade DU = depleted uranium EU = enriched uranium

24.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the special setups (IDCs 004 and 802) wastes are summarized in Tables 24-9 and 24-10. The overall yield for the special setups and solidified laboratory

wastes radioassay data is a compilation of the data from all three radioassay systems at the RWMC. The yield and the radionuclide and related radioassay information are presented in Table 24-9 and Table 24-10, respectively. A WSP for the special setups and solidified laboratory wastes was not developed during the 3,100 m^3 Project and no drums were characterized or shipped to the WIPP facility. The data for the individual radioassay systems information are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 24-9. Overall Radioassay Yield for Special Setups (IDC 004) and Solidified Laboratory (IDC 802) Wastes.

Total number of:	Number	Percentage of Total
Distinct containers	39	
"*WIPPOK*" containers	0	0%
"*Treatment*" containers	0	0%
"*Deficient / Permanently Rejected*" containers[a]	39	100%

a. Data acquired for assessing system performance.

Table 24-10. Radionuclide and Related Quantities for Special Setups (IDC 004) and Solidified Laboratory (IDC 802) Wastes.[a]

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	6.136E+00	4.657E+00	1.794E-02	1.966E+01	39
TRU Activity (Ci)	6.151E+00	4.669E+00	1.799E-02	1.972E+01	39
TRU Activity Concentration (nCi/g)	2.434E+04	1.896E+04	6.610E+01	8.005E+04	39
Thermal Power (W)	1.934E-01	1.465E-01	5.634E-04	6.188E-01	39
Thermal Power Density (W/ft^3)	2.631E-02	1.993E-02	7.665E-05	8.420E-02	39
Plutonium Fissile Gram Equivalent (g)	7.151E+01	5.439E+01	8.716E-01	2.240E+02	39
Americium-241 (g)	2.158E-01	1.547E-01	1.486E-04	5.939E-01	39
Plutonium-238 (g)	9.396E-03	7.956E-03	3.487E-05	3.541E-02	39
Plutonium-239 (g)	6.796E+01	5.303E+01	2.184E-01	2.218E+02	39
Plutonium-240 (g)	4.196E+00	3.287E+00	1.364E-02	1.386E+01	39
Plutonium-241 (g)	1.119E-01	8.589E-02	3.254E-04	3.305E-01	39
Plutonium-242 (g)	2.387E-02	1.896E-02	5.811E-05	7.142E-02	39
Uranium-233 (g)	1.702E-01	1.944E-01	9.889E-03	4.906E-01	6
Uranium-234 (g)	3.042E-03	3.355E-03	1.205E-04	1.344E-02	24
Uranium-235 (g)	3.634E+00	6.182E+00	5.456E-02	3.180E+01	34
Uranium-238 (g)	1.834E+02	3.500E+02	7.491E+00	1.102E+03	9

a. The absence of ^{137}Cs is verified during radioassay using the 661 keV line as described in the INEEL EDF-840 This also verifies the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

24.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

Liquid wastes containing complexing agents were treated in the process producing solidified laboratory waste. Complexing agents interfered with the first and second stage aqueous waste treatment systems in Building 774 [C073]. The complexing agents in the solidified laboratory waste include Versene (a trade name for ethenediaminetetraacetic acid), tetraphosphoric acid, tributyl phosphate, citrate, oxalic acid, sodium lignosulfonate, and americium oxalate [P024, U043].

24.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the special setups and solidified laboratory wastes (IDCs 004 and 802), the yield of successful RTR examinations was approximately 89% [P323]. Conversely, approximately 11% of the containers were dispositioned as *Treatment.* The principal reason for the *Treatment* disposition was that the layers of confinement were exceeded for the assigned shipping category All other reasons were less than 1% [P323]. The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

25. SOLIDIFIED ORGANIC WASTE

This waste group consists of organic liquid wastes that were solidified in Building 774. The liquid wastes were generated in numerous buildings on the plant site, but originated primarily from Buildings 707 and 777. The majority of the liquids were oil and chlorinated solvents generated from machining and degreasing of plutonium metal [P016, P024, P052]. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 25-1 [U092].

Although WSPs (INW164.001 and INW309.001) were initially planned for the 3,100 m^3 Project for the solidified organics (IDCs 700 and 801) and organic set ups (IDC 003) wastes, it was determined that the solids sampling data were insufficient to support characterization of the waste streams, as required by the WIPP WAP [U098, U099]. The wastes are characterized as homogeneous organic solids and as such require additional solid sampling and analysis for PCB content.

Table 25-1. Solidified Organic Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
003	Organic Set Ups, Oil Solids [C063] Grease-Bldg. 774 [C063] Organic Setups [P012] Solidified Organics [P014]	January 1973–March 1986
700	OASIS Waste [P012]	March 1986–May 1986
801	Cemented Grease (OASIS) [P063] Solidified Organics-Building 774 [P001]	February 1986–September 1988

***Item Description Code 003, Organic Setups*:** This waste consists of various organic liquids that were transferred to Building 774 where they were mixed with Microcel-E (a synthetic calcium silicate) to form a grease or paste-like material [P002, P024]. The organic liquids were primarily oil and chlorinated solvents generated from machining and degreasing of plutonium metal in Buildings 707 and 777 [P016, P024, P052]. Small amounts of Oil-Dri® were sometimes added to the mixture as well [P024]. The process generating this waste operated until November 1985 [P052].

***Item Description Code 700, OASIS Waste*:** This waste consists of various organic liquids cemented to form a solid monolith. IDC 700 was assigned to the waste generated by the experimental prototype Organic and Sludge Immobilization System (OASIS) process in Building 774 that would later generate IDC 801. The organic liquids solidified as well as the solidifying agents should be the same for IDCs 700 and 801 [P016]. The OASIS process began operation in November 1985 [P016, P052]. See the description for IDC 801 for more information about this waste.

Table 25-2 lists the typical waste material parameters for OASIS waste (IDC 700) identified during the 3,100 m^3 Project, including typical packaging materials [U099].

Table 25-2. Typical Waste Material Parameters Identified in the OASIS wastes (IDC 700) During the 3,100 m^3 Project [U099].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Other Inorganic Materials	Oil-Dri®, vermiculite[a]

Table 25-2. (continued).

Potential Waste Material Parameter	Description
Organic Matrix	Cement (ENVIROSTONE emulsifier, gypsum cement, accelerator)/OASIS sludge mixture

a. Absorbents may not be distinguishable from the organic matrix.

***Item Description Code 801, Solidified Organics*:** This waste consists of various organic liquids immobilized into a solid monolith in the OASIS process in Building 774. Oils and chlorinated solvents from machining and degreasing of plutonium metal in Buildings 707 and 777 were the primary liquids treated by the OASIS process [P016, P052]. The OASIS process also treated organic liquids from Buildings 334, 371, 443, 444, 447, 559, 771, 776, 778, 779, 865, 881, 883, and 991 [U040, U043]. The organic liquids were immobilized by mixing with water, ENVIROSTONE emulsifier, accelerator, and gypsum cement. The emulsifier was a polyethylene glycol ether, and the accelerator contained gypsum and potassium sulfate [P066].

Table 25-3 lists items that have been identified in containers during INEEL 3,100 m^3 Project examination of the Solidified Organics waste [U099].

Table 25-3. Miscellaneous Items Identified by RTR for Solidified Organics Waste (IDC 801) During the 3,100 m^3 Project [U099].

Item[a]	Comment
Miscellaneous Metals	Miscellaneous metals have been identified during RTR examination. The potential that additional HWNs might apply was evaluated. No additional HWNs are applicable.

a. All containers are being screened for light ballasts. Any container identified with light ballasts will not be shipped to WIPP.

Table 25-4 lists the typical waste material parameters for Solidified Organics waste identified during the 3,100 m^3 Project, including typical packaging materials [U099].

Table 25-4. Typical Waste Material Parameters the Solidified Organics Waste (IDC 801) Identified During the 3,100 m^3 Project [U099].

Potential Waste Material Parameter	Description
Steel (packaging materials)	55-gallon drum
Plastics (packaging materials)	90-mil drum liner, O-ring bag, drum bags
Other Inorganic Materials	Oil-Dri®, vermiculite
Organic Matrix	Cement (ENVIROSTONE emulsifier, gypsum cement, accelerator)/ OASIS sludge mixture

25.1 Waste Generation

Solidified organic wastes were produced by mixing organic liquids with solidification material [P002]. The liquids were transferred to Building 774 by pipeline or in containers. The organic liquids were generated in Buildings 334, 371, 443, 444, 447, 559, 707, 771, 776, 777, 778, 779, 865, 881, 883, and 991 [U040, U043]. In 1985, it appears as if the organic wastes were segregated into either the low-level or transuranic tank systems. Prior to this, both low-level and transuranic liquids may have been included in the solidified organic waste [U040].

25.1.1 Solidification Process

Organic setups (IDC 003) were produced by mixing the organic liquid with Microcel-E, a synthetic calcium silicate [P002]. Small amounts of Oil-Dri® were sometimes added to the mixture as well [P024]. The amounts of materials added to the mixture were not metered. However, the operator would adjust the composition if the outgoing mixture did not have a paste-like consistency. The mixture would then drop into an O-ring bag contained in a 55-gallon drum [P016]. The composition of organic setups was approximately 30 gallons of liquid organic waste to 100 pounds of Microcel-E [P024]. Figure 25-1 represents the flow of organic liquid waste into IDC 003 drums [P052].

Solidified organics (IDC 801) and OASIS (IDC 700) wastes were produced by the OASIS process. IDC 700 was assigned to the waste generated by the experimental prototype OASIS process in Building 774 that would later generate IDC 801. OASIS is a batch type process generating one drum per run. Waste oils were pumped into an O-ring bag contained in a 55-gallon drum attached to the bottom of the OASIS glovebox. ENVIROSTONE emulsifier, gypsum cement, and accelerator were also metered into the bag. House water (water which had not been used in any other processes) was added to the mixture as well [P016]. The typical composition of solidified organic waste was 170 pounds of organic liquid waste, 250 pounds of cement, 25 pounds of emulsifier, 10 pounds of accelerator, and 42 pounds of water [U010]. After all of the materials were added, a lightning mixer was lowered into the drum. The amount of materials added to the mixture was computer controlled [P016]. Figure 25-2 represents the flow of organic liquid waste into IDCs 700 and 801 drums [P052].

25.1.2 Liquid Waste Generation

Solidified waste oils and solvents were generated primarily in Buildings 707 and 777. Solvent-contaminated (carbon tetrachloride and 1,1,2-trichloro-1,2,2-trifluoroethane) wastes were generated by plutonium machining and tool degreasing. Ultrasonic cleaner baths using 1,1,1-trichloroethane were used to clean parts. Metal turnings and scrap were cleaned in carbon tetrachloride baths before forming the turnings into briquettes [P052]. Trichloroethane began replacing trichloroethylene for vapor degreasing of parts in plutonium areas beginning around 1973. By the end of 1974, trichloroethylene remained in use in only one plutonium operation, and by February 1975 was used only in research and analytical activities [P023]. Since 1985, the solidified organic waste was derived almost exclusively from Buildings 707 and 777 [U040].

Trace amounts of miscellaneous laboratory wastes including organophosphates and nitrobenzene were also introduced into the solidification process. In addition, PCB contaminated oils were processed until 1979 [P024]. Two documented cases (8/27/76 and 1/26/78) indicate PCB contaminated oils from Building 334 were processed [C207, U040]. PCBs are further discussed in Section 25.3.1.3.

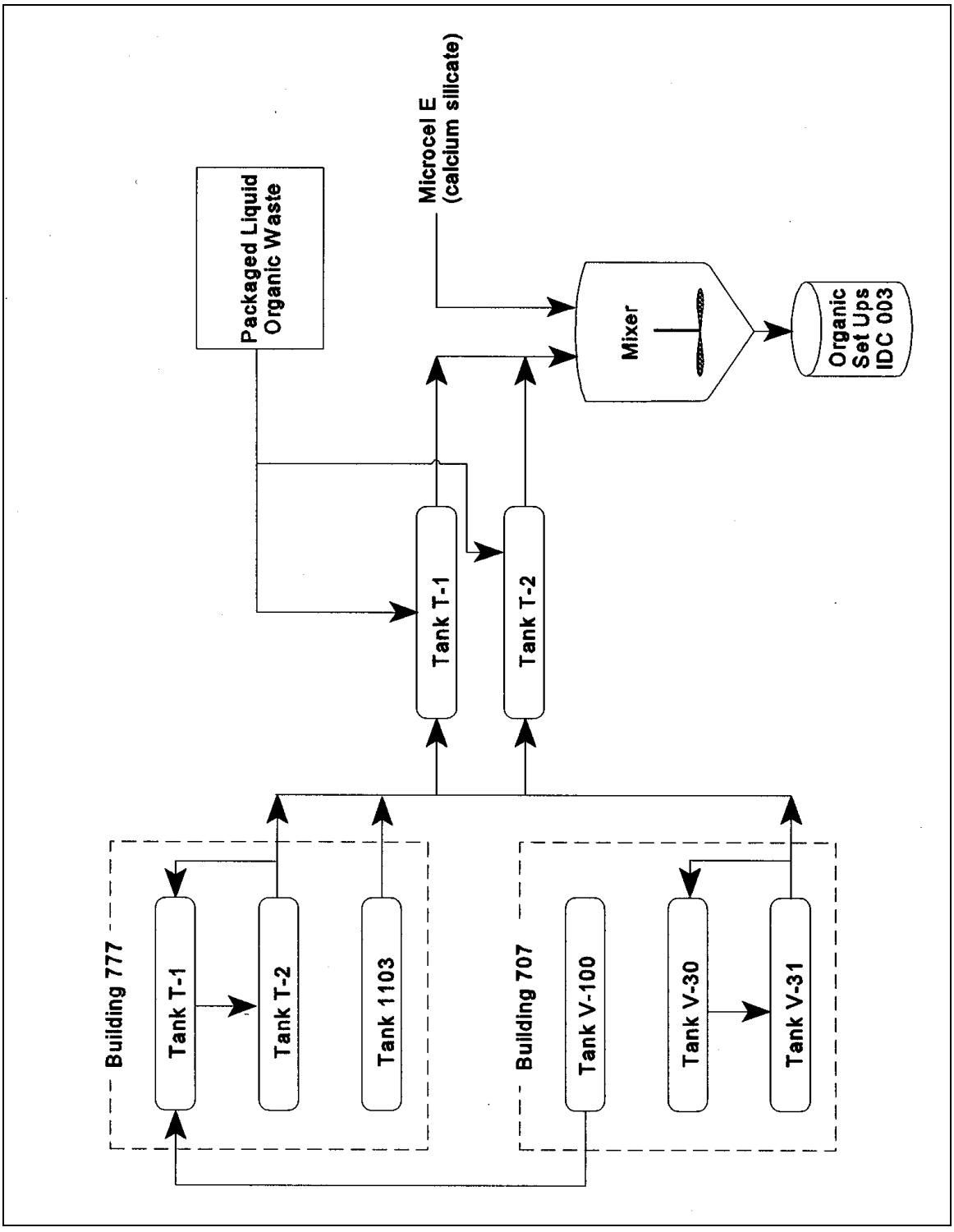

Figure 25-1. Flow of Organic Liquid Waste into IDC 003 Drum.

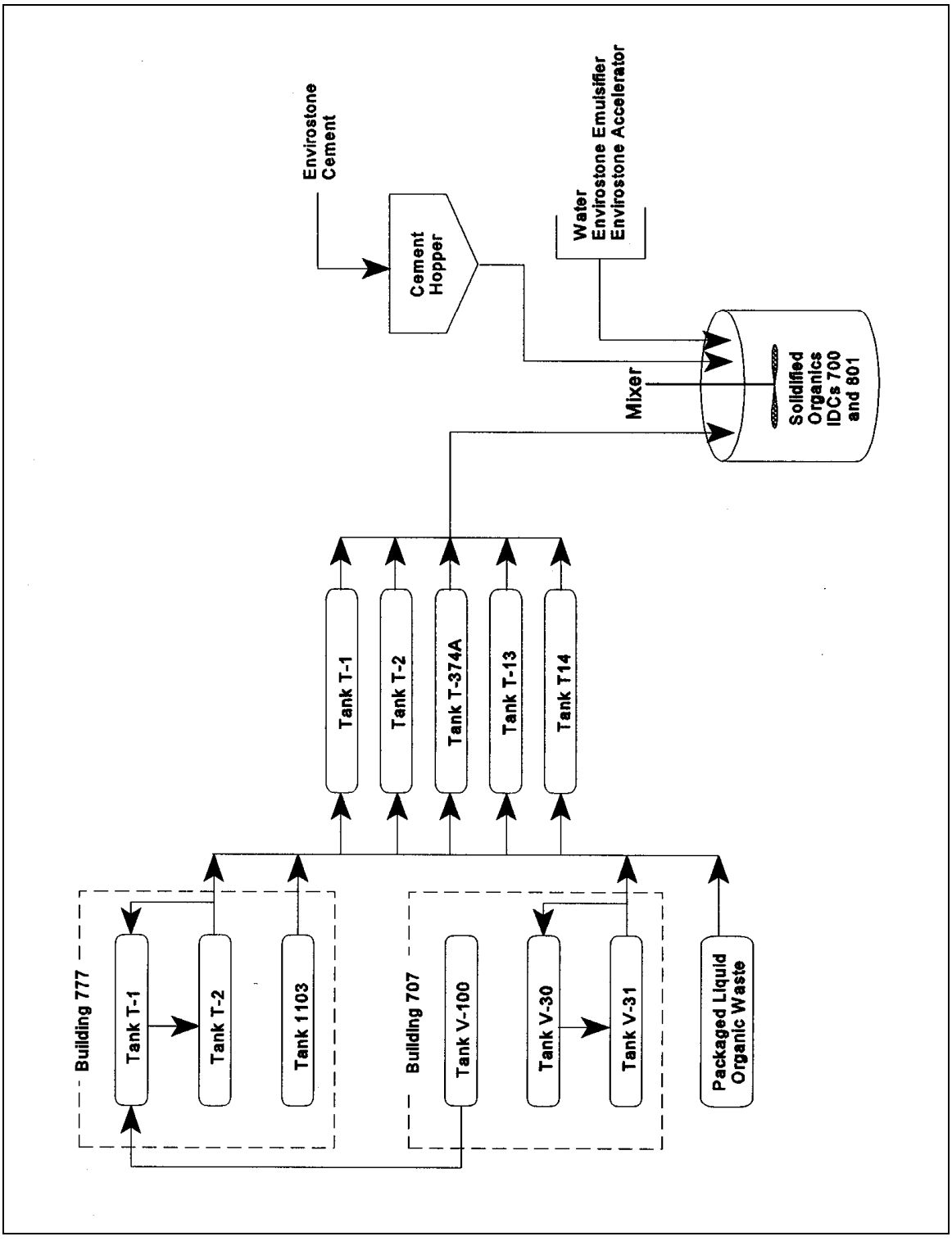

Figure 25-2. Flow of Organic Liquid Waste into IDCs 700 and 801 Drums.

A logbook was used in Building 774 to record the types of organic waste and generation source of the liquids that made up IDCs 003, 700, and 801. The date of treatment, generation location, waste description, and volume of waste were entered in the logbook. A description of the organic liquids included in IDCs 003, 700, and 801, the buildings from which they were generated, and the buildings function are presented in Table 25-5 [U040, U043]. Information in parentheses does not appear in the log book but is provided as clarification.

Table 25-5. Organic Liquid Wastes Included In IDCs 003, 700, and 801.

Building	Building Function	Organic Liquid Waste Description
334	Maintenance shops	waste oil, PCBs, Zyglo (Zyglo is a dye penetrant compound containing fluoranthene, petroleum distillates, and kerosene) [P142]
371	Plutonium recovery	oil
443	Power plant	oil
444	Depleted uranium casting and machining, beryllium machining	oil, trichlor (assumed to be 1,1,1-trichloroethane), Freon
447	Building 444 support	oil
559	Production support laboratories	pump oil, oil, toluene/H_3 (assumed to be tritium), silicon oil, organic waste (xylene/DHDECMP [dihexyl-n,n-diethylcarbamoyl methylphosphonate]) [C032, C086]
707	Plutonium component manufacturing	oil samples, hydraulic oil
771	Plutonium recovery	oil, etch solution, Freon oil, oil/CCl_4, mixed organics, halocarbon oil, TBP (assumed to be tributyl phosphate), organic extract, Chlorothene (Chlorothene is a trade name for 1,1,1-trichloroethane)
776	Pyrochemistry and waste operations	engine oil, lube oil, lathe cutting oil
777	Plutonium component manufacturing and research	coolant oil/CCl_4, perc (assumed to be tetrachloroethylene), or trichloroethylene
778	Maintenance	oil, Pydraul oil (Pydraul products are hydraulic oils containing triphenyl phosphate, trialkylphenyl phosphates, and alkyl aryl phosphates) [P091]
779	Plutonium research	hydraulic oil, equipment oil, H_3 (assumed to be tritium)/toluene, Freon
865	Depleted uranium and beryllium metallurgy research	beryllium waste oil
881	Laboratories and maintenance	oil, machine coolant, perchlor (assumed to be tetrachloroethylene), waste cocktail (assumed to be scintillation cocktail), Varsol oil (Varsol is a trade name petroleum solvent containing primarily saturated hydrocarbons and less than 2% toluene, xylene, and ethyl benzene) [P084]
883	Depleted uranium rolling and forming	oil, cooling solvent, D-38 (depleted uranium) oil, oil and perk (assumed to tetrachloroethylene)
991	Product warehouse	coolant, band saw coolant

25.2 Waste Packaging

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with two polyethylene drum bags. About four pounds of Oil-Dri® was placed in the bottom of the drum and in the bottom of each drum bag. Organic setup (IDC 003) waste was then placed in the drum. Use of the 90-mil rigid polyethylene liner began in 1972 [P024]. The rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or a polyethylene drum bag [P016, P024, P063, P064]. A polyvinyl chloride O-ring bag and a polyethylene bag were used if the drum was attached to the glovebox. About four pounds of Oil-Dri® was placed in the bottom of the rigid liner, the round bottom liner or drum bag, and the O-ring bag. The organic liquids were then placed in the O-ring bag along with the solidifying agents. When a drum was full, the drum liners were twisted and taped closed, the lid was secured with a bolted ring, and a tamper indicating device was attached to the drum [P012, P016, P024].

During the 3,100 m^3 Project, several combinations of drum bags, poly bags, and O-ring bags used as packaging were identified for the IDC 700 and IDC 801 wastes. Any combination of these plastic bags, provided that two layers of containment were not exceeded, did not impact acceptability of the drums. Drums that exceeded TRUPACT-allowed containment layers were flagged for treatment in the TRIPS [U099].

Prior to 1972, absorbent material (Oil-Dri®) may have been added to the top of the sealed drum bag, which contained the organic setup waste (IDC 003). Since approximately 1972, after drums were inspected, one to two quarts of Oil-Dri® was placed on the top of the outer, sealed polyethylene drum bag. This procedure changed in February 1982 when vermiculite was used to fill the space between the outer, sealed polyethylene drum bag and the top of the 90-mil rigid liner. The quantity of vermiculite varied from 3-12 pounds according to the amount of waste contained in each drum [P024]. During the 3,100 m^3 Project, it was determined during RTR examinations of IDC 700 and IDC 801 wastes that quantities of absorbent can vary significantly from expected quantities, and some drums may contain no absorbent. In addition, Oil-Dri® and vermiculite may be used in some drums outside of expected time periods [U099].

25.3 Waste Characterization

Solidified organic wastes were characterized based on knowledge of the materials, knowledge of the processes generating the wastes, RTR review of the wastes, VEs, and headspace gas analyses. This section provides RCRA and TSCA hazardous waste determinations for solidified organic wastes as well as radionuclide contaminants and potential complexing agents contained in the wastes. These wastes are at least 50% (by volume) inorganic particulates and are classified as homogeneous organic solids wastes [P141].

Two waste streams were initially proposed for this waste group by the 3,100 m^3 Project: Solidified Organic Wastes, IDCs 700 and 801, and Organic Set Ups Waste, IDC 003. A characterization report was drafted for the Solidified Organic waste stream (IDCs 700 and 801) for the 3,100 m^3 Project which included the results from solids sampling and analysis [U099]. Solid samples were also collected and analyzed for the Organic Set Ups waste (IDC 003) [U098]. The analytical data for both proposed waste streams require further assessment to ensure that sufficient data exist to fully characterize the waste stream per the WIPP WAP.

25.3.1 Hazardous Waste Determination

The materials in this waste group do not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The wastes were mixed with halogenated and non-halogenated solvents and are listed wastes. The

wastes may exhibit the characteristic of toxicity for chloroform, 1,1-dichloroethylene, and nitrobenzene. EPA HWNs applicable to some or all of the solidified organic waste group are presented by IDC in Table 25-6.

Table 25-6. Solidified Organic Waste Characterization.

IDC	Title	Proposed EPA HWNs
003	Organic Setups	D022, D029, D036, F001, F002, F003, and F005
700	OASIS Waste	D021, D022, D028-30, D032, D034, D036, D043, F001, F002, and F003
801	Solidified Organics	D021, D022, D028-30, D032, D034, D036, D043, F001, F002, and F003

25.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23).

Solids sample and headspace gas data were complied by the 3,100 m^3 Project at the INEEL for this waste group to be used to characterize the waste in two waste streams; Organic Setups (IDC 003) and Solidified Organic wastes (IDCs 700 and 801).

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquids but may contain some free liquids [P015]. Absorbents were added to wastes having the potential of generating free liquids (i.e., dewatering of wastes) [P015, P024]. Visual examination identified drums of organic setup waste (IDC 003) containing free liquid. However, analyses of the liquids did not identify any ignitable compounds [P015]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change [P012, P016, P024]. The materials are not compressed gas, nor do the wastes contain compressed gases [P012, P013, P015, P016, P022, P024]. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquids but may contain some free liquids [P015]. Absorbents were added to wastes having the potential of generating free liquids (i.e., dewatering of wastes) [P015, P024]. Visual examination identified drums of organic setup waste (IDC 003) containing free liquid. However, analyses indicated that the pH of the liquids did not meet the definition of corrosivity [P015]. The materials in this waste group are therefore not characteristic for corrosivity (D002).

Reactivity: The materials in this waste group do not meet the definition of reactivity as defined in 40 CFR 261.23. The materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173, nor do the drums contain any explosives [P012, P013, P015, P016, P022, P024]. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not characteristic for reactivity (D003).

Toxicity: The materials in this waste group meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and non-halogenated solvents, pesticides, herbicides, and other toxic compounds.

There is no documentation indicating the presence or use of metals in the areas or processes generating either the organic set ups or the solidified organic wastes. This conclusion is supported by the total metals data for the wastes. Solid samples of the organic setups waste (IDC 003) and solidified organics waste (IDCs 700, and 801) were collected and analyzed between 1996 and 1999. The resulting data from these samples were reviewed during the 3,100 m^3 Project for inclusion in the characterization of the two waste streams for shipment to WIPP. Summaries of the total metals data are presented in Tables 25-7 and 25-8 for the IDC 003 and IDCs 700 and 801 wastes, respectively [U098, U099]. The wastes included in this waste group should not exhibit the characteristic of toxicity due to metals (D004-D011).

Table 25-7. Organic Set Ups (IDC 003) Waste Stream Preliminary Solids Data — Metals [U098].

Analyte	Total Number of Samples	Number of Samples above MDL	SD (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Arsenic	41	9	0.934	1.85	4.20	2.05	100	N/A
Barium	41	41	72.2	75.1	350	89.8	2,000	N/A
Cadmium	41	40	2.17	2.76	9.90	3.21	20	N/A
Chromium	41	38	32.5	22.7	210	29.4	100	N/A
Lead	41	14	30.3	12.5	180	18.9	100	N/A
Mercury	41	3	2.64	0.501	17.0	1.28	4	N/A
Selenium	41	9	1.27	1.38	8.30	1.65	20	N/A
Silver	41	7	4.32	1.18	28.0	2.15	100	N/A

a. RTL – Regulatory Threshold Limit

Table 25-8. Solidified Organics (IDCs 700 & 801) Waste Stream Preliminary Solids Data—Metals [U099].

Analyte	Total Number of Samples	Number of Samples above MDL	SD (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Arsenic	10	0	0.394	1.25	1.55	1.42	100	N/A
Barium	10	10	11.1	14.3	40.0	19.2	2,000	N/A
Cadmium	10	5	1.79	0.728	5.80	1.51	20	N/A
Chromium	10	9	0.429	1.36	1.80	1.55	100	N/A
Lead	10	3	0.548	1.75	2.30	1.99	100	N/A
Mercury	10	0	0.052	0.090	0.155	0.113	4	N/A
Selenium	10	0	0.044	0.895	0.950	0.914	20	N/A
Silver	10	8	0.272	0.639	0.960	0.758	100	N/A

a. RTL – Regulatory Threshold Limit

Historical AK indicated that the organic setups waste (IDC 003) included in this waste group may exhibit the toxicity characteristic for the organic compounds; chloroform, 1,1-dichloroethylene, and nitrobenzene. Nitrobenzene was a contaminant in non-routine laboratory waste, and small amounts of this compound were introduced into five or fewer drums of organic setups (IDC 003). There is no documentation specifying the individual drums or time frame; however, the source of this information was from a document published in October 1982 [P024, P052]. 1,1-Dichloroethylene was detected in one of 42 headspace gas samples collected from containers of organic setups (IDC 003) waste. This single detection was at a high enough concentration to cause the UCL_{90} to exceed the PRQL for that compound [P033]. There is no indication that nitrobenzene was ever used as an F004 solvent at Rocky Flats. Solid sample data compiled during the 3,100 m^3 Project, confirmed the presence of toxicity characteristic organic contaminants in the organic setups waste (IDC 003) as shown in Table 25-9. Toxicity characteristic contaminants detected in the solids samples with concentrations resulting in UCL_{90}s greater than their PRQL are: 1,1-dichloroethylene, 1,2-dichloroethane, chloroform, and hexachloroethane. The determination that the toxicity characteristic HWNs appropriate for the IDC 003 waste; D029, D028, D022, D034, and D036, was based on AK and this data (Table 25-9) [U098].

Historical AK indicated that the solidified organics wastes (IDCs 700, 801) also may exhibit the toxicity characteristic for 1,1-dichloroethylene, chloroform, and nitrobenzene (D029, D022, and D036, respectively). The presence of these toxicity characteristic contaminants was confirmed by the preliminary solids data (Table 25-10) compiled for the 3,100 m^3 Project [U099]. The presence of 1,1-dichloroethylene in the solidified organics waste (IDCs 700 and 801) was confirmed by the statistical evaluation of 3,100 m^3 Project headspace gas analyses (Table 25-11). Additional toxicity characteristic organic compounds detected in the solids data resulting in UCL_{90}s greater than their PRQL were vinyl chloride, 2,4-dinitrotoluene, hexachlorobenzene, and hexachloroethane (D043, D030, D032, and D034, respectively).

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating solidified organic wastes. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Table 25-9. Organic Set Ups (IDC 003) Waste Stream Preliminary Solids Data—Organics [U098].

	Analyte	Total Number of Samples	Number of Samples above MDL	SD (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Volatiles	1,1-Dichloroethylene	40	37	229	123	950	170	14	D029[c]
	1,2-Dichloroethane	40	15	69.5	22.6	335	37.4	10	D028[d]
	Benzene	39	2	1.56	1.64	5.00	2.41	10	N/A
	Carbon tetrachloride	40	40	13E4	1E5	45E4	13e4	10	F001/F002[c]
	Chlorobenzene	39	0	1.59	1.57	5.00	B	2,000	N/A
	Chloroform	40	37	1,268	530	7,700	791	120	D022[c]
	Methyl ethyl ketone	41	13	42.5	10.3	274	19.3	4,000	N/A
	Pyridine	41	8	114	21.5	735	46.8	100	N/A
	Tetrachloroethylene	39	35	83.0	33.1	485	50.4	10	F001/F002[c]
	Trichloroethylene	40	32	30.3	13.7	160	20.0	10	F001/F002[c]
	Vinyl chloride	28	9	1.78	1.35	8.80	1.82	4	N/A

Table 25-9. (continued).

	Analyte	Total Number of Samples	Number of Samples above MDL	SD (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Semi-Volatiles	1,4-Dichlorobenzene	36	0	4.19	7.37	12.0	B	150	N/A
	2,4-Dinitrotoluene	8	0	0.494	0.454	1.05	B	2.6	N/A
	Cresols	36	3	8.94	8.75	49.0	11.6	4,000	N/A
	Hexachlorobenzene	8	0	0.564	0.489	1.15	B	2.6	N/A
	Hexachloroethane	39	28	1589	344	1E4	679	60	D034[d]
	Nitrobenzene	36	0	4.90	8.27	14.0	B	40	D036[b]
	Pentachlorophenol	36	0	6.71	11.6	19.0	B	2,000	N/A

a. Regulatory Threshold Limit.

b. HWN assigned based on AK only.

c. HWN assigned based on AK and solid sample results.

d. HWN assigned based on solid sample results only.

Table 25-10. Solidified Organics (IDCs 700 & 801) Waste Stream Preliminary Solids Data—Organics [U099].

	Analyte	Total Number of Samples	Number of Samples above MDL	SD (mg/kg)	Mean (mg/kg)	Maximum (mg/kg)	UCL_{90} (mg/kg)	RTL[a] (mg/kg)	EPA HWNs
Volatiles	1,1-Dichloroethylene	10	4	34.9	29.9	98.0	45.2	14	D029[c]
	1,2-Dichloroethane	10	2	3.47	7.32	12.5	8.83	10	N/A
	Benzene	10	0	3.23	5.61	10.8	7.03	10	N/A
	Carbon tetrachloride	10	9	54,000	44,440	150,000	69,000	10	F001/F002[c]
	Chlorobenzene	10	0	12.7	10.0	45.3	15.6	2,000	N/A
	Chloroform	10	9	93.3	112	263	153	120	D022[c]
	Methyl ethyl ketone	10	1	5.96	19.6	32.5	22.2	4,000	N/A
	Pyridine	10	1	6.56	17.9	33.5	20.7	100	N/A
	Tetrachloroethylene	10	6	442	198	1,100	464	10	F001/F002[c]
	Trichloroethylene	10	2	1.89	4.93	7.60	7.3	10	F001/F002[b]
	Vinyl chloride	10	0	3.23	5.61	10.8	7.03	4	D043[d]
Semi-Volatiles	1,4-Dichlorobenzene	10	0	42.9	94.1	150	113	150	
	2,4-Dinitrotoluene	10	0	41.1	86.1	130	104	2.6	D030[d]
	Cresols	10	0	40.5	85.8	138	104	4,000	
	Hexachlorobenzene	10	0	41.0	90.1	150	108	2.6	D032[d]
	Hexachloroethane	10	0	43.5	98.1	170	117	60	D034[d]
	Nitrobenzene	10	0	41.0	91.6	145	109	40	D036[c]
	Pentachlorophenol	10	0	47.4	102	195	122	2,000	

a. Regulatory Threshold Limit.

b. HWN assigned based on AK only.

c. HWN assigned based on AK and solid sample results.

d. HWN assigned based on solid sample results only.

Table 25-11. Statistical Evaluation of all HSG Data Collected During the 3,100 m^3 Project for Solidified Organics Waste (IDC 700 and IDC 801).

Analyte	Total Number of samples	Number of samples above MDL[a]	Mean (ppmv)	Standard deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	20	20	9,603	13,000	50,000	14,000	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	5	0	2.69	2.29	5.00	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	14	14	4,357	6,587	16,000	6,734	10	F001/F002[c]
1,1-Dichloroethane	4	3	71.6	103	220	184	10	N/A
1,1-Dichloroethylene	7	7	254	209	530	368	10	D029[d]
1,2,4-Trimethylbenzene	3	1	1.82	2.07	4.15	b	10	N/A
1,2-Dichloroethane	3	1	11.3	16.3	30.0	b	10	N/A
1,3,5-Trimethylbenzene	3	1	1.71	2.01	3.95	b	10	N/A
Acetone	12	5	290	408	990	571	100	F003[c]
Benzene	3	1	2.16	2.24	4.70	b	10	N/A
Bromoform	8	0	2.91	1.98	5.00	b	10	N/A
Butanol	8	0	29.5	20.0	50.0	b	100	N/A
Carbon tetrachloride	20	20	14,000	13,000	46,000	18,000	10	F001/F002[d]
Chlorobenzene	3	0	1.55	1.88	3.65	b	10	N/A
Chloroform	11	11	102	199	690	184	10	D022[d]
Cis-1,2-dichloroethylene	3	1	2.49	2.21	4.25	b	10	N/A
Cyclohexane	6	1	31.8	72.6	180	b	10	N/A
Ethyl benzene	5	0	2.70	2.28	5.00	b	10	N/A
Ethyl ether	2	0	1.62	2.23	3.20	b	10	N/A
Methanol	20	12	110	102	290	150	100	F003[c]
Methyl ethyl ketone	9	1	11.8	7.41	20.0	b	100	N/A
Methyl isobutyl ketone	11	0	14.7	14.9	47.0	b	100	N/A
Methylene chloride	3	2	31.3	52.6	92.0	146	10	F001/F002[c]
Tetrachloroethylene	3	1	1.78	2.02	4.05	b	10	F001/F002[e]
Toluene	3	1	2.27	2.42	5.00	b	10	N/A
Trichloroethylene	3	2	3.40	2.97	5.70	9.86	10	F001/F002[e]
m&p-Xylene	2	0	1.09	1.50	2.15	b	10	F003[e]
o-Xylene	3	1	1.66	2.01	3.90	b	10	F003[e]

a. When a measurement is reported as below detection, one-half the analysis method detection limit (MDL) is used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. Assignment of HWN based on HSG and AK.

d. Assignment of HWN based on AK, HSG, and solid sample data.

e. Assignment of HWN based on AK only.

Carbon tetrachloride, tetrachloroethylene, and trichloroethylene, which were used for cleaning and degreasing, are present in the organic setups and solidified organic wastes as confirmed by the solid sample data for both waste streams. These compounds were used as solvents and are specifically addressed in the treatment standards for listed hazardous wastes [P080]. Because the organic set ups and solidified organic wastes are characterized as listed hazardous wastes due to spent solvent contamination, the wastes do not carry the toxicity characteristic HWNs for the F-listed organic compounds.

Chloroform was used in laboratory analysis and as a solvent for joining plastics [P053]. Only 3 drums of solidified organics (IDC 801) were sampled as reported in data results collected previous to the 3,100 m^3 Project. Of these three samples, one contained chloroform in the headspace [P033]. Although there is no AK documentation indicating that chloroform was introduced into the organic solidification process the confirmatory solid sample analyses (Tables 25-9 and 25-10) for both wastes, indicate its presence in concentrations resulting in UCL_{90}s greater than its PRQL. During the 3,100 m^3 Project chloroform also was detected in HSG samples collected from containers of IDC 700 and IDC 801 wastes in concentrations resulting in a UCL_{90} greater than the HSG PRQL (Table 25-11). The EPA HWN D022 was assigned to this waste group.

25.3.1.2 Listed Hazardous Waste. The materials in this waste group are listed hazardous wastes because they were mixed with a waste listed in 40 CFR 261, Subpart D as hazardous waste from non-specific sources (40 CFR 261.31). The materials are not, or were not mixed with, hazardous wastes from specific sources (40 CFR 261.32), or discarded commercial chemical products, off-specification species, container residues, or spill residues thereof (40 CFR 261.33).

Carbon tetrachloride, 1,1,2-trichloro-1,2,2-trifluoroethane, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene spent solvents were mixed with the organic setups and solidified organic wastes. Analytical data from headspace gas samples collected prior to and during the 3,100 m^3 Project confirmed the presence of the F001/F002 solvents for both wastes (Tables 25-11 and 25-12). Therefore, EPA HWNs F001 and F002 were appropriately assigned to the wastes.

Methylene chloride was present in paints and paint strippers and was used in several laboratories and process areas for sample preparation and analysis [P053]. There is no documentation indicating that methylene chloride was mixed with solidified organic waste. However, methylene chloride was detected in headspace gas samples of organic setups (IDC 003) collected prior to the 3,100 m^3 Project [P033]. Methylene chloride also was detected in headspace gas samples collected from containers of solidified organics (IDCs 700 and 801) during the 3,100 m^3 Project (Table 25-12). Methylene chloride is an F001/F002-listed solvent and was included as one of the hazardous waste constituents for both wastes.

Solvents such as methanol and xylene were used in laboratory analysis [P107]. Documentation indicates one drum (IDRF074318283) of solidified organics (IDC 801) containing 7.6 liters of solidified xylene waste. There is no documentation indicating that xylene (spent solvent) was mixed with organic setups (IDC 003). However, xylene was detected in headspace gas samples from containers of organic setups (IDC 003) collected prior to the 3,100 m^3 Project [P033]. Analytical results from IDC 003 headspace gas samples collected during the 3,100 m^3 Project were inconclusive due to the limited number of samples collected. Although F003-listed solvents are listed solely due to ignitability, and the organic setups waste does not exhibit that characteristic, these compounds may have been ignitable at the point of generation. Based on the mixture rule, the EPA HWN F003 was assigned to the organic set ups waste.

Table 25-12. Statistical Evaluation of HSG Data Collected During the 3,100 m^3 Project for Organic Setups (IDC 003).

Analyte	Total Number of Samples	Number of Samples above MDL[a]	Mean (ppmv)	Standard Deviation (ppmv)	Maximum (ppmv)	UCL_{90} (ppmv)	PRQL (ppmv)	EPA HWNs
1,1,1-Trichloroethane	3	3	23,000	37,000	66,000	64,000	10	F001/F002[c]
1,1,2,2-Tetrachloroethane	1	0	3.50	N/A	3.50	b	10	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	3	3	2,011	3,368	5,900	5,678	10	F001/F002[c]
1,1-Dichloroethane	1	0	1.80	N/A	1.80	b	10	N/A
1,1-Dichloroethylene	1	0	2.05	N/A	2.05	b	10	N/A
1,2,4-Trimethylbenzene	1	0	2.05	N/A	2.05	b	10	N/A
1,2-Dichloroethane	1	0	2.40	N/A	2.40	b	10	N/A
1,3,5-Trimethylbenzene	1	0	2.15	N/A	2.15	b	10	N/A
Acetone	1	0	3.10	N/A	3.10	b	100	N/A
Benzene	1	0	2.20	N/A	2.20	b	10	N/A
Bromoform	1	0	1.95	N/A	1.95	b	10	N/A
Butanol	1	0	9.50	N/A	9.50	b	100	N/A
Carbon Tetrachloride	3	3	13,000	14,000	29,000	29,000	10	F001/F002[c]
Chlorobenzene	1	0	2.05	N/A	2.05	b	10	N/A
Chloroform	1	1	110	N/A	110	b	10	N/A
Cis-1,2-Dichloroethylene	1	0	2.95	N/A	2.95	b	10	N/A
Cyclohexane	1	0	3.05	N/A	3.05	b	10	N/A
Ethyl Benzene	1	0	3.75	N/A	3.75	b	10	N/A
Ethyl Ether	1	0	3.10	N/A	3.10	b	10	N/A
Methanol	3	1	7.27	9.32	18.0	b	100	N/A
Methyl Ethyl Ketone	1	0	8.50	N/A	8.50	b	100	N/A
Methyl Isobutyl Ketone	2	0	15.3	17.2	27.5	b	100	N/A
Tetrachloroethylene	1	0	2.25	N/A	2.25	b	10	F001/F002[d]
Toluene	1	0	2.45	N/A	2.45	b	10	F005[d]
Trichloroethylene	1	0	1.60	N/A	1.60	b	10	F001/F002[d]
o-Xylene	1	0	3.75	N/A	3.75	b	10	F003[d]

a. When a measurement is reported as below detection, one-half the analysis method detection limit (MDL) is used. Note that the MDL for a given analyte may vary from sample to sample.

b. The mean and standard deviation presented are the mean and standard deviation of the method detection limits (after dividing by 2) since all measurements (or all but one) are below detection. Therefore, there are no degrees of freedom associated with the t statistic and the UCL_{90} cannot be calculated.

c. HWN assigned based on AK and headspace gas results.

d. HWN assigned based solely on AK.

There also is no documentation indicating that methanol was mixed with the solidified organic wastes, however methanol was detected in headspace gas samples collected from containers of solidified organic waste (IDC 801) prior to the 3,100 m^3 Project [P033] and F003 listed solvents, acetone and methanol, were detected in headspace gas samples collected from containers of solidified organics waste during the 3,100 m^3 Project (Table 25-12). Both of these compounds had calculated UCL_{90}s greater than

their PRQL. Although F003-listed solvents are listed solely due to ignitability, and the solidified organics wastes do not exhibit that characteristic, these compounds may have been ignitable at the point of generation. Based on the mixture rule, the EPA HWN F003 was assigned to the solidified organics wastes.

Organic setups (IDC 003) may contain trace concentrations of nitrobenzene [P024]. There is no indication that nitrobenzene was ever used as a solvent, nor is there documentation indicating the presence or use of any other F004-listed solvents in the areas or processes generating solidified organic waste. Therefore, this waste group is not an F004-listed hazardous waste.

There is documentation that a tritium/toluene mixture was twice added to organic setups (IDC 003) in the 1970s. The toluene is described as a constituent of scintillation cocktail [U043]. Scintillation cocktail, when spent, is considered solvent use. Varsol oil, which contains toluene, was mixed with solidified organic waste. However, Varsol oil contains less than a half of a percent toluene. Therefore, the EPA HWN F005 was assigned to the organic set ups waste (IDC 003).

Headspace analysis performed on samples of solidified organic waste obtained at INEEL prior to the 3,100 m^3 Project confirmed the presence of F-listed solvents. The detected F-listed compounds in which the UCL_{90} was above the PRQL were as follows [P033]:

- 1,1,1-trichloroethane
- 1,1,2-trichloro-1,2,2-trifluoroethane (IDC 003 only)
- carbon tetrachloride
- methylene chloride (IDC 003 only)
- tetrachloroethylene (IDC 003 only)
- trichloroethylene
- methanol (IDC 801 only)
- xylene (IDC 003 only)
- toluene (IDC 003 only)

The materials in this waste group are not hazardous waste from specific sources because they were not generated from any of the processes listed in 40 CFR 261.32. The materials in this waste group are not K-listed hazardous wastes.

The materials in this waste group are not discarded commercial chemical products, an off-specification species, container residues, or spill residues thereof (40 CFR 261.33). The materials in this waste group are therefore not P- or U-listed hazardous wastes.

25.3.1.3 Toxic Substances Control Act (TSCA) Waste. The materials in this waste group may be PCB-contaminated wastes as defined in 40 CFR 721.3. PCB wastes are subject to the TSCA and regulations (40 CFR Part 761) implemented by the U.S. EPA. The WIPP WAP requires PCB sampling and analysis for purposes of AK verification for wastes with process feeds indicating the possible presence of PCB-containing oils. Wastes with PCB concentrations equal to or greater than 50 parts per million are prohibited from disposal at the WIPP facility.

Organic setups (IDC 003) wastes were removed from consideration for the 3,100 m^3 Project based on PCB sampling and analysis data. PCB data for all IDC 003 solid samples collected from 1979 through 1986 had a UCL_{90} exceeding the action level of 50 ppm [C207]. Additional sampling and PCB analysis may be necessary to properly characterize this waste for shipment to the WIPP facility.

Mineral oils processed as part of the organic set ups (IDC 003) waste were identified in late 1984 found to contain PCBs. Therefore, IDC 003 waste generated prior to this discovery is assumed to be PCB waste. The PCB contaminated feed wastes were isolated at that time and appropriately managed at Rocky Flats after that date. PCB data associated with a total population of approximately 450 drums generated

from December 1984 through 1986 and later were assessed statistically using the approach required by the WIPP WAP. The aroclor concentrations were below the method detection levels for all drums. The mean and UCL_{90}s for total PCBs were based on the summation of 1/2 the individual aroclor MDLs and an action level of 50 ppm. The statistical parameters generated from this assessment were [C207]:

- Number of samples 11
- Mean 7.63 ppm
- Standard Deviation 2.61 ppm
- UCL_{90} 13.3 ppm.

Containers of the solidified organics (IDCs 700 and 801) wastes were generated from the same feed as the IDC 003 waste, but after the PCB contaminated oil was identified and management of the oil changed. The IDC 700 and 801 drums in storage at the INEEL were generated from February 1986 to September 1988 and do not contain the PCB contaminated mineral oils identified. The IDC 003 data from the post 1984 discovery of the PCB oil may be applicable not only to IDC 003 containers generated after the that date but also to the solidified organics wastes [C207].

25.3.2 Radionuclides

Historical assay values for waste drums were obtained from radiochemical analyses of batch treatments or analysis results of individual bottles and drums that were received for processing. Average values were usually assigned to waste drums [P016, P024]. Documented assay results and treatment log book descriptions for solidified organic waste drums indicate the presence of plutonium, americium-241, tritium, uranium-235, and uranium-238 [P016, P024, P033, U040]. The processes that generated waste oils and solvents contaminated with these and potentially other radioisotopes is presented below. In addition, Table 25-13 summarizes matrix and other physical parameters that could affect radioassay.

Table 25-13. Waste Matrix Evaluation.

Parameter	Results of Evaluation
Radionuclide Form, Particle Size, and Distribution	Because the oils and solvents originated from metal fabrication operations, the radionuclides will likely be in the form of metals and oxides. The radioactive contaminants should be evenly distributed throughout the waste because IDC 003 was blended in a continuous mixer, and IDC 801 was agitated for a set period of time to allow for proper mixing [P002, P024].
Hydrogen Content	IDC 003 contains no water and approximately 30 gallons of organic liquid [P024]. IDC 801 contains about 15 wt% water and 35 wt% organic liquids [P002, U010].
Other Interfering Waste Contaminants	Interfering waste contaminants may include aluminum, beryllium, and stainless steel (chromium) that were machined in Building 777 [P079]. Beryllium will also be present from degreasing solvents generated in Building 444 [P024].
Physical Matrix Parameters	IDC 003 is a paste-like material, and IDC 801 is a solid monolith. The waste contaminants should be evenly distributed throughout the waste [P002, P024].

Transuranic waste oils and solvents were generated primarily in Buildings 707 and 777. Radionuclide contamination in waste from Building 707 will primarily consist of weapons-grade plutonium from foundry, casting, and final assembly operations [P052, P053]. Building 777 performed

disassembly of site-return parts and fabrication operations, including machining, briquetting, assembly, and production support processes [C184, P052, P079]. Waste from fabrication operations will be contaminated with weapons-grade plutonium and enriched uranium. Wastes generated by disassembly operations will be contaminated with site-return plutonium (higher americium-241 decay product) and enriched uranium [C184, P079]. Tritium may also be present from disassembly operations [P053]. The isotopic compositions of weapons-grade plutonium and enriched uranium are presented in Section 3.0.

Waste oils or solvents contaminated with depleted uranium were generated from casting, machining, and other metal working processes in Buildings 444, 447, 865, and 883 [P053]. Although these oils have been segregated from transuranic oils since 1985, there is documentation that indicates waste oil 238 (assumed to be uranium-238) from Building 771 was introduced into solidified organic waste in 1986 [U040]. Therefore, there is a potential for depleted uranium contamination in all solidified organic waste. The isotopic composition of depleted uranium is presented in Section 3.

Research and development operations also generated waste oils and solvents from casting, machining, and cleaning [P002, P061, P079]. In addition to supporting production operations, these R&D laboratories used several other radioisotopes. Processing of most of the "special" radioisotopes, such as curium-244, thorium-232, and uranium-236, was performed until the early- to mid-1970s. [C154, P164, P189, P194]. Americium-241 and neptunium-237 were processed until 1985 or 1986, and uranium-233 was handled until about 1982 [C154, P164, P198, P200]. A more detailed description of plutonium and uranium production operations and R&D operations is provided in Section 3.

The Size Reduction Vault in Building 776 conducted repackaging operations (container prefixes 0019 and 0025) [C175, C184, P078, U059]. The package date on these drums is the date in which the waste was repackaged and was originally generated some time prior to this date. Therefore, it is assumed that the repacked containers could potentially contain any of the above radioisotopes. IDCs 700 and 801 will not contain uranium-233 because this waste was not generated until about 1986.

25.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix. Activity values of radionuclides are quantified and reported in accordance with Appendix A of the CH-WAC, DOE/WIPP-02-3122, Sections 3.1.4, 3.3.1, and 3.7.1. INEEL based most alpha-emitting isotope activities on NDA measurements and not AK. The NDA radioassay systems used at the INEEL measured americium-241; plutonium-238, -239, -240, -241; uranium-233, -235, and -238. Default values for mass isotopic ratios for the plutonium isotopes were obtained from 2,556 high resolution gamma spectrometric measurements of RFP wastes [P227]. Decision criteria for using default versus measured values were specific to the assay system. Determination of plutonium-242 used its mass fraction in weapons grade plutonium, based on AK of RFP wastes. Each drum assay included high resolution gamma spectrometry and the data from these measurements were reviewed to confirm the applicability of the default mass isotopic values [P240, P280]. Use of mass isotopic ratios for the plutonium isotopes, other than the default values, required a documented disposition as an anomaly. Default isotopic values were used only for the plutonium isotopes. Mass values for americium-241, uranium-233, -235, and -238 were based on the individual gamma spectrometric measurements. The uranium-234 activities were calculated based on ratios with detected uranium isotopes.

Fission products, including cesium-137 and strontium-90, were not expected components of any of the RFP TRU waste streams per AK. The absence of cesium-137 was verified during radioassay using the 661 keV line as described in the INEEL EDF-840 [P240]. Strontium-90, because its presence was predicated on the presence of cesium-137 (as a fission product), has never been reported for any of the RFP wastes analyzed to date [P322].

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 25-14. The building or area of generation for containers in the INEEL inventory is identified by the container prefix contained in the drum identification number in this table. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The generation dates, process descriptions, and potential radionuclide contaminants are identified for each population.

Table 25-14. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
003	774	0743	Liquid Waste Treatment	1/3/73 - 12/17/82	WG Pu, EU, ^{241}Am, DU, ^{233}U
003	774	0743	Liquid Waste Treatment	1/6/83 - 3/12/86	WG Pu, EU, ^{241}Am, DU
003	774	0744	Liquid Waste Treatment	12/18/84 - 12/18/84	WG Pu, EU, ^{241}Am, DU
003	774	7412	Liquid Waste Treatment	10/10/80	WG Pu, EU, ^{241}Am, DU, ^{233}U
003	776	0019	Size Reduction	1/8/85 - 5/31/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
003	776	0025	Drum Repack	5/16/84 - 8/26/85	WG Pu, EU, ^{241}Am, DU, ^{233}U
700	774	0743	Liquid Waste Treatment	3/12/86 - 5/13/86	WG Pu, EU, ^{241}Am, DU
801	371	0011	Note a	5/1/86	WG Pu, EU, ^{241}Am, DU
801	774	0743	Liquid Waste Treatment	2/12/86 - 9/19/88	WG Pu, EU, ^{241}Am, DU
801	776	0019	Size Reduction	8/24/87 - 9/8/87	WG Pu, EU, ^{241}Am, DU, ^{233}U
801	776	0025	Drum Repack	9/1/87 - 9/15/88	WG Pu, EU, ^{241}Am, DU, ^{233}U

a. This prefix was assigned to an MBA in Building 371 that is not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 371 unless the IDC further defines what radionuclides are in the waste.

WP = weapons grade DU = depleted uranium EU = enriched uranium

25.3.2.2 Confirmatory Radioassay Data. During the 3,100 m^3 Project all candidate waste containers were assayed for radionuclide content at the RWMC. Three radioassay systems were in operation during this time period. The PAN, coupled with a gamma spectrometry system, was the primary system in use. Two additional absolute gamma systems were also used, the SGRS and the WAGS. Radioassay data collected in the 3,100 m^3 Project for the Solidified Organic (IDCs 700 and 801) and Organic Setups (IDC 003) Waste streams are summarized in Tables 25-15 through 25-18. The overall yield for this radioassay data is a compilation of the data from all three radioassay systems at the RWMC. Table 25-15 and Table 25-16 present the yield and the radionuclide and related radioassay information for the Organic Setups waste (IDC 003), respectively. Table 25-17 and Table 25-18 present the yield and the radionuclide and related radioassay information for the Solidified Organics waste (IDCs 700 and 801), respectively. The data for the individual radioassay systems information for this waste stream are contained in EDF-3374, "Radioassay Data Collected During 3100 Cubic Meter Project" [P322].

Table 25-15. Overall Radioassay Yield for Organic Setups Waste (IDC 003) [P322].

Total number of:	Number	Percentage of Total
Containers	152	
"*WIPPOK*" containers	74	49%
"*Treatment*" containers	2	1%
"*Deficient / Permanently Rejected*" containers	76	50%

Table 25-16. Radionuclide and Related Quantities for Organic Setups Waste (IDC 003)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value[c]	High Value	
Plutonium Equivalent Curies (Ci)	1.263E-01	1.562E-01	-9.391E-03	1.146E+00	152
TRU Activity (Ci)	1.266E-01	1.565E-01	-9.411E-03	1.146E+00	152
TRU Activity Concentration (nCi/g)	7.751E+02	9.696E+02	-5.440E+01	6.287E+03	152
Thermal Power (W)	3.985E-03	4.992E-03	-2.951E-04	3.778E-02	152
Thermal Power Density (W/ft^3)	5.422E-04	6.792E-04	-4.015E-05	5.140E-03	152
Plutonium Fissile Gram Equivalent (g)	1.427E+00	1.582E+00	-1.092E-01	7.066E+00	152
Americium-241 (g)	5.367E-03	2.128E-02	-2.458E-04	2.616E-01	152
Plutonium-238 (g)	1.776E-04	2.091E-04	-1.212E-05	1.123E-03	152
Plutonium-239 (g)	1.361E+00	1.510E+00	-1.086E-01	7.032E+00	152
Plutonium-240 (g)	8.367E-02	9.308E-02	-6.603E-03	4.394E-01	152
Plutonium-241 (g)	2.317E-03	2.549E-03	-1.997E-04	1.234E-02	152
Plutonium-242 (g)	5.202E-04	5.845E-04	-4.963E-05	3.066E-03	152
Uranium-233 (g)	3.430E-02	2.620E-02	3.430E-02	3.430E-02	1
Uranium-234 (g)	2.585E-04	8.672E-04	-4.622E-06	5.926E-03	48
Uranium-235 (g)	1.341E-01	3.967E-01	-3.477E-02	3.023E+00	66
Uranium-238 (g)	7.027E+01	1.728E+02	2.988E-02	8.058E+02	21

a. The absence of ^{137}Cs is verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

c. The negative low values are from the "Deficient / Permanently Rejected" category. These assays are outside the systems capabilities. Since this report is merely summarizing the data stored in TRIPS the values were left in for completeness.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

Table 25-17. Overall Radioassay Yield for Solidified Organics Waste (IDCs 700 and 801) [P322].

Total number of:	Number	Percentage of Total
Distinct containers	65	
"*WIPPOK*" containers	40	62%
"*Treatment*" containers	1	2%
"*Deficient / Permanently Rejected*" containers	24	37%

Table 25-18. Radionuclide and Related Quantities for Solidified Organics Waste (IDCs 700 and 801)[a] [P322].

Quantity	Average	Standard Deviation[b]	Range		Events
			Low Value	High Value	
Plutonium Equivalent Curies (Ci)	4.346E-01	9.705E-01	1.970E-02	6.131E+00	65
TRU Activity (Ci)	4.355E-01	9.725E-01	1.974E-02	6.144E+00	65
TRU Activity Concentration (nCi/g)	2.133E+03	4.926E+03	8.900E+01	3.195E+04	65
Thermal Power (W)	1.366E-02	3.049E-02	6.191E-04	1.926E-01	65
Thermal Power Density (W/ft^3)	1.859E-03	4.148E-03	8.424E-05	2.620E-02	65
Plutonium Fissile Gram Equivalent (g)	5.179E+00	1.190E+01	2.284E-01	7.332E+01	65
Americium-241 (g)	1.178E-02	2.436E-02	5.282E-04	1.485E-01	65
Plutonium-238 (g)	6.141E-04	1.270E-03	2.536E-05	7.972E-03	65
Plutonium-239 (g)	4.989E+00	1.127E+01	2.272E-01	7.141E+01	65
Plutonium-240 (g)	3.054E-01	6.854E-01	1.382E-02	4.343E+00	65
Plutonium-241 (g)	8.760E-03	2.069E-02	4.178E-04	1.313E-01	65
Plutonium-242 (g)	2.053E-03	5.146E-03	1.039E-04	3.265E-02	65
Uranium-233 (g)	2.120E-02	3.482E-02	2.120E-02	2.120E-02	1
Uranium-234 (g)	3.390E-04	1.035E-03	2.269E-05	5.892E-03	33
Uranium-235 (g)	2.728E-01	8.880E-01	2.110E-02	5.481E+00	39
Uranium-238 (g)	4.411E+01	4.642E+01	4.437E+00	9.516E+01	3

a. The absence of ^{137}Cs is verified during radioassay using the 661 keV line as described in the INEEL EDF-840. This also verifies the absence of ^{90}Sr whose presence is predicated on the presence of ^{137}Cs, a fission product measurable by gamma spectrometry.

b. The standard deviation is the statistical variation of the population for which measurements were available.

g = gram(s); Ci = curie; nCi = nanocuries; W/ft^3 = watts per cubic foot

25.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

There are two documented cases of complexing agents included in the solidified organic waste. In 1983, 54 liters of tributyl phosphate were processed into a drum or organic setup waste (IDC 003) [U040]. In 1988, 7.6 liters of a xylene and dihexyl-n,n-diethylcarbamoyl methylphosphonate (DHDECMP) mixture were included in a drum (IDRF074318283) of solidified organics (IDC 801) [C027, C032, C086, U040].

25.3.4 Real Time Radioscopy

RTR examinations during the 3,100 m^3 Project allowed confirmation of physical form and the absence of prohibited items. For the organic setups waste stream (INW309.001) (IDC 003), the yield of successful RTR examinations was approximately 89% [P323]. Conversely, approximately 11% of the containers were dispositioned as *Treatment*. The reason for the *Treatment* disposition was presence of excess free liquids. All other reasons were less than 1% [P323].

The 3,100 m^3 Project RTR examinations for the solidified organics waste stream (INW164.001) (IDCs 700 and 801), had a yield of successful RTR examinations of approximately 98% [P323]. Conversely, approximately 2% of the containers were dispositioned as *Treatment*. The reason for the *Treatment* disposition was that the layers of confinement were exceeded for the assigned shipping category [P323].

The RTR technique was verified to be acceptable for characterization of this waste stream by VE based on a miscertification rate that met the requirements of the program [P321].

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26. 900–SERIES WASTE

This waste group includes plastic, paper, wood, metal, glass, concrete, and asphalt wastes generated in Buildings 771 and 774 and the 904 Pad. Historic IDC descriptions and dates of generation for the INEEL accessible storage inventory are presented by IDC in Table 26-1 [U092].

Table 26-1. 900–Series Waste in the Accessible Storage Inventory.

IDC	Title	Dates of Generation
900	LSA Plastics, Paper, etc. [P024] Plastic, Paper, etc. [P012]	December 1972–May 1973
950	LSA Metal, Glass, etc. [P024]	December 1972
960	Concrete, Asphalt, etc. [P024]	December 1972–January 1973
970	Wood [P024]	January 1973

***Item Description Code 900, Plastic, Paper, etc.*:** This waste consists primarily of combustible wastes such as plastics, paper, wipes, empty polyethylene bottles, booties, filter paper, and surgical gloves. The waste was generated outside of glovebox lines, primarily in Building 774 [P024, U092, U059]. A few of the drums are contaminated with depleted uranium and originated from a non-plutonium area. The waste may be dry or damp. Up to 15 pounds of Portland cement was added to drums containing damp waste. Limited amounts of non-combustible waste may also be included. IDC 900 was replaced by IDC 330, dry combustibles, in 1974 [P024].

***Item Description Code 950, Metal, Glass, etc.*:** This waste consists primarily of non-combustible wastes such as electrical conduit, water and steam pipes, tools, control panels, electronic instrumentation, light bulbs, windows, office equipment, lead shielding, and structural metal [P024]. The waste was generated primarily outside of glovebox lines in Building 774 [P024, U092, U059]. A few drums of this waste may be non-plutonium contaminated. The waste may also include some combustible wastes. Wastes generated inside the glovebox lines in Building 774 may also be included. IDC 950 has not been used since 1974 [P024]. Metal and glass wastes have since been segregated.

***Item Description Code 960, Concrete, Asphalt, etc.*:** This waste consists primarily of concrete and asphalt, but may also include limited amounts of dirt and combustible wastes [P024]. The wastes were generated in Buildings 771 and 774 and the 904 Pad [U092, U059]. IDC 960 was replaced in 1973 by IDC 374; blacktop, concrete, dirt, and sand.

***Item Description Code 970, Wood*:** This waste consists of lumber, plywood sheeting, filter frames, and ladders. Combustible wastes such as plastic sheeting and wipes, and non-combustible wastes including nails and sheetrock may also be present in the waste [P024]. The wastes were generated in Building 771 and the 904 Pad [U092, U059]. IDC 970 was discontinued in 1978, and is now included in IDC 330, dry combustibles [P024].

26.1 Waste Generation

The entire inventory of paper, plastic, glass, and metal wastes (IDCs 900 and 950) and a portion of the concrete and asphalt waste (IDC 960), was generated by liquid waste treatment operations in Building 774. Wood waste (IDC 970) and the remainder of the concrete and asphalt wastes (IDC 960) were generated by aqueous recovery operations in Building 771 and from the 904 Pad [U092, U059].

26.1.1 Paper, Plastic, Etc.

Paper and plastic wastes (IDC 900) were primarily nonline-generated combustibles from routine liquid waste treatment operations in Building 774 [P024, U092, U059]. When Building 774 was built in 1952, its primary purpose was for the treatment of radioactive aqueous waste from Building 771. Radionuclides were removed by precipitation, and the resulting slurry was filtered. The solids removed from the filters were combined with cement or another solidifying agent. The aqueous waste from this first stage went through a second stage which was essentially the same process [P053]. These processes used sodium hydroxide, ferric sulfate, magnesium sulfate, and calcium chloride [P109].

Around 1965, an evaporator was installed in Building 774 to treat liquids from the second stage treatment and from the solar ponds. The concentrate from the evaporator was dried which resulted in a salt waste. The evaporator was taken out in 1979, and the liquids from the second stage treatment and solar ponds have since been transferred to Building 374 [P053]. A more detailed description of wastes treated by these processes is presented in Section 23.0, Solidified Aqueous Sludge Building 774.

Liquid wastes from laboratory operations throughout Rocky Flats that were not compatible with the primary aqueous treatment system were treated separately from other liquid wastes. These wastes, including complexing agents, strong acids, or strong bases, were treated by mixing with cement and water to form a solid monolith. Prior to treatment, the acids were neutralized with sodium hydroxide [P070]. Section 24.0, Solidified Laboratory Waste, contains more detailed information on the wastes treated by this process.

Building 774 also processes organic liquid wastes. Plutonium-contaminated oil and chlorinated-solvent mixtures were generated from plutonium machining. The spent organic liquid was filtered and then mixed with Microcel-E solidifying agent, a synthetic calcium silicate [P002, P053]. Wastes treated by this process are described in greater detail in Section 25.0, Solidified Organic Waste.

26.1.2 Metal, Glass, Etc.

Metal and glass wastes (IDC 950) were primarily nonline-generated noncombustibles from liquid waste treatment operations in Building 774 [U092, U059]. The wastes generated from liquid waste treatment were usually associated with maintenance activities.

Building 774 liquid waste treatment operations required various types of machinery, instruments, and other equipment. Parts from the equipment were routinely changed due to normal wear and tear [P052]. Another maintenance activity that generated metal waste was the strip-out of glovebox lines, process piping, tanks, and associated systems. Methylene chloride was sometimes used for paint removal during cleanup. Other solvents such as trichloroethylene or 1,1,1-trichloroethane may also have been used during strip-out activities for decontamination. Maintenance activities also generated glass wastes including glovebox windows and light bulbs [P035, P049, P053].

26.1.3 Concrete, Asphalt, Etc.

Concrete and asphalt wastes (IDC 960) are primarily nonline-generated wastes that originated from cleanup of spills, decontamination activities, and maintenance operations in Buildings 771, 774, and the 904 Pad. The waste may contain any chemicals or compounds that were used in these areas.

Asphalt waste was generated from the cleanup of a spill in Building 771. The source or composition of the spill could not be identified. Concrete pieces, chips, and fines were also generated in Building 771 from removal of concrete blocks used to support Nash pumps. Also in Building 771,

concrete walls were cut out for doorways. In Building 774, concrete pieces and fines were generated from the removal of reinforced concrete treatment tanks [P024]. Concrete and asphalt waste was also generated at the 904 Pad [U092, U059]. The 904 Pad was a waste storage area for containers generated at any area of the plant site.

Nitric acid, hydrochloric acid, potassium hydroxide, potassium fluoride, and hydrogen peroxide were the primary reagents used in Building 771 recovery operations. Carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloroethylene, and methylene chloride were the primary solvents used during plutonium operations. Common chemicals used for decontamination activities include 1,1,1-trichloroethane, trichloroethylene, and paint thinner (toluene and methyl ethyl ketone) for cleaning, and methylene chloride for paint removal [P023, P053].

Information regarding metal contaminants in asphalt and concrete waste is limited. The waste from Building 774 may be contaminated with sludge from liquid waste treatment operations. These sludges contain various toxic metals. Mercury was used in instruments such as barometers, thermometers, plant machinery, and mercury switches [P053]. Lead-based paint, which may have been used to paint concrete floors and walls, is another source of metal contamination.

26.1.4 Wood

Wood waste (IDC 970) was generated primarily in Building 771 from the removal of wood filter frames from absolute filters. Filters contaminated with plutonium above the EDL were manually shaken to remove loose particulate which was sent for recovery. Filter frames were usually below the EDL and were discarded [P024, P061].

Wood waste was also generated at the 904 Pad [U092, U059]. It is speculated that the wood may be used waste boxes that were cut up [P024]. However, the source of this waste was not verified.

26.2 Waste Packaging

The 900-series wastes may be single- or double-bagged in polyvinyl chloride or polyethylene, or placed directly into a lined 55-gallon drum. The individual packages within a drum may or may not be sealed with tape. Concrete and asphalt waste (IDC 960) may also be contained in Fibre-Paks. Up to 15 pounds of Portland cement may have been added to IDC 900 drums containing damp waste [P012, P015, P024].

Depending on waste packaging requirements at the time, several combinations of bags and liners were used to prepare 55-gallon drums for shipment. From 1970 to 1972, waste drums were lined with one or two polyethylene drum bags. Cardboard liners might have been used to line the inner drum bag. Use of 90-mil rigid polyethylene liners began in 1972. A rigid liner was placed in each drum and lined with one polyethylene round bottom drum liner or two polyethylene drum bags. A polyvinyl chloride O-ring bag and a polyethylene bag placed inside the rigid liner were used if the drum was attached to a glovebox. A fiberboard liner and discs may also have been used between the waste and the drum liners for puncture protection. When a drum was full, the drum liners were twisted and taped closed, the rigid liner lid was sealed on the rigid liner, and the drum lid and gasket were installed and secured with a lock-chime [P012, P015, P024].

Since approximately 1972, drums have been inspected for free liquids, proper packaging, and use of proper IDC. Rejected drums were returned to the generator for correction. After inspection, one to two quarts of absorbent material (Oil-Dri®) was placed on top of the outer, sealed polyethylene drum bag [P024].

Visual Examination of paper and plastic (IDC 900) drums identified a variety of items other than combustibles including metal shims, welding rods, steel pipe, nuts, bolts, an electric motor and cord, a flashlight, concrete chunks, brushes, and lumber. Visual examination of one drum of asphalt and concrete (IDC 960) revealed only cinder blocks. Drums of wood (IDC 970) from Building 771 contained only filter frames [P015]. Visual Examination records were not identified for drums of IDC 950.

26.3 Waste Characterization

The 900-series wastes are characterized based on knowledge of the material, knowledge of the processes generating the waste, general chemical usage at Rocky Flats, and headspace gas analysis. This section provides a RCRA hazardous waste determination for 900-series wastes as well as radionuclide contaminants and potential complexing agents contained in the waste. This waste is at least 50% (by volume) materials that meet the CH-WAP criteria for classification as debris, and is classified as a heterogeneous waste [P141].

26.3.1 Hazardous Waste Determination

The material in this waste group does not qualify for any of the exclusions outlined in 40 CFR 260 or 261. The waste may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and 1,1-dichloroethylene. The waste may have been mixed with halogenated and non-halogenated solvents, and is therefore an F-listed hazardous waste. There is no evidence that 900-series wastes exhibit any other characteristic of hazardous waste. EPA HWNs applicable to some or all of this waste group are presented by IDC in Table 26-2. These conclusions are supported by the evaluation in Sections 26.3.1.1 and 26.3.1.2.

Table 26-2. 900-Series Waste Characterization.

IDC	Title	EPA HWNs
900	Plastic, Paper, etc.	D004-D011, D029, F001, F002, and F005
950	Metal, Glass, etc.	D004-D011, F001, F002, and F005
960	Concrete, Asphalt, etc.	D004-D011, F001, F002, and F005
970	Wood	F001, F002, and F005

26.3.1.1 Characteristic Waste. The materials in this waste group may exhibit a characteristic of hazardous waste as defined in 40 CFR 261, Subpart C as a toxic waste (40 CFR 261.24). The materials do not exhibit the characteristics of ignitability (40 CFR 261.21), corrosivity (40 CFR 261.22), or reactivity (40 CFR 261.23). The origin of the characteristic HWNs assigned to 900-series wastes is provided in Table 26-3. The table includes only the HWNs that are applicable to waste for which a specific source was identified.

Table 26-3. Buildings of Origin for Characteristic HWNs.

IDC	EPA HWNs	Building of Generation
960	D008 and D009	Generated in Building 771
	D004-D011	Generated in Building 774 or the 904 Pad

Ignitability: The materials in this waste group do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid, and an absorbent material was added to drums if moisture was detected [P012]. Visual examination identified an IDC 900 drum with 15 ml of liquid; however, the

liquid was identified as primarily water, silicates, and carbonates and is not ignitable [P015]. The materials are not compressed gases, and no compressed gases have been identified in this waste group [P012, P024]. The materials are not capable of causing fire through friction, absorption of moisture, or spontaneous chemical change. The materials are not DOT oxidizers as defined in 49 CFR 173. The materials in this waste group are therefore not ignitable wastes (D001).

Corrosivity: The materials in this waste group do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid, and an absorbent material was added to drums if moisture was detected [P012]. Visual Examination identified an IDC 900 drum with 15 ml of liquid; however, the liquid was identified as primarily water, silicates, and carbonates with a pH of 12, which is not corrosive by definition [P015]. The materials in this waste group are therefore not corrosive wastes (D002).

Reactivity: The materials in this waste group are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The materials do not contain cyanides or sulfides, and are not capable of detonation or explosive reaction. The materials are not forbidden explosives or Division 1.1, 1.2, or 1.3 (Class A or B) explosives as defined in 49 CFR 173. Explosives were not handled or used around radioactive material. The materials in this waste group are therefore not reactive wastes (D003).

Toxicity: The materials in this waste group may meet the definition of toxicity as defined in 40 CFR 261.24. The toxicity characteristic contaminants fall into one of two categories: metals and organics. Organic compounds include halogenated and non-halogenated solvents, pesticides, herbicides, and other toxic compounds. This waste group may exhibit the characteristic of toxicity for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver metals, as well as 1,1-dichloroethylene.

The entire inventory of plastic and paper (IDC 900) and glass and metal (IDC 950) were generated by Building 774 liquid waste treatment operations. Aqueous wastes treated in Building 774 may have contained all of the toxicity characteristic metals (See Section 23.0, Solidified Aqueous Sludge Building 774), and it is possible that these wastes may contain wastewater treatment sludge. Glass and metal (IDC 950) may also include leaded glovebox windows which contain barium and lead, fluorescent bulbs and instruments containing mercury, and lead shielding [P024, P053]. Therefore, IDCs 900 and 950 are assigned EPA HWNs D004-D011 since a representative sample of this waste cannot be obtained for verification purposes.

A portion of the concrete and asphalt (IDC 960) inventory was also generated by Building 774 liquid waste treatment operations. The remaining inventory of concrete and asphalt was generated by recovery operations in Building 771 and the 904 Pad. Since the 904 Pad is a waste storage area, the waste from this area could have originated from anywhere on plant site and may contain any of the toxicity characteristic metals. Lead-based paint, which may have been used to paint floors and walls, is a possible source of metal contamination in asphalt and concrete waste from Building 771, as well as other areas. In addition, concrete and asphalt could have been generated from spill cleanup of mercury containing instruments. Therefore, IDC 960 from Building 771 is assigned EPA HWNs D008 and D009, and IDC 960 from Building 774 and the 904 Pad is assigned EPA HWNs D004-D011 since a representative sample of this waste cannot be obtained for verification purposes.

Wood (IDC 970) consists primarily of filter frames from Building 771 recovery operations. Wood (possibly cardboard boxes) was also generated from the 904 Pad. There is no documentation that indicates a possible source for metal contamination on wood. Therefore, wood (IDC 970) does not exhibit the characteristic of toxicity due to metals (D004-D011).

There is no documentation indicating the presence or use of pesticides or herbicides in the areas or processes generating 900-series wastes. Therefore, this waste group does not exhibit the characteristic of toxicity due to pesticides or herbicides (D012-D017).

Tetrachloroethylene, trichloroethylene, carbon tetrachloride, and methyl ethyl ketone (common component of paint thinner) were used during production operations or decontamination activities. The 900-series wastes could potentially be contaminated with these solvents. However, since these compounds were typically used as solvents, the wastes are regulated as listed hazardous wastes and not characteristic wastes because these compounds are specifically addressed in the treatment standards for the listed hazardous waste [P080]. Since the 900-series wastes will be considered a listed hazardous waste due to the presence of spent solvents, the wastes are not toxicity characteristic wastes due to the presence of these compounds.

1,1-Dichloroethylene was detected in headspace samples of paper and plastic (IDC 900) and wood (IDC 900) [P033]. The only possible source identified for this compound is from radiolysis of 1,1,1-trichloroethane [P151]. It is possible that toxicity characteristic levels of 1,1-dichloroethylene may be present in paper and plastic (IDC 900). However, it is unlikely that this is the case for wood (IDC 970) based on the waste matrix. Therefore, IDC 900 is assigned EPA HWNs D029 since a representative sample of this waste cannot be obtained for verification purposes.

26.3.1.2 Listed Hazardous Waste. The material in this waste group may have been mixed with a waste listed in 40 CFR 261, Subpart D as a hazardous waste from non-specific sources (40 CFR 261.31). The waste is not, or was not mixed with, a hazardous waste from specific sources (40 CFR 261.32), or a discarded commercial chemical product, an off-specification species, a container residue, or a spill residue thereof (40 CFR 261.33).

Solvents such as carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, 1,1,2-trichloro-1,2,2-trifluoroethane, and methylene chloride, were used during production operations and decontamination activities. The 900-series wastes may be contaminated with these spent solvents, and are therefore assigned EPA HWNs F001 and F002.

There is no documentation indicating the presence or use of F004-listed solvents in the areas or processes generating 900-series wastes. Therefore, this waste group is not an F004-listed hazardous waste.

Toluene and methyl ethyl ketone were common components of paint and lacquer thinners that were commonly used for cleaning. The 900-series wastes may be contaminated with these spent solvents, and are therefore assigned EPA HWN F005.

Headspace analysis performed on samples of 900-series wastes (IDCs 900, 960, and 970) obtained at INEEL confirmed the presence of F-listed solvents. Headspace analysis results are not available for IDC 950. The detected F-listed compounds in which the UCL_{90} is above the PRQL are provided below. Only 2 to 4 samples were collected for each IDC. This sometimes resulted in undetected compounds being statistically above the PRQL due to the convention of using one-half of the detection limit in when calculating the UCL_{90}. In cases where this occurred, the affected compounds are not listed below [P033].

- 1,1,1-trichloroethane
- carbon tetrachloride (IDCs 900 and 970 only)
- tetrachloroethylene (IDC 900 only)

- toluene (IDCs 900 and 970 only)
- trichloroethylene.

Prior to September 1984, Building 774 treated spent stripping, cleaning, and plating solutions from Building 444 electroplating operations [P052]. The Building 444 electroplating operations utilized cyanide [P067], and therefore the Building 774 wastewater treatment operations received F007 and F009 wastes, and generated an F006 wastewater treatment sludge. Research and development electroplating operations in Building 444 started in approximately 1973 or 1974, and production scale in 1981 [C048, P053]. However, the 900-series wastes were generated before electroplating operations began. Therefore, the materials in this waste group are not F006-, F007-, and F009-listed hazardous wastes.

The material in this waste group is not a hazardous waste from specific sources since it was not generated from any of the processes listed in 40 CFR 261.32. The material in this waste group is therefore not a K-listed hazardous waste.

The material in this waste group is not a discarded commercial chemical product, an off-specification species, a container residue, or a spill residue thereof (40 CFR 261.33). The material in this waste group is therefore not a P- or U-listed hazardous waste.

26.3.2 Radionuclides

The feed materials to the recovery and purification processes (prefix 01) in Building 771 were impure plutonium residues which were processed to produce plutonium metal for use in the foundry and, therefore, wastes generated will be contaminated primarily with weapons-grade plutonium [P052, P163, U059]. Radionuclides from aqueous recovery operations will vary widely in chemical form depending on the specific process the waste originated, and because the majority of the aqueous processes were performed within one large MBA (prefix 0001), the specific process can not be determined. The different actinide forms are plutonium nitrate, plutonium chloride, plutonium peroxide, plutonium dioxide, plutonium tetrafluoride, and plutonium metal. Radioassay interferences may include aluminum nitrate from the dissolution process and beryllium which was removed during Part V leach [P163].

Aqueous waste treatment operations in Buildings 374 and 774 receive wastes from throughout plant site, including processes that generated low-level and nonradioactive liquid wastes. For this reason, wastes generated during treatment operations may contain any of the radioisotopes used at the plant. The most common radioactive materials handled were weapons-grade plutonium, americium-241, enriched uranium, and depleted uranium. Other radionuclides may also be found in the waste streams from R&D, analytical, and special order work [P164]. Radionuclide contaminants are removed from the aqueous wastes by precipitation using sodium hydroxide and, therefore, will be primarily in the form of hydroxides [P163]. Radioassay interferences may include magnesium sulfate and calcium chloride reagents used in the process [P106, P163.]

Building 774 also processed organic liquid wastes. Organic wastes are composed of a variety of oils and solvents. Most of the oils were from spent lathe coolant used in the plutonium machining area and lubricating oils used in machines throughout the plant [P164]. The majority of the transuranic organic liquids were oils and solvents from plutonium machining and degreasing operations in Buildings 707 and 777 and, therefore, will be contaminated with actinide metals and oxides [P052]. A more detailed discussion of the wastes treated in these buildings is provided in Sections 22 through 25.

26.3.2.1 Compilation of Radionuclides of Concern and Package Dates by Container Prefix.

The compilation of radionuclides of concern and package dates by container prefix is presented in Table 26-4. The building or area of generation for containers in the INEEL inventory is identified by the

container prefix contained in the drum identification number in this table. The acceptable knowledge relating to historical operations and the date of generation could in turn be used to assess a given container for potential process specific radionuclides or other contaminants. The accessible storage drum inventory is segregated in the table by IDC, container prefix, and building where generated. The generation dates, process descriptions, and potential radionuclide contaminants are identified for each population.

These IDCs were not part of the waste inventory addressed by the 3,100 m^3 Project and therefore there is no detailed NDA confirmatory characterization data available at this time.

Table 26-4. Radionuclides of Concern and Package Dates by Container Prefix and Building Where Generated.

IDC	Building	Prefix	Process Description	Package Dates	Radionuclides of Concern
900	774	0746	Liquid Waste Treatment	12/18/72 - 5/18/73	WG Pu, EU, ^{241}Am, DU, ^{233}U
950	774	0746	Liquid Waste Treatment	12/30/72	WG Pu, EU, ^{241}Am, DU, ^{233}U
960	707	0018	Note a	12/26/72	WG Pu
960	771	0001	Aqueous Recovery	12/1/72 - 1/3/73	WG Pu
970	771	0001	Aqueous Recovery	1/7/73	WG Pu

a. This prefix was assigned to an MBA in Building 707 that is not defined or was redefined after this waste was generated. It is assumed that this waste could contain any of the radionuclides handled in Building 707 unless the IDC further defines what radionuclides are in the waste.

WG = weapons grade DU = depleted uranium EU = enriched uranium

26.3.3 Complexing Agents

Because complexing agents can aid in the transport of transuranic radionuclides from the waste after disposal, the waste was assessed for potential complexing agents. This information may also be added to the chemical compatibility studies since limited information was available on these chemicals in the past.

EDTA is an example of a chelating compound. Chelating compounds are often found as constituents in commercial cleaning products. Versene (a trade name for EDTA) and citric acid, for example, are known constituents of KW, a decontamination detergent [P024, P068]. KW was used during a variety of decontamination activities at the plant, including wiping down filter frames. A buffer solution (TISAB) containing diaminocyclohexane tetraacetic acid was used during specific ion electrode analysis in Building 559 [P076]. Oxalic acid and tetraphosphoric acid were used to etch plutonium and other metals [P062, U043]. Oxalic acid was also used for americium recovery [P113]. The 900-series wastes may contain trace quantities of these complexing agents.

26.3.4 Real Time Radioscopy

RTR examination is used for the confirmation of physical form and the absence of prohibited items. The IDCs addressed in this section were not part of the waste inventory addressed by the 3,100 m^3 Project and therefore no detailed RTR confirmatory characterization data are available at this time.

Appendix A

Acceptable Knowledge Inventory

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Appendix A

Acceptable Knowledge Inventory

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C001	Internal correspondence from T. L. Clements, Jr. to distribution. "Content Code 7 Waste." TLC-1-83.	Summary of discussion between Tom Clements and Chuck Wickland about content code 7 sludge.	1983 January 17
C002	Internal correspondence from D. L. Zielger to C. E. Wickland. "P-Ci Calculations for WG Pu."	Weight %, specific activity, alpha activity, and equivalent plutonium curie activity for typical RFP transuranic waste.	1983 November 30
C003	External letter with attachments from W. D. Reinhart to Albert E. Whiteman, DOE/RFAO."Rockwell Discussions with EG&G Idaho, Inc." (Certification statements and data package deficiencies). 86-RF-1518.	Actions required by RFP to correct deficiencies on transuranic waste sent to INEL.	1985 May 8
C004	Memorandum from Joseph M. McGough to J. R. Nicks, Area Manager, RFAO. "Rockwell WIPP-WAC Nonconforming Sludge and Other Waste Management Concerns."	Letter from WIPP to RF that itemizes the nonconforming wastes from Rocky Flats. The letter provides status of treatment operations in the first quarter of FY85.	1985 January 14
C005	Internal correspondence from T. L. Clements, Jr. to L. A. Cook. "Addition of Content Code 303 to the Certifiable Waste Categories." TLC-11-86.	Scarfed graphite chunks information.	1986 January 23
C006	Internal correspondence from A. C. Ficklin to Distribution. "Box and Drum Identification to meeting WIPP Requirements."	Proposed changes for drum and box identification at RFP to meet WIPP requirements.	1986 February 4
C007	External letter from J. D. Wells to Ann Ficklin, Manager Solid Waste Operations, Rockwell International. "Item Description Codes." JDW-08-86.	Letter from INEL to RF accepting IDCs 368, 700,701, and 702.	1986 March 27
C008	Internal correspondence from G. F. Jaskot to Distribution. "Certification Waste Documentation."	The letter contains information on IDCs that will be certified to the WIPP criteria.	1986 May 9
C009	Internal correspondence from T. L. Clements, Jr. to J. M. Bower. "Addition of Content Codes 312 and 377 to the Certifiable Waste Category." TLC-40-86.	IDCs 312 (coarse graphite) and 377 (coarse firebrick) are added to the list of certifiable wastes stored at the RWMC.	1986 May 19
C010	External letter from J. D. Wells to W. D. Reinhart, Manager Waste Certification, Rockwell International. "Nonstandard Shipment Approval." JDW-14-86.	Listing of approved 800-series cemented wastes approved for shipment to the INEL.	1986 June 19
C011	Letter from G. F. Jaskot to Distribution."TRU Waste Determination."	Information on specific activity associated with Pu, Am, and U-235.	1986 October 21

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C012	Internal Correspondence from D. Vigil and W. A. Meisner to G. L. Hickle. "Diatomite-Cement-Sludge Mixture."	Information on the ratio of cement/diatomite to sludge for Building 374.	1986 December 15
C013	Letter from William F. Kane to Distribution."TRU/LLW Determination for Waste to meet the WIPP-WAC."	Discussion of sludge pico curies/gram for final waste form TRU/LLW determination in IDC 007/803 sludges.	1987 February 18
C014	Internal correspondence from G. F. Jaskot to B. C. Barrett. "IDC and WFN Revision."	Information to correlate IDCs to WIPP waste form numbers.	1987 March 24
C015	Internal correspondence from G. F. Jaskot to B. C. Barrett. "Certified IDC Update."	Information on certification of IDCs 335 and 490. Also, data on production of Building 374 sludge drums.	1987 April 15
C016	Internal correspondence from R. P. Brugger to Waste Review Board. "Waste Container Tare Weights."	Documentation of container tare weights.	1987 April 20
C017	Internal letter from C. D. Bretzke to B. A. Reynolds. "Solid Waste Information Management System Data Package."	Letter regarding assignment of 0.2 g Pu to grams assayed as zero g Pu.	1987 May 6
C018	Internal letter from L. A. Abila to W. D. Reinhart. "Guidelines for Repackaging Waste at Size Reduction."	Guidelines for repackaging Drums of combustibles and metal into metal boxes at Size Reduction.	1987 June 2
C019	Internal correspondence from L. A. Bearly to R. P. Brugger. "Drum Paint Requirements."	Response to WIPP request for painting waste drums the same as waste boxes.	1987 July 6
C020	Facsimile transmission from Jeff Paynter to Al Morgan, NMC. "Drums to be shipped as TRU Mixed Waste to 664."	List of lead drums for shipment.	1987 September 22
C021	Internal correspondence from J. K. Paynter to R. D. Mullet. "RCRA Mixed Waste IDCs."	Description of new and revised IDCs for mixed waste.	1987 October 5
C022	Internal correspondence from C. D. Bretzke to All Supervision. "New and Revised Waste Item Description Codes (IDCs)."	Description of new and revised IDCs for mixed IDCs and combustibles.	1987 November 30
C023	Internal correspondence from C. D. Bretzke to W. D. Reinhart. "Funding EG&G Evaluation of Sludge Processing Techniques."	Several memos regarding evaluation of free liquids in RFP sludge waste.	1988 February 11
C024	Internal correspondence from C. D. Bretzke, et. al., to Distribution. "Waste IDCs for Combustibles."	Description of IDCs used to segregate combustibles. IDCs 322, 323, and 324 were deleted.	1988 February 19
C025	Internal correspondence from C. L. Foxx to B. T. Reich. "Air Sparging to Eliminate Pyrophoric Sodium."	Description of air sparged pyrochemical salts from LANL.	1988 February 25

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C026	External letter from T. L. Clements, Jr. to Jeff Paynter, Rocky Flats Plant. "Content Code Description Data for TRUPACT II Payload Compliance Plan." TLC-22-88.	Information about INEL's program to verify content code descriptions.	1988 April 4
C027	Internal correspondence to E. A. Dicarlo from J. A. Hayden. "Disposal of Organic Lab Waste (DHDECMP in Xylene) from the Plutonium Lab, Bldg. 559."	Information regarding generation and possible disposal for DHDECMP in xylene lab waste.	1988 April 18
C028	External letter from Jeff Harrison to Sheila Hailey, LMITCO. "Comments on EDF RWMC-942, Rev 0; INEL/INT-97-00214, Rev 0."	A review of the assignments of D001 and D002 to combustible and plastic wastes and D003 to leaded rubber.	1997 November 14
C029	Internal correspondence from H. K. Fry to G. L. Aguero. "Counting IDCs 800 through 823 on Segmented Drum Counters."	Procedural steps for assay of IDCs 800-823 materials on SGS counters.	1988 April 29
C030	Internal correspondence from C. D. Bretzke to Distribution. "Item Description Codes (IDCs) for Non-PSZ Combustibles and Depleted Uranium Oxide."	Description of new IDCs for combustibles and D-38 oxide.	1988 May 12
C031	Internal correspondence from R. T. Scott to Distribution. "Line Generated Waste Drum Inspection."	List of IDCs requiring inspection.	1988 August 24
C032	External letter from J. K. Paynter to J. N. Davis, Idaho National Engineering Laboratory. "Data Package Information Change for Drum D40197-0743-18283." 88-RF-2813.	Description of one drum (IDC 801) containing xylene.	1988 September 9
C033	External letter from D. M. Hartley to J. Paynter, Rockwell International. "Content Code 700." DMH-1-88.	Letter from INEL requesting certification information on IDC 700 drums.	1988 December 22
C034	Memorandum from E. K. Hunter to A. E. Whiteman, Area Manager, RFAO."RFP Certification and QA Plan Formal Approvals and Reaudit."	Requested topics for WIPP-WACCC audit in January 1989.	1988 December 20
C035	External letter from J. K. Paynter to Marilyn Warrant, Sandia National Laboratories." Assay Information for Current Content Code Assessment." 89-RF-0195.	Responses to questions raised about RFP assay.	1989 January 18
C036	Internal correspondence from F. G. Trevino to Distribution. "Random Surveillance Implementation."	Random surveillance of waste program implemented on 2/6/89.	1989 January 30
C037	Internal correspondence from C. D. Bretzke, et al., to Distribution. "New IDCs." WCP7-28.	Description of IDCs 809, 854, 855, and 856.	1989 February 8

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C038	Internal correspondence from C. D. Bretzke to C. E. Trump. "Deviation from WO-4034, "Waste Packaging Requirements." WCP7-29.	Description of new requirements for IDCs 338 and 342.	1989 February 8
C039	Internal correspondence from J. K. Paynter to B. C. Barrett. "Radionuclide Information Required for TRUPACT II Shipments." WCP8-20.	Documentation of RFP isotopic distribution, decay heat, specific activity, and alpha curies for WR plutonium.	1989 March 23
C040	Internal correspondence from F. G. Trevino to Distribution. "Changes to Random Surveillance Program."	Change in procedures for issuing waste boxes to waste generators.	1989 April 10
C041	External letter from T. L. Clements, Jr. to C. D. Bretzke, Rocky Flats Plant. "Transuranic Waste Stream Profile Statements." TLC-65-89.	INEL acceptance of IDCs 338, 342, 809, 854, 855, and 856.	1989 May 8
C042	Internal correspondence from C. D. Bretzke to R. C. Lerche. "Hazardous Constituent Information." WCP8-85.	Characterization of IDCs 340, 333, and 331.	1989 May 30
C043	Internal correspondence from J. A. Detamore, et al., to Distribution. "New IDC/Revised IDCs."	Descriptions for IDCs 860, 443, and 444. IDCs 855 and 856 were deleted.	1989 July 3
C044	External letter from C. D. Bretzke to Dale Wells, EG&G Idaho, Inc. "Information Request Concerning New IDCs and Resin in IDC 806."	WFN assignments for IDCs 809, 854, 855, and 856. Reply to INEL regarding resin in IDC 806 drums.	1989 July 8
C045	Internal correspondence from J. K. Paynter to J. A. Detamore. "TRUPACT II Waste Requirements." PT-76.	Requirements to be implemented for TRU waste to meet TRUPACT II shipping requirements.	1989 July 25
C046	Use of the Passive-Active Drum Counter. Presentation given by Dr. McKamy of the Safeguards Measurements Group, Rockwell International, Rocky Flats Plant.	Three presentations on various assay topics.	1988
C047	Interview Record and associated documentation of William V. Conner by T. Widner and J. Lamb.	Interview with good details on historical information on Pu lab and Am recovery.	1991 August 13
C048	Interview Record of Mike Simmons by T. Widner and D. Herrick.	Information on Building 444 operations.	1991 August 6
C049	Interview Record of Ronald P. Teel by T. Widner and D. Herrick.	Historical information on liquid waste processing.	1991 August 7
C050	Informal memorandum from J. K. Paynter to Al Morgan, EG&G Rocky Flats, Inc. "Creation and deletion dates of IDCs."	Creation and deletion dates from the Safeguards Accountability Network (SAN).	1994 June 16
C051	Telecon between Jeff Paynter and Dick Saiki, EG&G RFP. "Composition of Rocky Flats Leaded Gloves."	Construction and usage information for RFP leaded gloves.	1994 July 19

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C052	Telecon between Jeff Paynter and Gary Dinghman, EG&G RFP. "RTR Acceptance of Mixed IDCs."	Information on acceptance of mixed IDCs by RTR inspection in the 1980s.	1994 July 27
C053	Telecon between Jeff Paynter and Al Morgan, EG&G RFP. "Usage of IDC 481."	Information on usage of IDCs 480 and 481 relative to metal washing.	1995 January 23
C054	Internal correspondence from Sheila M. Hailey to Distribution. "Oakridge pH analysis."	pH data for inorganic sludges.	1996 February 1
C055	Internal correspondence from Mary L. Adamic to John Krsul. "pH Determination of Drum Free Liquids." ED-AL-(MLA)-96-005.	pH data for inorganic sludges.	1996 February 16
C056	Telecon between Jeff Paynter and Jim Docktor, SafeSites. "Resolution of Solvent Usage with Graphite."	Solvent usage questions and answers for graphite waste generated by the Building 707 Foundry.	1996 March 25
C057	Drum, gasket, liner usage at RFP compiled by Larry Bearly.	Usage dates for drums, gaskets, and liners. Compiled for WIPP information request.	1989
C058	Informal notes from Jeff Paynter regarding HEPA and Drum Repackaging at the Size Reduction Facility.	Notes on HEPA filters and drum repackaging at Size Reduction.	Undated
C059	Excerpt from Rocky Flats Plant Quality Report August 1986. "Transuranic and Low Level Waste 1985-1986."	Information on rejected low-level and transuranic wastes.	1986
C060	Memorandum to File from L. S. Hendrickson. "Discrepancy Report on Graphite Waste Group."	Resolution of metal-contaminated graphite information. Results from nonline-generated graphite electrodes in Building 774.	1996 April 2
C061	Memorandum to File from Jeff Paynter. "Graphite Process Procedure from Building 707."	Justification for usage of procedure FO-0015 as a reference for historical graphite process operations.	1996 April 1
C062	External letter from Jacqueline W. Sales to Frank Czigler, S&W Waste Inc.	Application of F001–F005 solvent codes.	1987 May 20
C063	External letter from J. D. Wells to Ann Ficklin, Rockwell International Corporation. "Content Code Reconciliation."	Letter from INEL to RFP to reconcile changes and deletions of IDCs.	1985 November 8
C064	Internal correspondence from D. E. Kudera to T. L. Clements, Jr. "Combustibility of Graphite." DEK-10-86.	An assessment of the combustibility of graphite per WIPP criteria.	1986 December 2
C065	Telecon between Jeff Paynter and Mike Simmons, SMC. "Plating Wastes."	Information about cyanide plating waste transferred to Building 774.	1996 April 8
C066	Telecon between Jeff Paynter and Steve Cunningham, WorldWide Security. "Declassification of Graphite Molds."	History of graphite declassification and declassification criteria.	1996 April 23

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C067	Telecon between Jeff Paynter and John Collins, RMRS. "IDC 301 Drums from Buildings 371 and 559."	Possible graphite waste generation points for Buildings 371 and 559.	1996 April 24
C068	Memorandum from Jeff Paynter and Linda Hendrickson. "WSRIC Processes that Began after 1989."	Documentation that supercompaction and duct remediation began after 1989.	1996 April 25
C069	This is a duplicate of C043.		
C070	Internal correspondence from R. D. Thiel to A. M. Faucette. "TCLP Analysis of Raschig Rings."	TCLP metals analysis of Raschig rings.	1994 February 24
C071	Rocky Flats Personnel Interview of John Morrison by Flack and Herrick.	Information on Pu and Am recovery.	1991 August 14
C072	Record of Conversation of Rod Hoffman, recorded by Doug Herrick and Jennifer Lamb.	Special isotope information.	1991 September 4
C073	Record of Conversation of Maurie Maas, recorded by Doug Herrick and Jennifer Lamb.	Liquid waste treatment information.	1991 September 4
C074	External correspondence from Jeff Paynter to Don Kudera, Lockheed Idaho Technologies Company. "Information regarding Three IDC 301 Drums."	Process knowledge for three specific drums of IDC 301. In addition, characterization guidance for broken molds is included.	1996 April 24
C075	Telecon between Jeff Paynter and Don Kudera, Lockheed Idaho Technologies Company. "Prefixes for Organic Sludges."	Verification of organic sludge prefixes at INEL.	1996 May 1
C076	Internal Memorandum to File from Jeff Harrison. "Combustibles and Plastic Characterization."	Resolution of EPA Code discrepancies from references used for the Acceptance Knowledge document.	1996 May 23
C077	External Memorandum from R. B. Hoffman to K. C. Gerard, Lockheed Idaho Technology Company. "Classification Waste."	Classified waste input from the DOE-RFFO Classification Officer.	1996 April 24
C078	Internal Memorandum to File from Jeff Harrison. "Combustibles and Plastic Characterization."	Resolution of discrepancies between two characterization references.	1996 May 30
C079	Telecon between Wynn Eakins and Karlan Richards, EG&G Rocky Flats, Inc. "Characteristic Codes for B774 Wastes."	Use of characteristic EPA codes on Building 774 combustibles.	1994 September 8
C080	Telecon between Wynn Eakins and Pam Edrich, EG&G Rocky Flats, Inc. "Characterization of Combustible Laboratory Waste."	Characterization guidance used during the 1994 BWR for laboratory-generated combustibles.	1994 September 9
C081	Memorandum to File from Jeff Harrison. "Light Metal Characterization."	Resolution of characterization reference discrepancies for IDCs 480 and 481.	1996 May 29

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C082	Telecon between Jeff Harrison and Al Morgan of SafeSites of Colorado. "Generation of Leached Light Metal (IDC 481)."	Resolution of IDC 481 description discrepancy.	1996 May 28
C083	Memorandum to File from Jeff Harrison. "Light Metal Characterization."	Logic for assigning IDCs 480 and 481 with the same EPA codes.	1996 May 29
C084	Memorandum to File from Jeff Harrison. "Light Metal (IDC 480) Generated in Building 371 Analytical Laboratory."	Disposition of EPA codes assigned to IDC 480 wastes from the Building 371 analytical laboratory.	1996 May 29
C085	Memorandum from Thom Putney. "Historical Constituents of IDC 800/801."	Documentation of interviews concerning listed solvents in aqueous laboratory wastes from Buildings 559 and 779.	1993 November 8
C086	Memorandum from Jeff Paynter to Pamela of IT Corporation. "Use of the Complexing Agent DHDECMP."	Information on the use of DHDECMP and mass of crates loaded with combustible waste.	1989 February 7
C087	Telecon between Jeff Paynter and Carrie Wesley of RMRS. "Process Wastes Treated in Building 374."	Supplementary information on wastes treated in the Building 374 precipitation process.	1996 May 29
C088	Telecon between Jeff Paynter and Rod Hoffman/Bob Riddle of DOE RFFO Classification/SAIC. "Composition of "Grip" and ZPPR Fuel Elements."	Unclassified description of "Grip" and classification guidance for ZPPR fuel elements.	1996 May 29
C089	Telecon between Jeff Harrison and Al Morgan of SafeSites of Colorado. "Creation of IDCs 440, 441, 442, 444, and 855."	Summary of discussion with Al Morgan about the creation of glass IDCs.	1996 June 3
C090	Telecon between Jeff Harrison and Ron Bowen of SafeSites of Colorado. "Raschig Ring Tanks in Building 371."	Summary of discussion with Ron Bowen about solvents in Raschig ring tank in B371.	1996 June 3
C091	Memorandum to File from Jeff Harrison. "Glass Characterization."	Memo summarizing the characterization of LL glass that would not have been sent to INEL.	1996 June 3
C092	Memorandum to File from Jeff Paynter. "Resolution of Conflicting Characterization Information for Waste Group #4."	Resolution to conflicting characterization of IDC 802.	1996 June 4
C093	Letter assumed to have been written by David P. Simonson to Fred Dowsett of the Colorado Department of Health, and corresponding response letter. Discussion re. Definition of Hazardous Waste as defined by Colorado Hazardous Waste Regulations.	Characterization of wipes (corrosivity and U-listed), solvent carryover on metals, and glovebox (decommissioned) material characterization.	1989 November 9

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C094	DOE RFO Contact Record from David Maxwell to Ken Niswonger of Colorado Department of Health. "Confirm regulatory interpretation that listed waste codes on lab samples do not carry over to the waste generated from the analysis of the sample."	Lab waste characterization. Not listed if analyzing listed samples.	1994 September 9
C095	Internal memorandum from E. E. Ericson to L. C. Baaso. "Leaded Glovebox Gloves."	TCLP results and conclusions for lead in leaded gloves.	1993 June 9
C096	External Letter from K. J. Grossaint to J. L. Long. "Identification and Thermal Studies of the Residue from Nitric Acid Reaction with Leaded Neoprene Gloves."	Results of a study of the reaction of nitric acid with Neoprene leaded gloves.	1973 March 30
C097	External Letter from Frederick R. Dowsett to Michael S. Karol of DOE Rocky Flats Office. Discussion re. reclassification of certain waste streams formerly classified as subject to Land Disposal Restrictions."	Reassessment of Rocky Flats "carryover" characterization policy for insulation, metal, and filter waste.	1993 August 11
C098	Memorandum to File from Jeff Paynter. "Justification for not including DCHP in Building 371."	Justification for not including DCHP in Building 371.	1996 June 7
C099	Memorandum to File from Jeff Harrison. "Discrepancy with Washing of Leaded Gloves and Aprons."	Washing of acid-contaminated leaded gloves prior to 1974.	1996 June 13
C100	Telecon between Jeff Harrison and Al Morgan of SafeSites of Colorado. "Washing of Leaded Gloves."	Washing of acid-contaminated leaded gloves prior to 1974.	1996 June 13
C101	Memorandum to File from Jeff Harrison. "Characterization of Lead Containing Waste (IDCs 320 and 339)."	Resolution of characterization discrepancies with IDCs 320 and 339.	1996 June 17
C102	Letter from Frederick R. Dowset (Colorado Department of Health) to Michael S. Karol (DOE/Rocky Flats)	Characterization of Insulation, filter, and metal waste relating to solvent carry-over	1993 August 11
C103	Telecon between Jeff Harrison and Al Morgan of SafeSites of Colorado. "Creation of Filter IDCs."	Creation dates for IDCs 328, 331, 335, 342, 490, 492, 491, 338, and 376.	1996 June 6
C104	Telecon between Jeff Harrison and Jack Weaver of SafeSites of Colorado. "CWS Filters."	CWS Filters.	1996 June 18
C105	Interview Record of John Milner, Jr. by T. Widner and S. Flack.	Historical information on filter testing and contamination.	1991 August 20
C106	Telecon between Jeff Harrison and Al Morgan of SafeSites of Colorado. "CWS Filters."	Creation dates for IDCs 328, 331, 335, 342, 490, 492, 491, 338, and 376.	1996 June 18
C107	Memorandum to file from Jeff Harrison and Al Morgan of SafeSites of Colorado. "CWS Filters."	Resolution of characterization discrepancies.	1996 June 21

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C108	Letter to R. E. Yoder from E. Vejvoda. "Tritium Balance for Buildings 771 and 774 Processing."	Description of tritium disposition at Rocky Flats.	1976 August 6
C109	Letter to W. C. Bright, Rocky Flats, from B. L. Kelchner, DOW. "Emission of Carbon Tetrachloride Vapor from Building 774.	Questions the hazardous characteristic of discharged carbon tetrachloride vapor.	1971 February 5
C110	Personnel interview of Dick Del Pizzo by Herrick & Flack.		1992 January 21
C111	Letter from Lisa A. Leehy, Envirodyne, to Peg Beatty, Weston.	Soil samples.	1990 January 3
C112	Letter from E. L. D'Amico, Rocky Flats, to Cal Ozaki.	Analytical data.	1988 May 6
C113	Interoffice Correspondence from M. T. Saba to S. A. Anderson.	Evaluation of analytical data for by-pass sludge sampled May 1990.	1990 October 3
C114	Memorandum to File from Jeff Harrison. Historical Use of IDC 807.	Discussion of IDC 807 that was used for cemented incinerator sludge and for solidified bypass sludge.	1996 July 18
C115	Telecon between Jeff Harrison and Bill Connor of Kaiser-Hill LATO. "Generation of Americium Process Residue (IDC 241)."	Creation and processing of IDC 241.	1996 July 29
C116	Memorandum to file from Jeff Harrison. "Resolution of Incinerator Waste Characterization Discrepancy."	Clarification of EPA codes for incinerator waste.	1996 August 2
C117	Miscellaneous Correspondence and Draft Correspondence about Pyrochemical Salts.	Correspondence relating to the D003 and D007 characterization of pyrochemical salts.	1993-1995
C118	Telecon between Jeff Harrison and Bill Connor of Kaiser-Hill LATO. "R&D Activities Generating Sand, Slag, and Crucible (SS&C) Wastes (IDCs 391 and 393)."	Creation and processing of IDCs 391 and 393.	1996 August 13
C119	Discrepancy Report. "Evolution of the Characterization of Pyrochemical Salts and SS&C."	Discussion of the evolution of the pyrochemical salt and SS&C waste characterization, including D002, D003, and D007 determinations.	1996 August 14
C120	Telecon between Jeff Harrison and Bill Connor of Kaiser-Hill LATO. "Grit Blasting in Building 771."	Information about grit blasting process in Building 771.	1996 August 15
C121	Telecon between Jeff Harrison and Carrie Wesley, RMRS. "Information on Building 374 Aqueous Waste Treatment."	Information about liquid waste treatment operations.	1996 September 12

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C122	Memorandum to A. M. Faucette, Safe Sites, from Y. B. Mazza and D. L. Remington, Safe Sites. "Analysis of Cemented Bypass Sludge Samples for TCLP Extract Elements by ICP AES and GC/MS."	Building 374 Bypass Sludge analytical data.	1995 September 12
C123	Telecon between Jeff Harrison and Bud Nannie, Rocky Flats Plant-retired. "Use of Carbon Tetrachloride and 1,1,1-Trichloroethane in Pyrochemical Operations."	Information about pyrochemical processing and solvents.	1996 September 19
C124	Interoffice Correspondence from A. L. Schubert to Distribution. "Management of Spent Fluorescent Light Tubes." ALS-328-91.	Guidance for the hazardous waste management of fluorescent light bulbs.	1994 October 8
C125	Interoffice Correspondence from John Hill of Kaiser Hill, LLC Rocky Flats to Distribution. "Environmental Compliance Directive No. 1: Spent Incandescent Bulbs to be Collected for Recycling." JAH-009-95.	Management of incandescent light bulbs.	1995 August 4
C126	Battery Characterization. Attachment 8–Mercury Batteries.	RCRA characterization and constituent information for mercury batteries.	1996 November 12
C127	Telecon between Norm Cypher of RMRS-Rocky Flats and Ann Quinn.	Corrosivity of Aggregate Feed Streams to Building 374 Treatment Process.	1996 November 13
C128	Telecon between Paul Pigion of RTG and Ann Quinn.	Permit status for Building 374.	1996 November 13
C129	Informal memorandum from Jack Templeton of SAIC to Briand Wu and others. Evaluation of ITS Water and Recommended Discharge Options. ER-95-195.	Summary of ITS water data from 1989 to 1995.	1996 October 6
C130	Fax from Steve Cunningham, Rocky Flats, to Jeff Paynter. Rocky Flats Plutonium Isotopic Levels.	Plutonium isotopic levels at Rocky Flats for 1959 through 1974.	1992 February 18
C131	Telecon between Andy Leford of RMRS-Rocky Flats and Ann Quinn.	WSRIC Building Book 774—upcoming changes to process 10.	1997 January 15
C132	Telecon between Karlan Richards of RMRS-Rocky Flats and Ann Quinn.	WSRIC Building Book 774 Upcoming changes for LDR Assessment.	1997 January 13
C133	Telecon between Jim Hahn of Rocky Flats and Jeff Harrison.	Mercury Contaminated Combustibles from Building 125.	1997 January 28
C134	Interview Record and associated documentation of several former Rocky Flats employees.	Interview with information about general Rocky Flats history.	Unknown
C135	Interview Record of Mike Simmons by T. Widner and D. Herrick.	Interview with information about B444 operations.	1991 August 6

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C136	Interview Record of Joe Risinger by T. Widner and D. Herrick.	Interview with information about B776 electrorefining, B771 incinerators, and B444.	1991 August 29
C137	Interview Record of E. Putzier and E. Vejvoda by D. Herrick and J. Lamb.	Interview with information about historical process changes, historical air/water effluent monitoring and waste disposal practice, and plutonium types and usage.	1991 September 5
C138	Interview Record of Joe Aldrich by Flack and Herrick.	Interview with information about historical process changes to B886, B881, and B444.	1991 August 22
C139	Interview Record of C. Barrick by D. Herrick.	Interview with information about sensitivity of Th233 information.	1990 December 14
C140	Interview Record of N. Clark by D. Herrick.	Interview with information about historical process changes to B883 and relationship to changes in quantity of chemicals used in B883.	1991 December 13
C141	Interview Record of L.R. Crisler by T Widner and D. Herrick.	Interview with information about B771 operations and chemicals used, with references to historical documents written by L.R. Crisler.	1991 August 27
C142	Interview Record of N. Cypher by D. Herrick.	Interview with information about B774 evaporator, B883 classified project, chemicals in B374, incidents in B374 and B866.	1991 August 13
C143	Interview Record of R. Greinetz by D. Herrick.	Interview of Ph.D. chemist who worked at Rocky Flats.	1992 January 7
C144	Interview Record of M. Maas by D. Herrick and J. Lamb.	Interview with information about B774 functions.	1991 September 4
C145	Interview Record D. Del Pizzo by D. Herrick and Flack.	Interview with information about U233 use at Rocky Flats and the ZPPR project.	1992 January 21
C146	Interview Record of S. DeWitt by Flack and Herrick.	Interview with information about B771; structural.	1991 August 15
C147	Interview Record of V. Dingman by T. Widner and D. Herrick.	Interview with information about B777 and B707 chemicals, uranium processing.	1991 August 14
C148	Interview Record of J. Dorr by D. Herrick.	Interview with information about ZPPR Project and coating studies.	1992 January 22
C149	Interview Record of M.W. Beranek by T. Widner and D. Herrick.	Interview with information about B771 Am processing, filter system, and incinerator.	1991 August 7
C150	Interview Record of C. Forrey by D. Herrick and J. Lamb.	Interview with information about B771 fume scrubber, cooling tower, filter plenum, and caustic scrubber.	1991 August 23
C151	Interview Record of J. Hebert by D. Herrick.	Interview with information about B771 Pu metallurgy and fluorinator, the B447 chip roaster, and B460 waste from B881.	1991 August 6

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C152	Interview Record of F. McMenus by T. Widner and D. Herrick.	Interview with information about waste transfer system, cleanup of solar ponds, OASIS, B774 vacuum filter, B771 incinerator, and B374 holding ponds.	1991 August 7
C153	Interview Record of J. Morrison by D. Herrick and Flack.	Interview with information about Pu recovery process and Am recovery process.	1991 August 14
C154	Interview Record of W.V. Conner by T. Widner and D. Lamb.	Interview with information about several B771 operations, Am purification, Np work, chemicals used, and fume scrubber.	1991 August 13
C155	Interview Record of J.D. Weaver by T. Widner and J. Lamb.	Interview with information about B771 operations, including dissolution process, leached Pu, and ammonium thiocyanate process; and B371 construction and operation.	1991 August 15
C156	Interview Record of R. Jackson by T. Widner and J. Lamb.	Interview with information about B883 production.	1991 August 13
C157	Interview Record of R. Gisler by T. Widner and Flack.	Interview with information about Room 114, B771 and chemicals used.	1991 August 20
C158	Interview Record of R. Simmons by S. Flack.	Interview with information about health physics, some beryllium.	1991 November 21
C159	Interview Record of R. Hoffman by D. Herrick and J. Lamb.	Interview with information about SOW and U-233 use, nickel carbonyl, and limited ZPPR information.	1991 September 4
C160	Interview Record of M. Delhierro by D. Herrick.	Interview with information about pyrochemistry in B371.	1991 August 13
C161	Interview Record of K. Freiberg by D. Herrick.	Interview with information about Th-233 and Cu-244.	1991 May 9
C162	Interview Record of R. Hilbig by D. Herrick.	Interview with information about Freon in B460, composition of nitrad, and some solvents and chemicals used at Rocky Flats.	1991 August 13
C163	Interview Record of G. Ideker by T. Widner and S. Flack.	Interview with information about B881 stainless steel operations and B460 operations.	1991 August 14
C164	Interview Record of B. Kelchner by D. Herrick and J. Lamb.	Interview with information about U operations and chemicals used in B881.	1991 September 6
C165	Interview Record of L. Martella by T. Widner and D. Herrick.	Interview with information about Np, Am recovery, and U "special recovery".	1991 August 7
C166	Interview Record of L. Martella by D. Herrick.	Interview with information about Np, and Am recovery.	1991 August 7
C167	Interview Record of J. Merriman by D. Herrick and J. Lamb.	Interview with information about B559 ventilation upgrade and radionuclide emissions.	1991 August 20

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C168	Interview Record of J.D. Morrison by T. Widner and D. Herrick.	Interview with information about B771 and B774 Ops, a little bit about ZPPR, and chemical list attached.	1991 August 29
C169	Telecon between Al Morgan of Rocky Flats (retired) and Jeff Harrison.	Information regarding drum prefix usage and plutonium isotopic composition.	1997 January 9
C170	Telecon between Al Morgan of Rocky Flats (retired) and Jeff Harrison.	Information regarding drum prefix usage prior to WEMS.	1997 February 17
C171	Telecon between Bill Connor of Kaiser-Hill LATO and Jeff Harrison.	Nonroutine radionuclide work.	1997 February 13
C172	Interoffice correspondence between L. C. Basso and J. R. Ryan of RFETS.	Review of data for tar; the interpretation of the data is incorrect.	1994 May 10
C173	Telecon between Rick Wagner of RFETS and Jeff Harrison.	Graphite from drum prefix 0743.	1997 February 28
C174	Telecon between Bob Fiore of RFETS and Jeff Harrison.	Building 707 Operations.	1997 February 28
C175	Telecon between Al Morgan of Rocky Flats (retired) and Jeff Harrison.	Building 776 Size Reduction Area.	1997 February 27
C176	Telecon between Bill Connor of Kaiser-Hill LATO and Jeff Harrison.	Nonroutine and R&D Operations.	1997 February 27
C177	Telecon between Al Morgan of Rocky Flats (retired) and Jeff Harrison.	Graphite scarfing.	1997 February 26
C178	Interoffice Memorandum to A. J. Holifield of Safe Sites from A. M. Murray of Kaiser-Hill. KAP-006-96, Attachment 1.	Review of six item description codes with respect to potential water content– AMM-002-96.	1996 January 10
C179	Interoffice Memorandum to R. E. Wilson from A. M. Murray of Kaiser-Hill. KAP-006-96, Attachment 2.	Moisture content in pyrochemical salt residues with respect to considering them "wet" by nuclear material safety limits– AMM-014-96.	1996 March 19
C180	Informal Memorandum to J. M. Ball of SSOC from W. V. Connor of Kaiser-Hill. KAP-006-96, Attachment 3.	Moisture content of non-salt residue IDCs (WVC-96-6).	1996 March 20
C181	Informal Memorandum to J. M. Ball of SSOC from W. V. Conner of Kaiser-Hill. KAP-006-96, Attachment 4.	Moisture content of all non-salt residue IDCs (WVC-96-7).	1996 April 4
C182	Interoffice Correspondence to K. A. Phillips from A. M. Murray.	Information regarding item description code (IDC) 416 - AMM-019-96.	1996 April 16
C183	Telecon between Mike West of LATO, Lynn McCurry of WI (ORNL), and Kevin Peters.	Composition of MSE Salt, IDC 409 (drawing attached).	1997 March 11
C184	Interview Record of Al Morgan by Jeff Harrison.	Historical Rocky Flats Operations with emphasis on radionuclides.	1997 March 19
C185	Telecon between Bill Connor of LAPO and Jeff Harrison.	Special isotopes used in R&D Operations.	1997 March 20
C186	Interoffice Correspondence from K. Phillips of SSOC to J. Ball, SSOC.	Interim Residue Characterization Status Report KAP-017-96.	1996 December 31

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C187	Interoffice Correspondence from K. Phillips of SSOC to J. Ball, SSOC.	Interim Residue Characterization Status Report KAP-012-96.	1996 July 22
C188	Telecon between Bill Conner of LAPO and Jeff Harrison.	Defense Versus Non-Defense Related Projects.	1997 April 3
C189	Telecon between Al Morgan of Rocky Flats (retired) and Jeff Harrison.	Americium Recovery and Purification.	1997 April 3
C190	Telecon between Bill Conner of Rocky Flats and Jeff Harrison.	Defense and Non-Defense Activities.	1997 May 20
C191	Memorandum from DOE CAO to J. M. Roberson, RFFO and J. M. Wilcynski, INEEL.	Identification of Defense Waste Streams Generated at Rocky Flats. Also identifies that the wastes were not associated with nuclear fuels or high-level waste.	1997 May 20
C192	Letter from E. R. Naimon, Manager Waste Operations, to Albert E. Whiteman, Area Manager DOE, RFAO. "Classified Waste Characterization." 88-RF-0409.	List of classified waste IDCs that are not RCRA hazardous waste.	1988 February 10
C193	Facsimile Memorandum from Jeff Paynter to Jeff Harrison, WASTREN. "Info on 1518-4 Containers."	Unclassified description for retired weapons components stored at the Nevada Test Site.	1997 July 10
C194	Telecon between Jeff Harrison and Jeff Paynter, M. H. Chew & Associates. "General Discussion of NTS Inventory of Rocky Flats Waste."	Descriptions of classified waste IDCs.	1997 July 10
C195	Telecon between Jeff Harrison and Jeff Paynter, M. H. Chew & Associates. "Relation of Processes Generating Classified IDCs."	Description of how processes that generated classified waste IDCs are related.	1997 July 17
C196	Facsimile Transmission from Pat Arnold to Jeff Harrison, WASTREN. Density of Sludge Drums.	Sludge density calculations for IDC 800 performed by Pat Arnold.	1997 March 18
C197	Memorandum from Jeff Harrison to File.	Summary of drum prefix discrepancies for INEEL Accessible Storage TRU Waste Inventory-Rocky Flats Waste.	1997 August 12
C198	Light Ballasts, E-mail note from William Becker to Rodney Arbon, 4/19/2000. William Becker is a BBWI employee with an extensive background in TSCA.	E-mail provides information about the potential of PCBs in fluorescent light ballasts.	2000 April 19
C199	External letter from Kevin Peters, WASTREN, to Sheila Hailey. "Resolution of Magnesium Oxide Crucibles (IDC 368) Characterization Discrepancy." KJP/003/0501.	Resolution of conflicting characterization data for IDC 368. Assessment of documentation indicates waste is nonhazardous.	2001 May 15
C200	External letter from Kevin Peters, WASTREN, to Sheila Hailey. "Cyanide Content of Solidified Aqueous Sludge – Bldg. 774." KJP/004/0501.	Discusses analytical data, documentation, and telecons supporting the determination that cyanide concentrations in Bldg. 774 solidified aqueous sludge are low and will not cause the waste to be reactive.	2001 May 22

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C201	Interview of Gregg Park, BBWI by Sheila Hailey. “Free Liquids in First/Second Stage Sludge Samples.”	Based on past experience of Gregg Park, it describes the likelihood that First/Second Stage Sludge samples will pass a Paint Filter Liquids test.	2001 May 22
C202	Telecon/Interview between Carolyn Abbott and Rick Erdheim/Paul Krehl.	Potential hazards or lack of hazards due to the presence of lithium containing batteries in RFP First and Second Stage Sludge waste.	2001 May 23
C203	Telecon/Interview between Joan Connolly/Carolyn Abbott and Mason Harrup.	Potential hazardous or lack of hazards due to the presence of small amounts of cyanide from feed waste in the RFP First and Second Stage Sludge waste.	2001 May 23
C204	External letter from Kevin Peters, WASTREN, to Sheila Hailey. "Reclassification of Certain Homogeneous Waste to Debris Waste." KJP/006/0501.	Identifies IDCs in the INEEL inventory that can be re-classified as debris waste based on the Waste Analysis Plan, Attachment B. IDCs identified were: IDC 310, Graphite Scarfings and Fines; IDC 372, Grit; IDCs 432 & 822, Cemented Resin; IDC 370, LECO Crucibles; and IDCS 391 and 392, Unpulverized Sand, Slag and Crucible.	2001 May 25
C205	External letter from Kevin Peters, WASTREN, to Sheila Hailey. "Resolution of Grit (IDC 372) characterization Discrepancy." KJP/009/0601.	Resolution of conflicting characterization data for IDC 372. Assessment of documentation indicates waste should be conservatively assigned D007 (chromium).	2001 June 22
C206	Telecon between Betty Tolman and Kevin Peters / Jeff Paynter. "Beryllium Scrap in IDC 480 Waste Drum.”	Discusses the expectation of finding scrap beryllium in the IDC 480 waste stream.	2001 October 2
C207	Summary of Review of PCB AK Sources.	Compilation of correspondence and other documentation concerning historical management of PCB liquids and items at the Rocky Flats Plant. A cut-off date for PCB-contaminated waste cannot be firmly established and supported using this documentation.	2001 September 5
C208	External letter and Paper from R. H. Guyman to Brian R. Monson, Idaho Department of Environmental Quality. “Response to New Mexico Environment Department Concern with IDC 002.”	Paper discusses the potential presence of lithium batteries in the second stage sludge waste stream (IDC 002) generated at the Rocky Flats Plant, and the applicability of HWN D003 or D001 to the waste. The paper was prepared in response to State of New Mexico concerns relative to the consistency of characterization of lithium battery-containing waste between general INEEL practices and the TRU Waste Characterization program.	2001 September 27

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C209	INEEL Internal memorandum from Scott Roesener to Chris Brooks. "Radioassay System for Organic Setups, Item Description Code 003."WSR-01-01.	Notification that the total measurement uncertainty evaluation for the PAN active mode has been completed for the Organic Setups waste form.	2001 October 23
C210	INEEL Internal memorandum from Yale D. Harker to Sheila Hailey. "MDC for Item Description Code–337."	Concludes that the nominal MDC (minimum detectable concentration) assigned to IDC 337 for radioassay can be the same as that for IDCs 330 and 336.	2001 November 29
C211	External letter from Brian R. Monson, Idaho Department of Environmental Quality to Jack Depperschmidt, DOE-ID. "Regarding the April 24, 1997, Position Paper on the Addition of Absorption Activities Exempt from Permitting and Interim Status Requirements (OPE-EP-97-143) for the Idaho National Engineering and Environmental Laboratory."	Clarifies when addition of absorbent materials are acceptable and exempt from permitting requirements.	1997 June 25
C212	External letter from Robert Bullock, Idaho Department of Environmental Quality to Dave Wessman DOE-ID. "Receipt of INEEL Response to New Mexico Environment Department, Concerns with IDC 002 at the Radioactive Waste Management Complex on the Idaho National Engineering Laboratory."	States that an earlier letter and paper (C208) to Idaho DEQ resolves concerns relative to lithium batteries in the IDC 002 waste stream.	2001 October 29
C213	Internal Memorandum from Julie Hand to Joan Connolly. "Dilutions of TWCP Semivolatile Organic Analysis Data."	Discussion of analyses of data packages 98004S, 98005S, 98012S, and 99001S, for IDCs 700 and 801.	2002 January 7
C214	External Letter from Kevin Peters, WASTREN, to Lisa Frost. "PCB Label Research for NCR Number 26503."	Concludes that the filters waste stream drums do not contain PCB-contaminated wastes.	2002 March 24
C215	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory Waste Stream Profile INW243.001."	Formal DOE approval of the Waste Stream Profile Form for the glass waste stream and authorization to enter waste stream data into WWIS.	2001 March 28
C216	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory Waste Stream Profile INW169.001."	Formal DOE approval of the Waste Stream Profile Form for the combustible waste stream and authorization to enter waste stream data into WWIS.	2002 February 7
C217	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory Waste Stream Profile INW198.001."	Formal DOE approval of the Waste Stream Profile Form for the plastics waste stream and authorization to enter waste stream data into WWIS.	2002 February 7

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C218	External Letter and attachments from S. M. Hailey to C. C. Dwight, Argonne National Laboratory-West. "Core Sample Plans for Miscellaneous Solidified Waste." SMH-07-97.	Approach to be used for core sampling miscellaneous RFP solidified wastes (IDCs 292, 432, 817, 818, 822, and 823) to meet FY-97 milestone.	1997 March 6
C219	Internal Memorandum to Chris Brooks from Scott Roesener. "Radioassay System Certification Capabilities Implementation Information for Organic Setups Item Description Code 003." WSR-01-01.	Notification that the Passive-Active Neutron (PAN) assay system TMU evaluation for the active mode was completed for IDC 003. Includes TMU result and certification restrictions and conditions.	2001 October 23
C220	Internal Memorandum to David Morgan from Scott Roesener. "Radioassay System Certification Capabilities Implementation Information for Miscellaneous Cemented Waste Item Description Codes 292, 432, 806, 817, 818, 820, 822, and 823."WSR-05-02.	Notification that the Passive-Active Neutron (PAN) assay system TMU evaluation for the active mode was completed for the subject IDCs. Includes TMU result and certification restrictions and conditions.	2002 January 29
C221	Internal Memorandum to David Morgan from Scott Roesener. "Radioassay System Certification Capabilities Implementation Information for Plastic Waste Description Code 337."WSR-01-02.	Notification that the Passive-Active Neutron (PAN) assay system TMU evaluation for the active mode was completed for the IDC 337. Includes TMU result and certification restrictions and conditions.	2002 January 29
C222	Internal Memorandum to David Morgan from Scott Roesener. "Radioassay System Certification Capabilities Implementation Information for Solidified Organics and Special Setups Waste Item Description Codes 004, 700, 801, 802."WSR-03-02.	Notification that the Passive-Active Neutron (PAN) assay system TMU evaluation for the active mode was completed for the subject IDCs. Includes TMU result and certification restrictions and conditions.	2002 January 29
C223	Interview/conference between BBWI and Physics Group. "Roadmap to Physics Databases."	Provides pointers to the physics databases for post-2000 raw data, pre-2000 data, and TMU and MDC data from the Pan Gamma systems. Includes a CD disc containing Spectra for confirmatory measurement report provided by the Physics group.	2002 April 8
C224	Letter to File prepared by Joan Connolly, North Wind Environmental. "The D002 HWN is not Applicable to First and Second Stage Sludge (INW216.001) and Building 374 Sludge (INW218.001) Waste Drums that Contain Excess Free Liquid."	Conclusion that excess free liquids in the subject waste streams are not corrosive based on pH measurements.	2002 April 19
C225	External Memorandum from Kerry Watson, DOE-CAO. "Approval of INEEL Waste Stream Profile Form INW276.003."	Formal DOE approval of the Waste Stream Profile Form for the graphite (nonhazardous) waste stream and authorization to enter waste stream data into WWIS.	2000 July 20

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C226	External Memorandum from Kerry Watson, DOE-CAO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Revised Waste Stream Profile Form INW276.004, Rev. 1."	Formal DOE approval of the revised Waste Stream Profile Form for the graphite (hazardous) waste stream and authorization to enter waste stream data into WWIS.	2000 September 27
C227	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Forms INW247.001R1 and INW296.001, Rev. 1."	Formal DOE approval of the revised Waste Stream Profile Forms for Raschig Rings and Non-Special Source Metals waste streams and authorization to enter waste stream data into WWIS.	2000 November 14
C228	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW211.001."	Formal DOE approval of the Waste Stream Profile Form for the Filters waste stream and authorization to enter waste stream data into WWIS.	2001 April 24
C229	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW211.001, Rev. 1."	Formal DOE approval of the revised Waste Stream Profile Form for the Filters waste stream and authorization to enter waste stream data into WWIS.	2001 May 3
C230	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW216.001."	Formal DOE approval of the Waste Stream Profile Form for the First and Second Stage Sludges waste stream and authorization to enter waste stream data into WWIS.	2001 May 24
C231	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW218.001."	Formal DOE approval of the Waste Stream Profile Form for the Building 374 Sludges waste stream and authorization to enter waste stream data into WWIS.	2001 July 24
C232	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW169.001."	Formal DOE approval of the Waste Stream Profile Form for the Combustibles waste stream and authorization to enter waste stream data into WWIS.	2002 February 7
C233	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW198.001."	Formal DOE approval of the Waste Stream Profile Form for the Plastics waste stream and authorization to enter waste stream data into WWIS.	2002 February 7
C234	External Memorandum from Kerry Watson, DOE-CBFO. "Approval of Idaho National Engineering and Environmental Laboratory (INEEL) Waste Stream Profile Form INW222.001."	Formal DOE approval of the Waste Stream Profile Form for the Miscellaneous Cemented Sludges waste stream and authorization to enter waste stream data into WWIS.	2002 April 24

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C235	Letter to File: Assignment of unique IDC (696) to IDC 807b waste containers.	A unique IDC number has been assigned to IDC 807 Rocky Flats incinerator sludge in TRIPS specifically to distinguish the waste from IDC 807 Building 374 Sludge and to identify the containers for the NDA SAS and SAP systems. Includes superseded letter to file dated June 11, 2002.	2002 July 12
C236	Letter to File prepared by Carolyn Abbott, North Wind. "Rocky Flats Waste Streams with 'split' IDCs."	Clarifies that IDC 320 will not be segregated into two waste streams based on the presence or absence of lead in the waste container. All IDC 320 containers in the Rocky Flats inventory will be assigned HWN D008 and a single WMC (S5112).	2002 June 11
C237	Fax of Telecon between Jeff Harrison, WASTREN, and Jan Fretthold, Rocky Mountain Remediation Services. "HEPA Filter Frame Material."	Clarifies that 804A and B plenums in Building 374 were the only processes to use metal (14 gage, Type 304 stainless steel or chromized carbon steel) frames. HEPA filters used on gloveboxes had wood frames only.	1999 April 8
C238	Letter to file prepared by Carolyn Abbott, North Wind. "Calculating and reporting the net waste weight in standard waste boxes to WIPP."	States that INEEL will consider drums and poly liners in SWBs as packaging and not part of the waste matrix.	2002 May 20
C239	Fax of Memorandum from Dr. Ines R. Triay, CBFO-DOE to Warren Bergholz, DOE-ID. "Annual Re-evaluation of INEEL TRU Waste Program Compliance."	Documents the successful recertification of the INEEL TRU waste program based on completion of the July 30–August 3, 2001 recertification audit and the audit of the INEEL NDA systems conducted April 9–11, 2002. Includes approval to ship organic homogeneous solids and the list of certified procedures, documents, and systems to be used by INEEL.	2002 May 30
C240	Correspondence and other documentation related to the disposition of tantalum targets and subtargets at the Rocky Flats Plant.	This reference includes a variety of documents related to the disposition of tantalum targets and subtargets at RFETS. Documented in the reference are the handling and disposition of the targets following use and a determination that no classified tantalum targets were sent to the INEEL for storage as part of IDC 320.	March 1974 – September 2001
C241	Telecon between Carolyn Abbott, North Wind, and Jeff Harrison, WASTREN. "Material in IDC 376 Drum."	Describes and discusses cartridge type filter previously unidentified by AK discovered during visual examination in IDC 376 waste.	2002 July 18

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C242	Letter to L. S. Sygitowicz from T. H. Monk, BBWI. "Solidified Waste Residual Liquid De-watering Investigation at the Idaho National Engineering and Environmental Laboratory." CCN 22123	Addresses the potential de-watering of solidified wastes (IDCs 001, 002, 007, 800, 803, 807) at the INEEL. Summarizes the investigation by INEEL. Concludes that the INEEL container certification process is WAP compliant in the identification and segregation of homogeneous solid waste drums containing excess residual liquids. The miscertification rate indicates compliance with the WAP requirements. Excess residual liquids are not expected to generate during transport to the WIPP facility.	2001 May 30
C243	Letter to S. M. Edgett from J. J. Einerson, BBWI. "UPDATE OF RTR MISCERTIFICATION RATE DUE TO EXCESS FREE LIQUIDS." JJE-10-2002	Update to C242. Summarizes the observed miscertification rate for the period between the issuance of Revision 5 of the WIPP-WAC and August 19, 2002. Calculates a cumulative point estimate miscertification rate (due to excess free liquid) of 1.4% with an upper 90% confidence limit of 1.7%, easily meeting the relevant WAP criterion (true miscertification less than 14% with 90% confidence).	2002 August 19
C244	Memorandum to T. H. Monk from T. F. Fallon, "CAR 02-078, INVESTIGATIVE ACTION 2." TFF-005-02	Investigation of RTR versus confirmatory Visual data for prior miscertifications due to excess free liquids in homogenous solids drums. Pursuant to CAR-02-078, Investigative Action 2.	2002 August 28
C245	RF Internal Letter, J. K. Paynter to Distribution Hazardous Constituents of Rocky Flats Waste. WCP02-31.	This is an internal memo transmitting tables of Rocky Flats waste. These tables identify the hazardous constituents in the waste by IDC and Hazardous Waste Number.	1989 May 23
C246	Telecon - Mr. Rick Chavez, WTS; Ms. Joan M. Connolly, North Wind; and others.	Discussion of Leaded Rubber Gloves & Aprons WSPF and the new target analyte, methyl chloride. Also discussed updates to the operating record for minor changes such as TRUCON codes.	2002 August 26
C247	Telecon: Jeff Harrison, Wastren, and Charles Marcinkiewicz, North Wind Env., Inc.	Summarizes a discussion about the rationale for assigning D006 and D007 to Leaded Rubber Gloves and Aprons wastes from Building 774, And possible need to assign these HWNs to INEEL waste stream INW252.001. Since the process generating the relevant wastes was initiated after the last wastes were sent to INEEL, assignment of D006 and D007 is not appropriate.	2002 September 24

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
C248	Telecon: Mr. Rick Chavez, Westinghouse TRU Solutions; K. Gilbert, BBWI, and C. Abbott, J. Connolly, and C. Marcinkiewicz, North Wind Env., Inc.	Summarizes a discussion about the rationale to submit new target analyte data using TIC values to generate UCL 90 concentrations for the INW252.001 waste stream profile.	2002 August 26
C249	Letters: November 21, 1996 and December 4, 2001 from J. A. Nesheim, Worldwide Security Services to J. M. Schoen, Waste Systems and November 1, 1993 from J. A. Nesheim. EG&G Rocky Flats to F. M. Durel.	Letters regarding UCNI exemption for the Waste Stream and Residue Identification and Characterization (WSRIC) documentation and the WSRIC electronic database V. 3.2 CD.	2001 December 4
C250	Acceptable Knowledge Accuracy Assessments – First Quarter FY-2000, dated Nov. 29, 2000; Third Quarter FY-2001 dated July 19, 2991; FY-2002, Rev. 1, dated Aug. 8, 2002; Final FY-2002 dated Jan. 14, 2003.	Interoffice memorandums from S. Hailey for FY-2000 & FY-2001 and L. Frost for FY-2001 and FY-2002. Accuracy assessments of WMC, HWN and radioisotope assignments by AK by fiscal year were transmitted to T. H. Monk.	2003 January
C251	Acceptable Knowledge Resolution Checklist, AK-03-001.	Assessment of discrepancies between statistical evaluations of HSG data assuming normal distribution compared to transformation. It was determined for HSG data from RFP waste streams as presented in the attached tables, that statistical evaluation of the data assuming normal distribution (without transformation) resulted in more conservative assignment of EPA HWNS than if transformations to normality are used.	2003 January
P001	TRU Waste Compliance Program for WIPP-WAC (U). WO-4500-H.		1989
P002	Organic and Sludge Immobilization System. RFP-4095.	Description of the development and operation of the OASIS process (IDCs 700 and 801).	1987
P003	Quality Assurance Program for TRU Waste Certification. WC-4500-D.	Companion procedure to WO-4500 specific to certification procedures used by Rocky Flats to pre-certify Transuranic waste shipped to INEL.	1988
P004	Rocky Flats Plant Waste Management Site Plan.	Description of waste activities at Rocky Flats emphasizing solid and liquid waste treatment.	1987
P005	Procedure for Labeling and Marking Unclassified TRU Waste Containers for Shipment to INEL. Traffic 300-1.	Traffic Department Procedure for labeling and marking containers of transuranic waste transported via ATMX rail car to INEL.	1988
P006	Gas Generation Results and Venting Study for Transuranic Waste Drums. RFP-3739.	Gas generation measurements from IDCs 001, 003, 330, 336, 337, and 339 wastes.	1985

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P007	Waste Operations Internal Document Control for Documents Pertaining to the WIPP-WAC. WO-4000-A.	Procedure listing holders of controlled copies of procedures pertaining to generation of WIPP-certified waste.	1989
P008	Packaging and Handling Line- and Nonline-Generated Materials (U). 1-1002-C/0.	Packaging procedure stating general requirements for nonline- and line-generated waste. This procedure also includes IDC-specific packaging requirements.	1988
P009	Characterization and Categorization Study of TRU Waste for EG&G. CSE 80-0017.	Description of drums destructively examined for EG&G Idaho. IDCs included are 330, 336, 480, 481, 442, 339, and 440.	Undated
P010	Solid Waste Inspection. WC-4003-I.	Procedure for waste inspectors reviewing low-level waste and transuranic waste containers. (Page 9 has OASIS [IDC 801/700] recipe requirements.) IDC descriptions are included in the back of the procedures.	1989
P011	FY-1987 Waste Operations Operating Plan.	Describes manpower, budget, and waste operations for RFP during FY 1987.	Undated
P012	TRUPACT-II Content Codes (TRUCON). 89-004.	Content code descriptions (roll-up of IDCs) for transportation. Descriptions include generation area, short process write-up assay, and packaging configurations.	1992
P013	EG&G Sampling Program Results FY1987. PSD87-059.	Results from Destructive Examination of IDCs 292, 411, 440, 1, 3, 4, and 7 wastes.	1987
P014	TRU Waste Certification Program for WIPP-WAC (U). CO-4500-A.	Forerunner to WO-4500. First procedure to describe the WIPP certification program at RFP.	1983
P015	TRU Waste Sampling Program: Volume I-Waste Characterization. EGG-WM-6503.	Destructive Examination and gas sampling of transuranic wastes. A large number of IDCs from RFP and LANL are represented.	1985
P016	Idaho National Engineering Laboratory Code Assessment of the Rocky Flats Transuranic Waste. INEL-95/0281.	Description of each IDC shipped to INEL from RFP from 1985 until 1989.	1995
P017	Preliminary Assessment of Real-Time Radiography and Visual Characterization for Selected Waste Categories. RFP-4604.	A variety of transuranic wastes in drums were examined by RTR then destructively examined in the Size Reduction unit. This project report details the accuracy of the RTR examination compared to usual examination and weighing of contents.	1993
P018	Waste Drum Gas Generation Sampling Program at Rocky Flats during FY 1988.RFP-4311.	Inorganic and organic sludges, Raschig rings, and combustibles drums were evaluated for gas generation rate, gas composition, and physical contents in 1988.	1991

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P019	HEPA Filter Optimization/Implementation.RFP-4171.	Describes efforts to reduce IDC 490 waste volume by using prefilters. Describes the Building 771 plenums.	1988
P020	Characteristics of Transuranic Waste at Department of Energy Sites. RFP-3357.	Inventory data (1981) for transuranic wastes at DOE facilities. No specific process information; rather, inventory data, i.e., radionuclide content, volume, weight, etc.	1983
P021	EG&G Drum Sampling Program Results FY1986. PSD86-061.	Physical evaluation of drum contents for IDC 300, 303, 320, 339, 411, 432, 440, and 004. Drums originally generated at Rocky Flats, sent to Rocky Flats from INEL for examination, and then returned to INEL.	1986
P022	EG&G Sampling Program Results FY1989. PSD89-011.	Visual examination results for IDCs 003, 312, 300, 007, 001, 440, 442, 337, and 480. Waste originally generated at Rocky Flats, then returned to Rocky Flats from INEL for examination.	1989
P023	(Task 5 Draft Report) Estimating Historical Emissions from Rocky Flats.	Chemical usage information at RFP.	1992
P024	Content Code Assessments for INEL Contact-Handled Stored Transuranic Wastes. WM-F1-82-021.	Assessment, by content code, of transuranic wastes stored at INEL in 1981. Process, packaging, radionuclide, and certification information by content code is included.	1982
P025	Standard for DOT-17C 55 Gal. Drum. Rocky Flats Plant STD No. SX-200 (formerly P.E. No. P12413).	Procurement standard for white 55-gallon drums used for waste packaging.	1977
P026	Transuranic Solid Waste Inspection (U). WC-4003-A.	Procedure for inspector's examination of solid waste including paperwork, physical examination, and packaging.	1985
P027	TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant. WIPP/DOE-069.	Waste acceptance requirements for transuranic waste stored at the WIPP site.	1989
P028	TRU Waste Certification Compliance Requirements for Acceptance of Newly Generated Contact-Handled Wastes to be Shipped to the Waste Isolation Pilot Plant. WIPP-DOE-114.	Discussion of WIPP/WAC criterion, intent, controlled properties, and compliance requirements.	1989
P029	Safety Analysis Report for Packaging - Corrugated Steel Container (SAND Box) for DOE Specification 7A Packaging. RFP-3345.	This report details the Type A testing performed on the SAND Box.	1983
P030	Drop Test of DOT Specification 7A Type A Metal Corrugated Box (SANDbox) with a 3/4" Plywood Liner. WPS 89-001.	This report details the testing of the wooden liner for metal wastes placed in the SANDbox.	1989

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P031	Full-Scale Drop-Impact Tests with DOT Specification 7A Waste Containers. WPS 88-001.	Details on testing of 55-gallon drums and SAND boxes for the revised ATMX SAR.	1988
P032	Waste Item Description Code Manual. WC-4004-A.	1987 procedure that provides IDC definitions and certification status for each IDC.	1987
P033	Summary of Transuranic Waste Characterization Programs at the INEL (1979-Present). INEL-95/0397.	This document describes the transuranic waste characterization programs to date including results of RTR examinations, visual examinations, headspace gas analysis, solid sample analysis, and radioassay.	1995
P034	Health, Safety & Environment Manual.Disposal of Excess Chemicals, Waste Oils, and Organic Solvents. HSE 21.01.	This procedure applies to the disposal of excess chemicals, waste oils, and organic solvents.	1982
P035	Backlog Residues at the DOE Rocky Flats Plant: Residue IDC Descriptions.	Document generated by the Residue Elimination project. The document describes the residue, IDC by IDC, with regard to form, plutonium content, RCRA characterization, and shipment information.	1993
P036	Radioactive Waste Package Development at the Rocky Flats Plant. IAEA-SR-10/26.	Development of rigid liners for transuranic waste drums.	
P037	Rocky Flats Environmental Technology Site 1995 Annual Land Disposal Restriction Progress Report.	Characterization information for LDR wastes. This document uses BWR as the primary characterization reference.	1995
P038	Residue Analysis Study. CE-010-001.	This document includes extracts of complete data/details for individual IDCs when required for analysis or discussion. General information on the scope, assumptions made, and methodologies used can be found in Chapters I through IV of the Study.	1992
P039	Rocky Flats Plant Radioactive Waste Packaging Requirements. 1-M12-WO-4034.	Waste packaging requirements for low-level and transuranic waste.	1994
P040	Operating the Building 771 Waste Collection System (Decontamination Shower and Process Sinks (U). CO-4017-F.	Operating procedure for Building 771 process waste (2nd stage treatment).	1984
P041	Waste Receiving and Transferring, Second Stage Tanks (U). WO-4026-A/0.	Operating procedure for 2nd stage treatment tanks in Building 774.	1987
P042	Liquid Waste Processing (Second Stage (U). WO-4004-A.	Operating procedure for 2nd stage precipitation in Building 774.	1987

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P043	TRU Waste Compliance Program for WIPP-WAC (U). WO-4500-F.	Procedure that RF was audited to for WIPP certified waste (pre-certified waste to INEL). Process descriptions for individual waste forms are located as appendices in the back.	1987
P044	Evaluation of RFP TRU/TRU-Mixed Inventory for Compliance with Selected WIPP and TRAMPAC Requirements. 94-RF-06806.	Comparison of RF transuranic wastes to WIPP waste acceptance and transportation requirements.	1994
P045	Standard for Corrugated Metal Waste Container (Steel Box). Rocky Flats Plant STD No. SX-231.	Procurement standard for corrugated metal boxes (also known as a 4 × 4 × 7 metal box or SAND Box).	1983
P046	ATMX-600 Rail Car Safety Analysis Report. RFP-2444 (Draft).	Provides details on the ATMX-600 rail car construction, operation, and safety features. The ATMX-600 was used to transport waste from RFP to INEL.	1985
P047	Filtering, Drying, Conveying, Cementing, and Packaging Sludge (U). WO-5014-A/1.	Procedure for waste treatment in Building 374.	1987
P048	Waste Operations Supplies. WO-4040.	Document provides details on proper handling, storage, and preparation of waste supplies (empty containers, pallets, liners).	1989
P049	Annual Land Disposal Restriction Progress Report. Rocky Flats Plant.	This document provides current (at the time of publishing) information on inventory and treatment development.	1994
P050	Waste Acceptance Criteria for the Waste Isolation Pilot Plant. WIPP-DOE-069.	Waste acceptance requirements for transuranic waste at the WIPP site.	1991
P051	Rocky Flats Environmental Technology Site Proposed Site Treatment Plan.Background Volume and Compliance Plan Volume.	Plan for treatment of RFP mixed wastes.	1995
P052	Backlog Waste Reassessment Baseline Book.	The Backlog Baseline Book provides RCRA characterizations and associated rationales for wastes stored at RF. Good source of process descriptions.	1995
P053	(Tasks 3 & 4 Final Draft Report) Reconstruction of Historical Rocky Flats Operations and Identification of Release Points.	Excellent historical description of Rocky Flats operations.	1992
P054	Handling Miscellaneous Wastes in Size Reduction, Building 776. WO-4016-E.	Describes wastes treated in Size Reduction and secondary wastes generated from the waste treatment activities.	1988
P055	Inspection of Raschig Rings in Contaminated Tanks (U). CO-3002.	Procedural requirements for inspecting Raschig rings including taking ring samples.	1988
P056	Removal and Replacement of Raschig Rings (U). CO-3001.	Procedural requirements for removal of Raschig rings from tanks.	1989

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P057	Operational Safety Analysis (OSA). Raschig Ring Inspection, Removal, and Replacement. 771.037.	Operational safety analysis for Raschig ring inspection, removal, and replacement.	1989
P058	Rocky Flats Plant Hazardous Waste Determination Status Report No. 2.	Preliminary characterization data for residues. Published in 1991.	1991
P059	Graphite Process Operations in Building 707. FO-0015.	Description of used graphite mold processing.	1991
P060	Waste Stream and Residue Identification and Characterization Building 707. 707-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 707.	1992
P061	Waste Stream and Residue Identification and Characterization Building 771. 707-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 771.	1992
P062	Waste Stream and Residue Identification and Characterization Building 779. 779-V3.2.	Process description, flow diagrams, and descriptions for process outputs for Building 779.	1991
P063	Packaging Wastes for Shipment Offsite (U). WO-4034-C.	Packaging requirements for transuranic and low-level wastes at RFP.	1986
P064	Waste Packaging Requirements. WO-4034-F.	Packaging requirements for transuranic and low-level wastes at RFP.	1988
P065	Material Safety Data Sheet for Purifloc (R) A23 Flocculant.	Composition of precipitation flocculant used in Building 774.	1985 March 1
P066	Material Safety Data Sheet for ENVIROSTONE (and related data).	Composition of Envirostone products used in the OASIS process.	1986 May 12
P067	Waste Stream Identification and Characterization.	Descriptions of Rocky Flats waste streams and processes.	1987
P068	Chemical Safety Bulletins Building 81-83.	MSDS-like composition information for chemicals at RFP.	1962
P069	Nuclear Materials Control Elements printout. SAN Database. Report No. 6016-01.	Element coding in SAN for accountable nuclear material.	1984 Query date June 1
P070	Operational Safety Analysis (OSA). Waste Receipt and Processing No. 774.001.	Contains treatment process descriptions from Building 774.	1995
P071	Waste Receiving and Transferring, (Second Stage) Bldg. 774. WO-2026.	Operating procedure for tanks associated with 2nd stage treatment in Building 774.	1990
P072	EG&G Rocky Flats Plant Waste Operations Procedures Nuclear Safety Related Category 3. TRU Organic Waste Sampling and Transferring, Buildings 707 and 777. WO-2010.	Operating procedure for pipeline transfers of organic waste to Building 774.	1991
P073	Process Qualification Report for Miscellaneous Waste Handling and Solidification (Bottlebox) Building 774. A-008-LWTO.	Process development information for IDC 004/802 waste.	1993
P074	Plutonium Recovery Waste Collection System, Building 771. WO-4007-B.	Information on collection and treatment of liquid wastes from Building 771.	1988

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P075	Liquid Waste Processing (First Stage). WO-4001-A.	Operating procedure for 1st stage waste treatment.	1988
P076	Waste Stream and Residue Identification and Characterization Building 559. 559-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 559.	1991
P077	Waste Stream and Residue Identification and Characterization Building 774. 774-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 774.	1992
P078	Waste Stream and Residue Identification and Characterization Building 776. 776-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 776.	1992
P079	Waste Stream and Residue Identification and Characterization Building 777. 777-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 777.	1992
P080	RCRA Land Disposal Restrictions: A Guide to Compliance. 1995 Edition. The Hazardous Waste Consultant. Vol. 12, Issue 6. ISSN 0738-0232.	The document is a guidance and interpretation book on RCRA regulations. Specifically, the book provides guidance on assigning EPA hazardous waste numbers and the applicability of the land disposal restrictions.	1994 October/ November
P081	Waste Stream and Residue Identification and Characterization Building 371. 371-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 371.	1992
P082	Waste Stream and Residue Identification and Characterization Building 374. 374-V3.2.	Process description, flow diagrams, and descriptions for process outputs generated in Building 374.	1992
P083	Waste Stream and Residue Identification and Characterization Database.	Rocky Flats waste stream information. Originally gathered in 1989-1990.	1996
P084	Material Safety Data Sheet for Varsol 1.	Varsol is a trade name petroleum solvent or Stoddard solvent.	1986 August 25
P085	Waste Systems Progress Report March 1983 through February 1984. RFP-3682.	Summary of waste treatment technology development for transuranic wastes.	1984
P086	Neptunium Processing at the Rocky Flats Plant. RFP-2899.	Summary of neptunium-237 processing at Rocky Flats.	1981
P087	Nondestructive Radioassay for Waste Management — An Assessment. RFP-3256.	History of waste radioassay at Rocky Flats from 1964 to 1981.	1981
P088	Glovebox Window Materials. RFP-1424.	Information regarding glovebox window and window adhesive materials used at Rocky Flats in 1970.	1970
P089	Waste Systems Progress Report March 1984 through February 1985. RFP-3871.	Summary of waste treatment technology development for transuranic waste.	1986
P090	History of Rocky Flats Waste Streams.RFP-3186.	History of Rocky Flats waste shipped to the INEL from 1971 to 1979.	1982
P091	Materials Hazards Manual.	Hazards and composition of chemicals used at Rocky Flats.	1976

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P092	Residue Dissolution (Lines 23 and 25) (U). CO-1026-T/0.	Process procedure for dissolution of pulverized incinerator ash, graphite, sand, slag, and crucible, along with the resultant heels.	1988
P093	Residue Dissolution, Gloveboxes 1500 A, 1500 B, and 1515, Building 371 (U). CO-1130-B/0.	Process procedure for dissolution of incinerator ash in Building 371.	1988
P094	Special Recovery Operation General Procedures (U). CO-2018-E/0.	General procedures for tank and powder sampling in the Special Recovery area of Building 771.	1988
P095	Plutonium-Neptunium Separation (U). CO-2017-B/0.	Procedures for processing plutonium-neptunium mixtures including oxide dissolution, feed preparation, wash preparation, ion column operations, and product evaporation.	1987
P096	Operating the Ion Columns (Special Recovery, Line MT-4) (U). CO-2010.	Operating procedures for the Special Recovery ion column system.	1989
P097	HSA Incineration System Scarfing and Grinding (U). CO-6017-C.	Procedures for scarfing of graphite and firebrick in Building 371.	1984
P098	Resin Cementing Line 2 (U). CO-1027.	Operating procedures for the cementation of resin, sludge, grit, ash, and heel in Building 771.	1988
P099	Molten Salt (8%) Residue Process (Line 30) (U). CO-1012-G.	Operational procedure for dissolution of 8% magnesium chloride molten salt in Building 771.	1978
P100	Leaching Tantalum Fixtures and Inserts (Line 5) (U). CO-1019-K/0.	Operating procedure for acid leaching to remove plutonium from tantalum fixtures in Building 771.	1988
P101	Modified Purex Solvent Extraction Process (Special Recovery; Lines MT-3, MT-7) (U). CO-2005-K/0.	Operational procedure for organic/aqueous solvent extraction of uranium from plutonium in the special recovery area of Building 771.	1988
P102	Anion Exchange (Lines 42 and 43D) (U). CO-1033-AA/0.	Operating procedure for plutonium nitrate solution purification using anion exchange resin in Building 771.	1988
P103	Sand, Slag, and Crucible Size Reduction, Lines 43A and C (U). CO-1005-J/0.	Operating procedure for crushing and grinding sand, slag, and crucible generated in the reduction process during plutonium metal production.	1988
P104	Scarfing Graphite (Line 43A) (U). CO-1076-D.	Operating procedure for scarfing graphite in Building 771.	1988
P105	Operational Safety Analysis (OSA). Special Recovery Ion Exchange. 771.047.	Operational safety analysis for ion exchange separation of actinides in the Special Recovery area of Building 771.	1989
P106	Waste Stream Residue Identification and Characterization Building 374. 374-V5.0.	Process description, flow diagrams, and descriptions for process outputs generated in Building 374.	1993

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P107	Waste Stream Residue Identification and Characterization Building 559. 559-V5.0.	Process description, flow diagrams, and descriptions for process outputs generated in Building 559.	1993
P108	Waste Stream and Residue Identification and Characterization Building 707. 707-V5.0.	Process description, flow diagrams, and descriptions for process outputs generated in Building 707.	1995
P109	Waste Stream Residue Identification and Characterization Building 774. 774-V5.0.	Process description, flow diagrams, and descriptions for process outputs generated in Building 774.	1993
P110	Waste Stream Residue Identification and Characterization Building 776. 776-V5.0.	Process description, flow diagrams, and descriptions for process outputs generated in Building 776.	1993
P111	Waste Stream Residue Identification and Characterization Building 777. 777-V5.0.	Process description, flow diagrams, and descriptions for process outputs generated in Building 777.	1992
P112	Waste Stream and Residue Identification and Characterization Building 779. 779-V5.0.	Process description, flow diagrams, and descriptions for process outputs for Building 779.	1991
P113	Actinide Processing at Rocky Flats.	Detailed description of actinide recovery and waste treatment at Rocky Flats	1991
P114	Federal Facilities Compliance Agreement Compliant Order Storage Report.	Information on Rocky Flats LDR wastes as compiled in 1989 and 1990 including process descriptions and inventories.	1990
P115	Solid Waste Information Management System Database.	Container information for transuranic waste shipped to INEL from Rocky Flats 1985 through 1989.	
P116	Federal Facilities Compliance Agreement/Compliance Order Inventory Report.	Process descriptions and inventories for Rocky Flats mixed waste that was not LDR in 1989.	1989
P117	Sorting and Scarfing Firebrick (Line 48) (U). CO-1039-D.	Operating procedure for sorting and scarfing firebrick from the Building 771 incinerator.	1988
P118	Material Safety Data Sheet for Supertemp 1900/Ramcote 1200.	MSDS for cement referred to as pipe insulation or magnesia cement.	1991 January
P119	Material Safety Data Sheet for Metex Chemicals.	Composition of Metex-series chemicals used at Rocky Flats. Metex solution is referenced in the Building 774 setup log book (U043). It is unclear which Metex product was treated.	1985-1986
P120	Flammability of Leaded Dry-Box Gloves. RFP-1354.	Results of a study of the reaction of nitric acid with neoprene and Hypalon leaded gloves.	1969
P121	Waste Characterization Report Heavy Metals. Item Description Code 320.	Description of the heavy metal inventory (IDC 320) of Rocky Flats.	1993
P122	Document title unknown. Exhibit 1 excerpt. RFP-2487.	Excerpt from RFP-4148—results of the analysis of 774 sludge samples.	Date unknown

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P123	Packaging Rocky Flats Waste. Radioactive Waste. RFP 2487.	Packaging of liquid and solid treated wastes at Rocky Flats.	1976 May 17
P124	A Survey of the Rocky Flats Division Waste Streams. CRDL-950351-009.	Source, volume, composition, and disposition of aqueous and solid waste streams and air emissions from Rocky Flats Plant.	1972 June 30
P125	Waste Stream and Residue Identification and Characterization Sampling and Analysis Database.	Analytical data from WSRIC waste stream sampling and sampling of Rocky Flats inventory waste.	1992
P126	Waste Stream and Residue Identification and Characterization Building Valve Vaults.	Describes the aqueous process wastes from various buildings on plant site that are sent to Building 374 through the process waste transfer system.	1993
P127	INEL SWEPP Track Accessible Database.	INEL accessible drum storage data for Rocky Flats inventory, including number of containers and dates of generation.	1996
P128	Material Safety Data Sheet for Mariko.		1986 September 11
P129	Material Safety Data Sheet for OX-Out 536.		1986 May 5
P130	Material Safety Data Sheet for TRIM SOL.		1992 February 27
P131	Waste Analysis At Facilities That Generate, Treat, Store, and Dispose of Hazardous Wastes. A Guidance Manual. PB94-963603. OSWER 9938.4-03.	EPA Guidance for Waste Analysis and when acceptable knowledge should be used.	1994 April
P132	Predecisional Draft Transuranic Waste Characterization Acceptable Knowledge Guidance Document. R-6078.	Guidance document for the use of acceptable knowledge.	1995 August
P133	Quality Assurance Program Description. CAO-94-1012.	Quality management document which identifies federal and industry quality requirements applicable to the CAO quality assurance program.	1994 June
P134	Waste Isolation Pilot Plant RCRA Part B Permit Application. Appendix C9, TRU Waste Characterization Using Acceptable Knowledge. DOE/WIPP 91-005.	Methodology for the use of Acceptable Knowledge.	1996 January 15
P135	Guidance For Preparing Transuranic Waste Sampling Plans (Draft). R-6157.	Guidance on how to develop site-specific sampling plans.	1995 November
P136	Guidance For Preparing Transuranic Waste Sampling Plans. R-6157.	Guidance on how to develop site-specific sampling plans.	1996 February
P137	Transuranic Waste Characterization Quality Assurance Program Plan. CAO-94-1010.	Identifies the quality of data necessary and techniques designed to attain and ensure the required quality to meet WIPP-DQOs.	1995 April 30

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P137A	Transuranic Waste Characterization Quality Assurance Program Plan. CAO-94-1010.	Identifies the quality of data necessary and techniques designed to attain and ensure the required quality to meet WIPP-DQOs.	1996 November 15
P138	Waste Acceptance Criteria For The Waste Isolation Pilot Plant. DOE/WIPP-069.	Waste acceptance criteria for WIPP.	1996 January
P139	Reactivity of Pyrochemical Salts at Rocky Flats Plant. 14-RF-04701.	Review of the reactivity characterization of pyrochemical salts.	1994 April
P140	Analytical Methods for Determining the Reactivity of Pyrochemical Salts. TDR-94-011.	Methods developed to analyze pyrochemical salts for reactivity; includes description of metals in pyrochemical salts.	1994
P141	Matrix Parameter Category Groups (MPCG). Engineering Design File. LMITCO. RWMC-EDF-805; INEL-95/029, Rev. 0. December 13, 1995. RWMC-EDF-805; INEL-95/029, Rev. 1. October 27, 1997. RWMC-EDF-805; INEL-95/029, Rev. 2. April 12, 2001. RWMC-EDF-805; INEL-95/029, Rev. 3. July 9, 2002. RWMC-EDF-805; INEL-95/029, Rev. 4. September 13, 2002.	Groups the waste streams stored in the Transuranic Storage Area at the Radioactive Waste Management Complex into MPCGs. Also included with Revision 0 is a logic diagram for characterization of TRU wastes (from CAO-94-1010) and definitions for various MPCs (from the DOE Waste Treatability Group Guidance document, DOE/LLW-217).	1995 December 13
P142	Material Safety Data Sheet for ZL-22A Zyglo Penetrant.	Zyglo Penetrant MSDS.	1993 June 14
P143	Material Safety Data Sheet for Developer Fluid Contained in Film Pod.	Developer Fluid contained in film pod MSDS.	1986 February 10
P144	Material Safety Data Sheet for KODAK Developer D-19. CAT 146 4593, CAT 194 6045.	Kodak Developer D-19 MSDS.	1984 March 14
P145	Material Safety Data Sheet for KODAK INDUSTREX Developer Replenisher, Part A. CAT 139 7215.	Kodak INDUSTREX Replenisher MSDS.	1985 January 3
P146	Material Safety Data Sheet for KODAK INDUSTREX Developer Starter. CAT 162 8528.	Kodak INDUSTREX Starter MSDS.	1984 August 27
P147	Material Safety Data Sheet for KODAK HRP Developer. CAT 140 1306.	Kodak HRP Developer MSDS.	1984 June 25
P148	Material Safety Data Sheet for KODAK RP X-OMAT Developer Replenisher.	Kodak RP X-OMAT MSDS.	1985 December 31
P149	Material Safety Data Sheet for ZE-3 Zyglo Emulsifier.	Zyglo Emulsifier MSDS.	1991 December 5
P150	Material Safety Data Sheet for ZP-5 Zyglo Aqueous Developer.	Zyglo Aqueous Developer MSDS.	1991 December 5
P151	Safety Analysis Report for the TRUPACT-II Shipping Package. Appendix C, Volume 4.	Appendix 3.6.8 - radiolytic G values for waste materials.	1994 October

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P152	"Plutonium Metal Feed Specification for Use in the Weapons Program." Volume I.	Metallurgical, chemical, and isotopic specifications for Rocky Flats WR Plutonium (nonspecification plutonium definition).	1985 March 22
P153	Analytical Requirement Review of Saltcrete. Item Description Code 804. 96-RMRS-SSOC-0004.	Analytical requirements for saltcrete for LDR regulations.	1996 February 20
P154	Uncertainty Analysis of the SWEPP Drum Assay System for Graphite. Content Code 300. INEL-95/0475.	Describes the methodology for determining the total uncertainty of the SWEPP drum assay system for graphite content code 300.	1995 September
P155	Uncertainty Analysis of the SWEPP PAN Assay System for Glass Waste. Content Codes 440, 441, and 442. INEL-96/0343.	Describes the methodology for determining the total uncertainty of the SWEPP drum assay system for glass waste, content codes 440, 441, and 442.	1996 October
P156	Uncertainty Analysis of the SWEPP PAN Assay System for Combustible Waste. Content Codes 330 and 336. INEL-96/0257.	Describes the methodology for determining the total uncertainty of the SWEPP drum assay system for combustible waste, content codes 330 and 336.	1996 August
P157	Proceedings of the Non-Destructive Assay and Non-Destructive Examination Waste Characterization Conference. CONF-940216.	Experience gained from Passive/Active Neutron (PAN) assay managements on 12,600 TRU waste drums at INEL LV East, G.K. Becker; Second Generation PAN.	1994 February
P158	Matrix Effects in TRU Assays using the SWEPP PAN Assay System. EGG-PHY-9204.	DAS (Drum Assay System) study of DAN system results of 50,000 drums of TRU waste from RFP. Active assay matrix dependent correlation factors for many IDCs.	1990 August
P159	SWEPP Non-Destructive Assay (NDA) Methodology for Waste Entrained Uranium. RWMC-657.	Describes the process used to quantify U238 in waste using PAN.	1993 September 1
P160	Relative Isotopic Mass Ratio Gamma Measurements. RWMC-EDF-533.	Describes the technique used for radionuclide identification and the determination of relative isotopic mass ratios in wastes in SWEPP.	1994 June 28
P161	Dose Reconstruction Project Task 5. Estimating Historical Emissions from Rocky Flats.	Development of estimates for routine radioactive airborne emissions, routine nonradioactive airborne emissions, routine surface-water-borne emissions, and Nonroutine contaminant releases.	1992 November
P162	Dose Reconstruction Project Task 1. Identification of Chemicals and Radionuclides Used at Rocky Flats, Draft Report.	Preparation of a list of the radionuclides and chemicals that have been used or produced at Rocky Flats since 1952.	1991 January
P163	Rocky Flats Plant Plutonium Recovery Reference Process. (Including Historical References 1952 to 1991). RT92-002.	Plutonium recovery at Rocky Flats.	1992 February 3

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P164	A History of the Rocky Flats Plutonium/Actinide Recovery Plant, 1952-1991. RT92-003.	Actinide recovery at Rocky Flats; includes plutonium, americium, uranium, neptunium, and curium processes.	1992 February 3
P165	A Comprehensive History of the Rocky Flats Plutonium/Actinide Recovery Operations. 1952-1991 (Draft).	A more comprehensive version of "A History of the Rocky Flats Plutonium/Actinide Recovery Plant."	Unknown
P166	Rocky Flats Risk Assessment Guide. RF/03/00/85/0/5.	Methodologies used to determine risk of facilities and operations at the Rocky Flats Plant.	1985 March
P167	Neptunium Processing at the Rocky Flats Plant. RFP-2899.	Processes used at Rocky Flats to recover and purify neptunium and processes used for conversion to metal for casting and rolling.	1981 September 20
P168	Status of Americium-241 Recovery at Rocky Flats Plant. RFP-3061.	Extraction of americium 241 by MSE.	1981 March 18
P169	Plutonium Isotopic Ratios at Rocky Flats.	Inventory of plutonium fallout from mass spectroscopic analysis of plutonium recovered from soil around Rocky Flats.	1990 November 16
P170	The Past 30 Years at Rocky Flats Plant. HS371.	A summary of experiences and observations at Rocky Flats Plant over the past 30 years with an emphasis on health and safety.	1982 November
P171	Evaluation of Residue Drum Storage Safety Risks. RFP-4826, UC-721, DOE/OSTI-4500.	Potential safety problems of packaged drums at Rocky Flats.	1994 June 17
P172	Standard for Cylindrical HEPA Filters. SMU-404.	Standard for cylindrical shaped, fire resistant, water resistant, high efficiency particulate air (HEPA) filter units.	1974 February 1
P173	Standard for HEPA Filters, General Purpose. SMU-401.	Standard for square and rectangular shaped, fire resistant, water resistant, high efficiency particulate air (HEPA) filter units.	1974 February
P174	Building 374 Evaporator Feed Streams.	Identifies waste that is treated in the evaporation process at Building 374. Drawings referenced in the table are not included.	1992 April 21
P175	Conceptual Design Report—Plutonium Recovery Project. Volume II, Part 3—Technical Appendix: Specifications and Drawings. 87-RF-1817.	Specifications and drawings for the conceptual design of the plutonium recovery processes in Building 371.	1987 March 16
P176	Project Plan for Inspection, Sampling, and Characterization of Solid Residues. SRM-012-022.	Detailed chemical and physical analysis of a representative sampling of the residues.	1995 December 13
P177	(Task 2 Final Report) Selection of the Chemicals and Radionuclides of Concern.	Excellent historical description of Rocky Flats operations.	1991 June

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P178	Research and Development Quarterly Progress Report. October, November, and December 1968. RFP-1311-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1969 January 31
P179	Research and Development Quarterly Progress Report. April, May, and June 1969. RFP-1406-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1969 July 31
P180	Research and Development Quarterly Progress Report. July, August, and September 1969. RFP-1436-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1969 October 31
P181	Research and Development Quarterly Progress Report. January, February, and March 1970. RFP-1519-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1970 April 30
P182	Research and Development Quarterly Progress Report. April, May, and June 1970. RFP-1579-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1970 September 16
P183	Research and Development Quarterly Progress Report. July, August, and September 1970. RFP-1602-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1970 October 30
P184	Research and Development Quarterly Progress Report. October, November, and December 1970. RFP-1638-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1971 January 31
P185	Research and Development Quarterly Progress Report. January, February, and March 1971. RFP-1691-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1971 April 30
P186	Research and Development Quarterly Progress Report. April, May, and June 1971. RFP-1748-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1971 July 30
P187	Research and Development Quarterly Progress Report. July, August, and September 1971. RFP-1790-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1971 October 29
P188	Research and Ecology Annual Report. Chemistry Research and Development. (Published 4/14/72). RFP-1837-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1972 April 14
P189	Research and Ecology Semi-Annual Progress Report. Chemistry Research and Development. January-June 1972. RFP-1921-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1972 August 30

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P190	Research and Ecology Semi-Annual Progress Report. Chemistry Research and Development. July through December 1972. RFP-2004-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1973 May 16
P191	Research and Ecology Semi-Annual Progress Report. Chemistry Research and Development. January-June 1973. RFP-2102-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1973 August 13
P192	Research and Ecology Semi-Annual Progress Report. Chemistry Research and Development. July-December 1973. RFP-2200-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1974 March 18
P193	Research and Development Semi-Annual Progress Report for July through December 1994. RFP-2360-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1975 February 24
P194	Research and Development Semi-Annual Progress Report for January through June 1975. RFP-2417-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1975 August 29
P195	Research and Development Semi-Annual Progress Report for January through June 1977. RFP-2680-A.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1977 October 21
P196	Chemistry Research and Development Annual Progress Report. November 1, 1979 to October 31, 1980. RFP-3180.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1981 August 4
P197	Chemistry Research and Development Annual Progress Report. November 1, 1980 to September 30, 1981. RFP-3324.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1982 August 11
P198	Chemistry Research and Development Annual Progress Report. October 1, 1981 to September 30, 1982. RFP-3511.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1983 September 16
P199	Chemistry Research and Development Annual Progress Report. October 1, 1982 to September 30, 1983. RFP-3654.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1984 September 24
P200	Chemistry Research and Development Annual Progress Report. October 1, 1983 to September 30, 1984. RFP-3825.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1986 June 13
P201	Chemistry Research and Development Annual Progress Report. October 1, 1984 to September 30, 1985. RFP-3931.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1986 August 18

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P202	Chemistry R&D Monthly Progress Report. R&D 86-012.	Reports summarizing special order, research and development, analytical development, production support (recovery development).	1986 January
P203	Interim Guidance on Ensuring that Waste Qualifies for Disposal at the Waste Isolation Pilot Plant.	Guidance to assist the transuranic waste sites in establishing and demonstrating that only TRU waste generated by atomic energy defense activities is certified for disposal at WIPP.	1997 February 13
P204	Linking Legacies. Connecting the Cold War Nuclear Weapons Production Processes To Their Environmental Consequences. DOE/EM-0319.	Historical report connecting the missions and functions of the nuclear weapons facility with the inventory of waste and materials remaining at the site.	1997 January
P205	Nonmixed Waste Determination for IDC 300 Waste (Graphite Molds). INEEL/EXT-98-01137.	Summarizes TCLP sampling, headspace sampling, headspace gas sampling, visual examinations, RTR examinations, and AK Knowledge Information used to make nonmixed determination for graphite molds	1999 February
P206	234U Activity with Respect to Total Alpha Activity. INEEL/INT-98001268, EDF-RWMC-1045.	Reviews the results of the U-234 content in all drums processed at the RWMC from September 25, 1997 through September 18, 1998.	1999 March
P207	RWMC HWMA/RCRA Permit Permit Condition II.K.4 Semi-Annual Verification/Characterization Progress Report, RWMC Document Control should be contacted for most current revision.	Document used to report characterization progress to the State of Idaho. This report is no longer being used for inventory values of accessibly stored waste (inventory values are now obtained from TRIPS). The most current version of this report will not be maintained separately in the AK report.	2001 February
P208	Hydrogen Permeability Through Taped and Untapped “Clam Shell” Containers Used at Rocky Flats Environmental Technology Site.	Documents the fact that clam shells are airtight containers greater than 1 liter.	1999 February
P209	Radioactive Waste Management Complex Area Map, Drawing No. 175603, Rev. 7, February 24, 2000. Rev. 8, September 8, 2002.	Provides a map of the RWMC.	2000 February 24
P210	Default Plutonium Mass Fractions for Rocky Flats Plant Waste EDF-1242.	This report establishes the plutonium mass fractions used at the INEEL for assaying Rocky Flats Plant transuranic waste. Extensive use was made of historical shipping records. This document is superseded by EDF-1609 (P227).	1999 September

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P211	Waste Stream Profile Form INW276.003-Graphite and Transmittal Letter (CCN 00-011499) from Thomas Monk to Jerry Wells, U.S. DOE, and Update for WIPP Operating Record sent October 3, 2002.	Submittal of waste stream characterization data for non-mixed graphite waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2000 July 25
P212	Waste Stream Profile Form INW276.004-Graphite and Transmittal Letter (CCN 00-013770) from Thomas Monk to Jerry Wells, US DOE, Update for WIPP Operating Record sent October 3, 2002	Submittal of waste stream characterization data for mixed graphite waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2000 September 26
P213	Waste Stream Profile Form INW296.001 Non-special Source Metals and Transmittal Letter (CCN 00-014770) from Thomas Monk to Jerry Wells, U.S. DOE, Update for WIPP Operating Record sent May 2, 2002	Submittal of waste stream characterization data for non-special source metals waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2000 October 23
P214	Waste Stream Profile Form INW247.001-Raschig Rings and Transmittal Letter (CCN 15439) from Thomas Monk to Jerry Wells, U.S. DOE.	Submittal of waste stream characterization data for Raschig Rings waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2000 November 13
P215	Waste Stream Profile Form INW243.001-Glass and Transmittal Letter (CCN 19871) from Thomas Monk to Jerry Wells, U.S. DOE, and Update for WIPP Operating Record sent September 9, 2002.	Submittal of waste stream characterization data for Glass waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2001 March 26
P216	Waste Stream Profile Form INW211.001-Filters and Insulation and Transmittal Letter (CCN 21154) from Thomas Monk to Jerry Wells, U.S. DOE, Update for WIPP Operating Record sent May 2, 2002.	Submittal of waste stream characterization data for Filters and Insulation waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2001 April 26
P217	Waste Stream Profile Form INW216.001-First/Second Stage Sludge, Transmittal Letter (CCN 21151) from Thomas Monk to Jerry Wells, U.S. DOE, and WSPF Update for WIPP Operating Record sent August 29, 2002.	Submittal of waste stream characterization data for First/Second Stage Sludge waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2001 May 24

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P218	Waste Stream Profile Form INW218.001-Building 374 Sludge, Transmittal Letter (CCN 23889) from Thomas Monk to Jerry Wells, U.S. DOE, and WSPF Update for WIPP Operating Record sent August 29, 2002.	Submittal of waste stream characterization data for Building 374 Sludge waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CAO). The WSPF reconciles applicable data with program-required data quality objectives.	2001 July 19
P219	Hazardous Waste Code Determination for First/Second Stage Sludge Waste Stream (IDCs 001, 002, 800). Arbon, R. E., Bechtel BWXT Idaho, LLC. INEEL/EXT-01-00015.	Summarizes INEEL's hazardous waste code determination for IDCs 001, 002, and 800. Incorporates acceptable knowledge, waste form sampling, chemical analyses, and headspace gas data. Also includes an assessment of pre-WAP solidified sampling and analysis data (referred to as preliminary data).	2001 May
P220	Characterization of Rocky Flats Plant Building 374 Sludge Waste Stream (IDCs 007, 803, 807). Arbon, R. E., Sheila Hailey, Joan Connolly, Carolyn Abbott. INEEL/EXT-01-00517.	Summarizes INEEL's hazardous waste code determination for IDCs 007, 803, and 807. Incorporates acceptable knowledge, waste form sampling, chemical analyses, and headspace gas data. Also includes an assessment of pre-WAP solidified sampling and analysis data (referred to as preliminary data).	2001 July
P221	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Graphite. Bechtel BWXT Idaho, LLC. EDF-1175, Rev. 0. July 19, 1999. EDF-1175, Rev. 1. April 18, 2000. EDF-1175, Rev. 2. June 26, 2000. EDF-1175, Rev. 3. July 20, 2000. EDF-1175, Rev. 4. September 6, 2000. EDF-1175, Rev. 5. May 8, 2002. EDF-1175, Rev. 6. August 6, 2002. EDF-1175, Rev. 7. January 6, 2003.	Summary of characterization data for graphite, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	1999 July 19
P222	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Light Metals. Bechtel BWXT Idaho, LLC. EDF-1686, Rev. 0. October 24, 2000. EDF-1686, Rev. 1. May 8, 2002. EDF-1686, Rev. 2. August 6, 2002. EDF-1686, Rev. 3. January 6, 2003.	Summary of characterization data for light metals, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2000 October 24
P223	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Raschig Rings. Bechtel BWXT Idaho, LLC. EDF-1594, Rev. 0. November 7, 2000. EDF-1594, Rev. 1. May 8, 2002. EDF-1594, Rev. 2. August 6, 2002. EDF-1594, Rev. 3. January 6, 2003.	Summary of characterization data for Raschig rings, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2000 November 7

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P224	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Glass (Except Raschig Rings). Bechtel BWXT Idaho, LLC. EDF-1926, Rev. 0. March 26, 2001. EDF-1926, Rev. 1. May 8, 2002. EDF-1926, Rev. 2. August 6, 2002. EDF-1926, Rev. 3. January 6, 2003.	Summary of characterization data for glass, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2001 March 26
P225	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Filters and Insulation. Bechtel BWXT Idaho, LLC. EDF-1927, Rev. 0. May 3, 2001. EDF-1927, Rev. 1. May 10, 2001. EDF-1927, Rev. 2. June 13, 2001. EDF-1927, Rev. 3. May 8, 2002. EDF-1927, Rev. 4. August 6, 2002. EDF-1927, Rev. 5. January 6, 2003.	Summary of characterization data for filters and insulation, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2001 May 3
P226	INEEL Acceptable Knowledge Waste Stream Summary Sheet–First/Second Stage Sludge. Bechtel BWXT Idaho, LLC. EDF-1809, Rev. 0. January 17, 2001. EDF-1809, Rev. 1. May 24, 2001. EDF-1809, Rev. 2. May 8, 2002. EDF-1809, Rev. 3. August 6, 2002. EDF-1809, Rev. 4. August 29, 2002. EDF-1809, Rev. 5. January 6, 2003.	Summary of characterization data for first/second stage sludge, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2001 January 17
P227	Plutonium Mass Fractions Derived from SGRS Data. Bechtel BWT Idaho, LLC. EDF-1609.	Results of a review of plutonium mass fraction data measured by the SWEPP Gamma Ray Spectrometer (SGRS) from September 25, 1997 to August 12, 1999. Includes recommended replacement values used in the analysis of PAN data. The new values supersede the plutonium mass fraction data given in EDF-1242.	2000 December 20
P228	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Organic Setups Sludge Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum. INEEL/EXT-2001-00324, Rev 0.	Results of a total uncertainty analysis of the PAN system's active mode measurements of organic setups sludge waste (waste code 003). The radiochemistry data were obtained from core samples of the waste drums. Recommends the bias correction equation to be applied to uncorrected PAN active mode mass.	2001 May

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P229	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Solidified Aqueous Sludge Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum. INEEL/EXT-97-01273.	Results of a total uncertainty analysis of the PAN system's active mode measurements of aqueous sludge waste (IDCs 001, 002, 007, 800, 803, and 807). The radiochemistry data were obtained from core samples of the waste drums. Recommends the bias correction equation to be applied to uncorrected PAN active mode mass.	2000 April
P230	SWEPP PAN Assay System Uncertainty Analysis: Passive Mode Measurements of Graphite Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum, Woo Y. Yoon. INEEL/EXT-97-00812.	Results of a total uncertainty analysis of the PAN system's passive mode measurements of graphite waste (waste code 300). Describes the methodology used for determining the total uncertainty. Analysis indicates a bias correction does not need to be applied. This report supersedes INEL-95/475, Uncertainty Analysis of the SWEPP Drum Assay System for Graphite Content Code 300.	1997 July
P231	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Graphite Waste. Blackwood, Larry G., Yale D. Harker. INEEL/EXT-98-01215.	Results of a total uncertainty analysis of the PAN system's active mode measurements of graphite waste (IDC 300). Describes the methodology used for determining the total uncertainty. Recommends the bias correction equation to be applied to uncorrected PAN active mode mass.	1998 December
P232	SWEPP PAN Assay System Uncertainty Analysis: Passive and Active Mode Measurements of Combustible Waste. Blackwood, Larry G., Yale D. Harker., Teresa R. Meachum, Woo Y. Yoon. INEEL/EXT-2000-01006, Rev. 0. November 2000.INEEL/EXT-2000-01006, Rev. 1. October 2001.	Results of a total uncertainty analysis of the PAN system's passive and active mode measurements of combustible waste (waste codes 300 and 336). Describes the methodology used for determining the total uncertainty. Recommends a bias correction for the PAN passive mode. This report supersedes INEL-96/0257, Uncertainty Analysis of the SWEPP Drum Assay System for Combustible Waste (Content Codes 330 and 336).	2000 November
P233	SWEPP PAN Assay System Uncertainty Analysis: Passive and Active Mode Measurements of Filter Waste. Blackwood, Larry G., Yale D. Harker., Teresa R. Meachum, Woo Y. Yoon. INEEL/EXT-2001-01001.	Results of a total uncertainty analysis of the PAN system's passive and active mode measurements of filters waste (waste codes 328, 335, 338 and 376). Describes the methodology used for determining the total uncertainty. Recommends bias corrections for both passive and active modes.	2001 January

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P234	SWEPP PAN Assay System Uncertainty Analysis: Passive and Active Mode Measurements of Glass Waste. Blackwood, Larry G., Yale D. Harker., Teresa R. Meachum, Woo Y. Yoon. INEEL/EXT-2000-00969.	Results of a total uncertainty analysis of the PAN system's passive and active mode measurements of glass waste (waste code 440). Describes the methodology used for determining the total uncertainty. Recommends bias corrections for both passive and active modes.	2000 July
P235	SWEPP PAN Assay System Uncertainty Analysis: Passive and Active Mode Measurements of Raschig Rings Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum, Woo Y. Yoon. INEEL/EXT-2000-01000.	Results of a total uncertainty analysis of the PAN system's passive and active mode measurements of Raschig rings waste (waste codes 441 and 442). Describes the methodology used for determining the total uncertainty. Recommends bias corrections for both passive and active modes.	2000 July
P236	SWEPP PAN Assay System Uncertainty Analysis: Passive and Active Mode Measurements of Mixed Metal Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum, Woo Y. Yoon. INEEL/EXT-99-00939.	Results of a total uncertainty analysis of the PAN system's passive and active mode measurements of mixed metals waste (waste codes 480 and 481). Describes the methodology used for determining the total uncertainty. Recommends bias corrections for both passive and active modes.	2000 October
P237	Characterization of Wastes Used in the 1991 through 1993 SWEPP Certified Waste Sampling Program. Lockheed Idaho Technologies Company. INEEL/INT-98-01210; EDF-RWMC-1043.	Assigns IDCs and HWNs to seven RFP containers identified as "unknown." Uses results of the SWEPP certified waste sampling programs for FY91, FY92 and FY93 (EDF RWMC-563 and EDF-RWMC-675) as the basis for the IDC and HWN assignments.	1999 April 7
P238	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Building 374 Sludge. Bechtel BWXT Idaho, LLC. EDF-2657, Rev. 0. July 26, 2001. EDF-2657, Rev. 1. May 8, 2002. EDF-2657, Rev. 2. August 6, 2002. EDF-2657, Rev. 3. August 29, 2002. EDF-2657, Rev. 4. January 6, 2003.	Summary of characterization data for Building 374 sludge, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2001 May 24
P239	Disagreement with the Assignment of EPA Hazardous Waste Numbers by the Acceptable Knowledge Document, INEL-96/0280. LMITCO. EDF-RWMC-942, Rev. 0; INEL/INT-97-00214, Rev. 0.	Discusses LMITCO's opinions of the assignments of certain EPA hazardous waste numbers to IDCs 330, 336, 337, and 339 in the AK document.	1997 August 14
P240	Document SWEPP NDA Compliance Development. Bechtel BWXT Idaho, LLC. EDF-RWMC-840, Rev. 2. March 6, 2000. EDF-RWMC-840, Rev. 3. May 10, 2001. EDF-RWMC-840, Rev. 4. August 6, 2002.	Describes the data assessment and technical review process used to evaluate the SWEPP radioassay data.	2000 March 6

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P241	TWCP WIPP WAC Nondestructive Assay Requirements and QAO Compliance Demonstration. EDF-RWMC-843, Rev. 0. June 25, 1997. EDF-RWMC-843, Rev. 3. April 20, 2000. EDF-RWMC-843, Rev. 4. November 29, 2001.	QAOs and associated requirements for the SWEPP facility waste assay system and associated techniques.	1997 June 25
P242	RTR Review Process to Support the Total Uncertainty Evaluation.EDF-RWMC-919.	Methodology used to review RTR video tapes and process the information for use in the uncertainty analysis evaluation.	1997 August 12
P243	INEEL CH TRU Waste Certification Capabilities Implementation. EDF-924, Rev. 8. November 26, 2001; EDF-924, Rev. 9. April 8, 2002; EDF-924, Rev. 10. June 20, 2002; EDF-924, Rev. 11. July 18, 2002; EDF-924, Rev. 12. September 25, 2002.	Defines and documents the INEEL's ability to certify individual waste containers for disposal at the WIPP. This revision updates TMU analysis for miscellaneous waste, clarifies restrictions to 807a and 807b waste streams, and removes qualification of PAN/Gamma and SGRS Absolute to process IDCs 320, 321, and 339.	2001 November 26
P244	Zero Matrix Calibration of the SWEPP PAN System. EDF-973, Rev. 3. November 29, 2001. EDF-973, Rev. 4. April 4, 2002.	Reports the results of zero matrix calibration of the SWEPP PAN system during 1997, 1998, 1999, 2000, 2001, and 2002.	2001 November 29
P245	SWEPP Assay System Minimum Detectable Concentration for Solidified Aqueous Sludge Waste Forms. EDF-RWMC-1009.	Applies the minimum detectable concentration (MDC) prescription, given in EDF-843, to drum assays involving SWEPP Assay System and solidified aqueous sludge waste forms.	1998 February 2
P246	Available Inventory for SWEPP Processing for the 3,100 m^3 Project. EDF-1402, Rev. 3. February 21, 2002. EDF-1402, Rev. 4. April 19, 2002.	Describes the candidate stored contact-handled TRU waste inventory for examination and characterization to meet the 3,100 m^3 Settlement Agreement milestone.	2002 February 21
P247	MDC for Glass, Filters, Mixed Metals, Combustibles. EDF-1769 Rev. 0. December 20, 2000. EDF-1769, Rev. 1. April 19, 2002.	Reports on the determination of the minimum detectable alpha concentration for waste categories for which total measurement uncertainty analysis has been completed–Glass (IDC 440, 441, 442); Filters (IDCs 328, 335, 338, 360, 376, 490); Mixed Metals (IDCs 480, 481); and Combustibles (IDCs 330, 336, 337).	2000 December 20

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P248	SWEPP Assay Systems. RWMC-EDF-2670, Rev. 1. August 16, 2001. RWMC-EDF-2670, Rev. 2. June 27, 2002.	Analysis and review of (1) historical calibration data up to an effective mass of 31 WGPu; (2) applicability of TMU bias corrections for aqueous sludge waste forms to an extended mass range; (3) QAO test performance at an extended calibration range; and (4) Performance Demonstration Program results for Inorganic Aqueous Sludge Waste forms. Revision 2 expands SWEPP PAN, Active Mode, qualified range to 47 g Pu FGE for solidified inorganic sludge wastes.	2001 August 16
P249	WAGS Absolute Calibration, QAO, TMU, and MDC.EDF-2721, Rev. 0, March 15, 2002.EDF-2721, Rev. 1, August 1, 2002. EDF-2721, Rev. 2, September 3, 2002.	Documents the WAGS (Waste Assay Gamma Spectrometer) Absolute Assay System calibration method and compliance with QAOs established by the WIPP WAC. Includes analyses for minimum detectable concentration (MDC) and total measurement uncertainty (TMU).	2002 March 15
P250	Generalized MDL-MDC for SWEPP PAN Active Mode.EDF-2986.	Generalized method for determining the nominal transuranic activity minimum detectable concentration and total plutonium mass minimum detectable limit for the SWEPP Passive Active Neutron (PAN) active mode.	2002 February 11
P251	Minimum Detectable Concentrations for IDC 004, IDC 700, IDC 801, and IDC 802.EDF-3068.	Calculated MDC values for the subject IDC wastes using SWEPP PAN active mode count data and applying the generalized MDC equation given in EDF-2986.	2002 February 12
P252	Minimum Detectable Concentrations for Miscellaneous Cemented Sludges.EDF-3107, Rev. 0. March 13, 2002. EDF-3107, Rev. 1. April 11, 2002.	Calculated MDC values for the subject IDC wastes using SWEPP PAN active mode count data and applying the generalized MDC equation given in EDF-2986. Revision 1 adds IDC 806.	2002 March 13
P253	Minimum Detectable Concentrations for IDCs 320, 321, and 339.EDF-3146.	Calculated MDC values for the subject IDC wastes using SWEPP PAN active mode count data and applying the generalized MDC equation given in EDF-2986.	2002 February 19
P254	SAS Minimum Detectable Concentration for Inorganic Sludge Waste Forms. EDF-RWMC-1035.	Applies the minimum detectable concentration prescription, given in EDF-843, to drum assays involving SWEPP Assay System and inorganic sludge waste forms.	1998 July 27
P255	Uncertainty Analysis for Non-300 Graphite Codes. EDF-1104.	Examines non-IDC 300 graphite wastes (IDCs 301, 303, 310, and 312) and concludes they can be included with IDC 300 under the same uncertainty parameters.	1999 May 5

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P256	SAS Minimum Detectable Concentration for Mixed Metals Waste Forms. EDF-1255.	Applies the minimum detectable concentration (MDC) prescription, given in EDF-843 and EDF-1035, to drum assays involving the SWEPP Assay System and mixed metals waste forms. Superseded by EDF-1769 (P247).	1999 October 19
P257	SWEPP PAN Assay System Uncertainty Analysis: Passive and Active Mode Measurements of Lead-Containing Waste.EDF-3147.	Describes the results of a total uncertainty analysis of the Passive Active Neutron (PAN) system measurements of IDCs 320, 321, and 339. Includes bias correction equation.	2002 February 19
P258	Bias Correction Parameters with Increased Significant Digits for PAN Active Mode Measurements for Graphite Waste. EDF-RWMC-1092.	Reproduction of Appendix B of INEEL/EXT-98-01215 (SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Graphite Waste). Lists increased significant digits given for all parameters previously documented for PAN active mode measurements of graphite waste.	1999 April 22
P259	Uncertainty Analysis of SWEPP Gamma-Ray Spectrometer System Absolute Plutonium Mass Measurements. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum, E. Wayne, Killian. INEEL/EXT-01-01204.	Results of a total uncertainty analysis of the SWEPP Gamma-Ray Spectrometer (SGRS) absolute Pu mass measurements for 787 208-liter waste drums from 8 diverse waste types (aqueous sludge, combustibles, glass, graphite, filters, mixed metal, organic sludge, and Raschig rings).	2001 November
P260	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Plastic Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum. INEEL/EXT-01-01392.	Results of a total uncertainty analysis of the Passive Active Neutron (PAN) system's active mode measurements of plastic waste (IDC 337). Includes bias correction equation.	2001 November
P261	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Solidified Organics and Special Setups Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum. INEEL/EXT-01-01590.	Results of a total uncertainty analysis of the Passive Active Neutron (PAN) system's active mode measurements of solidified organics and special setups waste (IDCs 004, 700, 801, and 802). Includes bias correction equation.	2001 December
P262	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Miscellaneous Cemented Waste. Blackwood, Larry G., Yale D. Harker, Teresa R. Meachum. INEEL/EXT-01-01614.	Results of a total uncertainty analysis of the Passive Active Neutron (PAN) system's active mode measurements of miscellaneous cemented waste (IDCs 290, 292, 432, 806, 817, 818, 820, 822, and 823). Includes bias correction equation.	2001 December
P263	Radioassay Total Uncertainty Process using Modified Statistical Sampling Approach. MCP-2990, Rev. 2. February 29, 2000. MCP-2990, Rev. 3. March 22, 2001. MCP-2990, Rev. 4. November 20, 2002.	Defines activities for completing the total measurement uncertainty process for debris-type waste forms using modified statistical sampling approach.	2000 February 29

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P264	Radioassay Total Uncertainty Process using Statistical Sampling Approach. MCP-2991, Rev. 2. February 29, 2000. MCP-2991, Rev. 3. March 22, 2001. MCP-2991, Rev. 4. November 8, 2001. MCP-2991, Rev. 5. June 5, 2002. MCP-2991, Rev. 6. TBD.	Defines activities for completing the total measurement uncertainty process for homogeneous-type waste forms using a statistical sampling approach.	2001 November 8
P265	Certification of INEEL Contact-Handled Stored Transuranic Waste. PLN-579, Rev. 2. April 26, 2001. PLN-579, Rev. 3. April 4, 2002. PLN-579, Rev. 4. May 17, 2002. PLN-579, Rev. 5. July 15, 2002.	Describes the methods and procedures used by the INEEL to certify defense-generated contact-handled stored transuranic waste as compliant with requirements and criteria defined in the WIPP contact-handled WAC.	2001 April 26
P266	SWEPP Absolute Gamma Analysis Package (SAP) Software Requirements Specification. Killian, E. W. INEEL/INT-01-01365.	Provides a basis for SAP software development and maintenance. Gives the basic requirements for data acquisition and control, gamma spectrum analysis, and SWEPP-specific analysis.	2002 February
P267	SWEPP Absolute Analysis Package (SAP) Software Design Description. Killian, E. W. INEEL/INT-01-01366.	Describes the design, functions, input requirements, and output of the main routines and subroutines of the Gamma Control System for Personal Computers (GCPC) and SWEPP RESPMATS Analysis Code (SRAC) computer programs associated with the SAP.	2002 February
P268	SWEPP Absolute Analysis Package (SAP) Calculation Methods. Killian, E. W., C. V. McIsaac. INEEL/INT-01-01367.	Provides the basis for SGRS/WAGS development and documents the established calculation methods used in the SAP software. Companion document to the Software Requirements Specification (INEEL/INT-01-01365), Software Design Description (INEEL/INT-01-01366), and Test Plan (INEEL/INT-01-01368) for the SAP software.	2002 February
P269	SWEPP Absolute Analysis Package (SAP) Software Test Plan and Report. Hoffman, C. R. INEEL/INT-01-01368, Rev. 2. February 2002. INEEL/INT-01-01368, Rev. 3. April 02, 2002.	Specifies the test plan for GCPC (Gamma Control System for Personal Computers) and SRAC (SWEPP RESPMATS Analysis Code) and reports the results of the tests on the SAP software. Tests and validates the transuranic nuclide mass determination.	2002 February
P270	SWEPP Absolute Analysis Package (SAP) Users Guide. Killian, E. W. INEEL/INT-01-01369.	Describes the operation of the production version of SAP for characterization of waste shipments to the WIPP.	2002 February
P271	User Guide for the Stand-Alone Version of SRAC. Killian, E. W. INEEL/INT-01-01537.	Describes the operation of the non-production version of SRAC, which will be used off-line for total measurement uncertainty and other TRU program support functions.	2002 January

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P272	SWEPP Assay System Version 3.2 Software Requirements Specification. East, Larry V. INEEL/EXT-98-00957. Rev. 0. March 2000. INEEL/ EXT-98-00957, Rev. 1. May 18, 2001.	Provides a technical basis for SAS software design, development, verification, and validation. Covers SAS interfaces. Full document is on attached CD-R.	2000 March
P273	SWEPP Assay System Version 3.2 Design Description. East, Larry V. INEEL/EXT-98-00958.	Provides the foundation for SAS development, verification, and validation comformable to INEEL TRU Programs quality requirements. Covers SAS internal and external interfaces.	2000 March
P274	SWEPP Gamma Analysis Package (SGAP) Software Requirements Specification. Ausdeln, L. Van, E. W. Killian, L.O. Johnson. INEEL/INT-2000-00289.	Provides basic requirements for data acquisition and control, gamma spectrum analysis, and SWEPP-specific analysis.	2000 September
P275	Calibration of SWEPP Radioassay Systems. TPR-1719, Rev. 16. November 30, 2001. TPR-1719, Rev. 17. May 20, 2002. TPR-1719, Rev. 18. May 20, 2002. TPR-1719, Rev. 19. November 15, 2002.	Direction for performance of formal calibration, testing, and evaluation activities for the SWEPP SGRS (SWEPP Gamma-Ray Spectrometer), WAGS (Waste Assay Gamma Spectrometer), and PAN (Passive-Active Neutron) assay systems.	2001 November 30
P276	IDC 339 Mass Attenuation Coefficient Table for SGAP.EDF-2019.	Identifies a set of mass attenuation coefficients to be used for IDC 339 for the calculation of attenuation corrected isotopic mass ratios by the SWEPP Gamma Analysis Program (SGAP).	2002 April 2
P277	Generalized MDL/MDC for SWEPP Absolute Analysis Package (SAP) when Analyzing Spectra from the SWEPP Gamma Ray Spectrometer (SGRS). EDF-3154, Rev. 0, April 2, 2002. EDF-3154, Rev. 1, August 2, 2002.	Documents the results of an evaluation to determine the minimum detectable TRU concentration (MDC) and minimum detectable Pu-239 limit (MDL) for the SGRS when operating as an absolute assay system using the SWEPP Absolute Analysis Package (SAP). Low-activity spectra are re-analyzed to determine posteriori detection limits.	2002 April 2
P278	TWCP WIPP WAC Nondestructive Assay QAO Compliance Testing of the SWEPP Absolute Analysis Package. EDF-3156, Rev. 0. March 11, 2002. EDF-3156, Rev. 1.April 02, 2002.	Provides specifications and information necessary to perform the measurement sequences and data analysis and compliance evaluation.	2002 March 11
P279	Uncertainty Analysis Gamma-Ray Spectrometer System Absolute Plutonium Mass Measurements. EDF-1994.	Describes the results of a total uncertainty analysis of the SWEPP SGRS absolute Pu mass measurements for 208 liter waste drums. Includes bias correction equation.	2002 April 2

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P280	WAGS Absolute Technical Review Process. EDF-3017, Rev. 0. April 2, 2002. EDF-3017, Rev. 1. July 18, 2002. EDF-3017, Rev. 2, August 5, 2002.	Describes NDA data generation level assessment and technical review process, for independent technical review (ITR)/expert technical review (ETR), used to evaluate the SWEPP radioassay data.	2002 April 2
P281	WAGS Absolute System Acceptance Test Report.CI-IDA-NDA-013.	Results of testing of WAGS Absolute System. Includes (1) Nuclear Data and References; (2) Calibration Source Certificates; (3) Validation and Verification Raw Data Measurement Reports; (4) Minimum Detectable Concentration Determination Measurement Reports; and (5) Initial Measurement Control Determination Data Reports. Data for EDF-2721 (P249).	2001 December 10
P282	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Combustibles. Bechtel BWXT Idaho, LLC. EDF-2891, Rev. 0. February 1, 2002. EDF-2891, Rev. 1. May 8, 2002. EDF-2891, Rev. 2. August 6, 2002. EDF-2891, Rev. 3. January 6, 2003.	Summary of characterization data for combustibles, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2002 February 1
P283	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Plastics. Bechtel BWXT Idaho, LLC. EDF-2944, Rev. 0. February 1, 2002. EDF-2944, Rev. 1. May 8, 2002. EDF-2944, Rev. 2. August 6, 2002. EDF-2944, Rev. 3. January 6, 2003.	Summary of characterization data for plastics, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2002 February 1
P284	Waste Stream Profile Form INW169.001-Combustibles and Transmittal Letter (CCN 29583) from Thomas Monk to Jeff Cotton, Westinghouse TRU Solutions LLC.	Submittal of waste stream characterization data for combustibles waste to Westinghouse TRU solutions for submission to DOE-Carlsbad (CBFO). The WSPF reconciles applicable data with program-required data quality objectives.	2002 February 1
P285	Waste Stream Profile Form INW198.001-Plastics and Transmittal Letter (CCN 29583) from Thomas Monk to Jeff Cotton, Westinghouse TRU Solutions LLC.	Submittal of waste stream characterization data for plastics waste to Westinghouse TRU solutions for submission to DOE-Carlsbad (CBFO). The WSPF reconciles applicable data with program-required data quality objectives.	2002 February 1

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P286	INEEL Acceptable Knowledge Waste Stream Summary Sheet–Miscellaneous Cemented Sludges. Bechtel BWXT Idaho, LLC. EDF-2722, Rev. 1. April 11, 2002. EDF-2722, Rev. 2. August 6, 2002. EDF-2722, Rev. 3, August 29, 2002. EDF-2722, Rev. 4, January 6, 2003.	Summary of characterization data for miscellaneous cemented sludges, combining acceptable knowledge information with INEEL characterization results. Includes a description of the waste stream, packaging, and areas of operation, RCRA characterization, and potential radionuclides.	2002 April 11
P287	Characterization of Rocky Flats Plant Building Miscellaneous Cemented Sludge Waste Stream (292 and 807b). Hailey, Sheila, Joan Connolly, Carolyn Abbott, Christine Gomez, and Paul Gomez.INEEL/EXT-02-00112.	Summarizes INEEL's hazardous waste code determination for IDCs 292 and 807b. Incorporates acceptable knowledge, waste form sampling, chemical analyses, and headspace gas data. Also includes an assessment of pre-WAP solidified sampling and analysis data (referred to as preliminary data).	2002 March
P288	Waste Stream Profile Form INW222.001-Miscellaneous Cemented Sludges, Transmittal Letter (CCN 31196) from Thomas Monk to Jerry L. Wells, U.S. DOE, and Update for WIPP Operating Record sent August 29, 2002.	Submittal of waste stream characterization data for miscellaneous cemented sludges to US DOE for submission to DOE-Carlsbad (CBFO). The WSPF reconciles applicable data with program-required data quality objectives.	2002 April 10
P289	Waste Stream Profile Form and Associated Evaluations for IDC 300. EDF-1180.	Consists of WSPFs IN-W276.001 and IN-W276.002 and associated documentation; and Site Data Summary Report and TIC Evaluation for Lot IN-W276.002.01. This EDF was superseded by WSPFs INW276.003 and INW276.004 and supporting documentation.	2000 April 18
P290	Disposition of Ash Residue Material from the 1969 Building 776 Fire at the Rocky Flats Environmental Technology Site. Freiboth, Cameron J. and Frank E. Gibbs, Ph.D. Prepared by IT Corporation for Safe Sites of Colorado.	This report includes a review of the Backlog Waste Reassessment Baseline Book (BWRBB) to determine the EPA Codes that would apply to waste originating from the 1969 fire in Building 776. The report concludes that EPA Codes D006, D007, D008, F001, F002, F005, F006, F007, and F009 should be assigned to ash waste from the 1969 fire. During review of this report, a limitation/discrepancy was identified. The EPA codes F006, F007, and F009 were identified in the BWRBB associated with combustible subpopulations that had become contaminated with Saltcrete. The earliest generation date of Saltcrete was July 1985, and therefore, F006, F007, and F009 are not applicable to waste generated during clean-up of the fire waste.	2000 February 10

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P291	^{234}U Activity with Respect to Total Alpha Activity. EDF-RWMC-1045, Rev. 1.	Reports on the review of ^{234}U content in all drums processed at the RWMC from September 25, 1997 through September 18, 1998. Concludes ^{234}U was not a significant concern in wastes being certified at SWEPP. Outlines the modifications to the SAS so that ^{234}U activity is computed and reported on a regular basis.	1999 March 17
P292	RWMC Data Generation Level Data Validation. MCP-1815, Rev. 19. May 20, 2002. MCP-1815, Rev. 20. August 7, 2002. MCP-1815, Rev. 21. November 20, 2002.	This document provides instructions for the Data Generation Level (DGL) review and validation of data generated for the TWCP. It documents the required review of critical isotopic ratios in radioassay data, as required in EDF-840 (Reference P240).	2002 May 20
P293	Description of SWEPP Gamma Analysis Package (SGAP) Software Calculation Methods. INEEL/INT-2000-00288, Rev. 0.	This document describes the calculations performed by the analysis software associated with the gamma-ray spectrometer systems operated at SWEPP at the Idaho National Engineering and Environmental Laboratory. It includes a description of the methods used to calculate isotopic ratios from measured photopeaks.	2000 September
P294	SWEPP PAN Assay System Uncertainty Analysis: Passive And Active Mode Measurements Of Firebrick Waste. INEEL/EXT-02-00287, Rev 0.	This report describes the results of a total uncertainty analysis of the Passive Active Neutron (PAN) system measurements of firebrick waste (waste codes 371 and 377).	2002 March
P295	SWEPP PAN Assay System Uncertainty Analysis: Passive And Active Mode Measurements Of Firebrick Waste. EDF-2059, Rev. 0.	This EDF describes the results of a total uncertainty analysis of the Passive Active Neutron (PAN) system measurements of firebrick waste (waste codes 371 and 377).	2002 May 1
P296	SWEPP PAN Assay System Uncertainty Analysis: Active Mode Measurements of Lead-Miscellaneous Cemented Waste. EDF-1553, Rev. 0.	This report is one of a series of reports quantifying the results of the uncertainty analysis of the PAN system measurements for specific waste types and measurements modes. In particular this report covers active mode measurements of weapons grade plutonium-contaminated miscellaneous cemented waste contained in 208-liter drums (waste codes 290, 292, 432, 806, 807b, 817, 818, 820, 822, and 823).	2002 June 28

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P297	Surrogate Matrix Response Evaluation For The SWEPP PAN System. EDF-2957, Rev. 1.	This document describes assay response checks using surrogate matrices with the INEEL Passive Active Neutron (PAN) assay system. The surrogate matrices used were Graphite (Item Description Code [IDC] 300) for production year 2000, Combustibles (IDC 330) for production year 2001, and Mixed Metals (IDC 480/481) for production year 2002. The data for the response checks was collected on 16 March 2000, 8-9 January 2001, and 10-11 January 2002 using INEEL Transuranic Waste Characterization Program Technical Procedure (TPR) 1719.	2002 April 19
P298	Waste Assay Gamma-Ray Spectrometer (WAGS) Absolute System Description. SDD-105, Rev. 0.	This document describes the Waste Assay Gamma Spectrometer (WAGS) Absolute Assay System. Results from the WAGS Absolute Assay System do not require further analysis by a Neutron Assay System such as passive-active neutron (PAN).	2002 April 05
P299	Overview of SAS V3.3 Software Changes.EDF-2775, Rev. 0.	This document describes modifications made to Version 3.3 of the PAN system's application software, SAS (short for SWEPP Assay System). The described modifications were made to correct one minor error, enhance the user interface and to add additional analysis capabilities.	2002 February 07
P300	SWEPP Gamma Analysis Package (SGAP) Software Test Plan and Report. INEEL/INT-2000-00290, Rev. 1, January 2001.	This document presents the test plan and report for the Windows NT 4.0 acquisition and analysis software package called SGAP associated with the SGRS and WAGS systems. It supersedes all prior test plans and reports.	2001 January
P301	SWEPP Gamma Analysis Package (SGAP) Software Design Description. INEEL/EXT-2000-00287, Rev. 0, September 2000.	This document describes the SWEPP Gamma Ray Spectrometer (SGRS)/Waste Assay Gamma Spectrometer (WAGS) Gamma Analysis Package software associated with the gamma ray spectrometer systems operated at the SWEPP. These passive gamma-ray assay systems were developed as non-intrusive methods for determining the relative quantities of actinide isotopes in 208-L waste drums.	2000 September

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P302	Effect of Background on SGRS Assay Results and the Determination of Default Isotopic LLDs for the SGRS.EDF-2018, Rev. 0, August 2, 2002.	The first part of this EDF reports on the effect of background gamma spectrum peaks on quantitative results generated by the SGRS. The second part of this EDF addresses the determination of default level of detection (LLDs) for isotopes normally found in INEEL TRU Waste. The default LLDs were derived from separate analyses of background spectra contained in this EDF.	2002 August 2
P303	Description of the SWEPP Certified Waste Sampling Program. RWMC-EDF-363, Rev. 0, May 19, 1989. RWMC-EDF-363, Rev. 11, July 28, 1998. RWMC-EDF-363, Rev. 12, April 20, 1999. RWMC-EDF-363, Rev. 14, March 28, 2000. RWMC-EDF-363, Rev. 15, June 28, 2000. RWMC-EDF-363, Rev. 16, Dec. 5, 2000. RWMC-EDF-363, Rev. 17, August 2, 2001. RWMC-EDF-363, Rev. 18, August 2, 2002. RWMC-EDF-363, Rev. 19, Aug. 29, 2002. RWMC-EDF-363, Rev. 20, Oct. 22, 2002. RWMC-EDF-363, Rev. 21, Nov. 20, 2002.	Establishes the requirements and verification sampling frequency for the SWEPP Visual Examination Certified Waste Sampling Program.	1989 May 19
P304	Transuranic Waste Sampling Plan for the Idaho National Engineering and Environmental Laboratory. EDF-909, Rev. 0, November 8, 1996. EDF-909, Rev. 1, January 12, 1998. EDF-909, Rev. 2, September 3, 1998. EDF-909, Rev. 3, November 9, 2000.	Documents the homogeneous solids sampling plan for INEEL, describes the waste streams to be sampled, and the collection of representative samples from the waste streams.	1996 November 8
P305	Waste Stream Profile Form INW252.001-Leaded Rubber Gloves and Aprons; EDF-2981, Waste Stream Summary Sheet–Leaded Rubber Gloves and Aprons, and Transmittal Letter (CCN 36785) from Thomas Monk to Jerry Wells. EDF-2981, Rev. 0. October 2, 2002. EDF-2981, Rev. 1. January 6, 2003.	Submittal of waste stream characterization data for Leaded Rubber Gloves and Aprons waste to the U.S. DOE Idaho Operations Office for submission to DOE-Carlsbad (CBFO). The WSPF reconciles applicable data with program-required data quality objectives.	2002 October 15
P306	Waste Stream Profile Form INW161.001-Fire Brick/Coarse Fire Brick; EDF-3019, Waste Stream Summary Sheet–Fire Brick/Coarse Fire Brick; and Transmittal Letter (CCN 35971) from Thomas Monk to Jerry Wells, EDF-3019, Rev. 0. September 19, 2002. EDF3019, Rev. 1. January 6, 2003.	Submittal of waste stream characterization data for Fire Brick/Coarse Fire Brick waste to the US DOE Idaho Operations Office for submission to DOE-Carlsbad (CBFO). The WSPF reconciles applicable data with program-required data quality objectives.	2002 September 20
P307	Hazardous Waste Constituents of INEL Contact-Handled Stored Transuranic Waste, EDF-369, D. E. Kudera	This EDF contains information on the types of hazardous constituents that are expected to be present in the RWMC stored contact handled waste, organized by content code.	1989 May 19

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P308	RFETS Waste Stream Profile Form for Leaded Drybox Gloves, RF124.01, and associated Characterization Information Summaries and Waste Stream Summaries	Submittal of waste stream characterization data for Leaded Rubber Gloves waste to the DOE-Carlsbad. The WSPF and associated documentation provide characterization data and AK for the subject waste stream and reconciles applicable data with program-required data quality objectives	2002 August 14
P309	Argonne National Laboratory-East Remote-Handled Waste. EG&G Idaho EDF-RWMC-759.	This document provides process knowledge and additional analyses of generator data for 586 drums of remote handled waste stored at the Intermediate Level Transuranic Storage Facility. Research into the generators records determined that there was insufficient total lead in the waste to Classify the waste as hazardous. The waste was therefore concluded to be non-mixed.	1994 August
P310	EPA Hazardous Waste Codes Found in INEL Stored TRU Waste Content Codes, EG&G Idaho, Inc. EDF-RWMC-421, Rev. 0, Nov. 21, 1990. EDF-RWMC-421, Rev. 1, Feb. 23, 1991. EDF-RWMC-421, Rev. 2, June 30, 1993. EDF-RWMC-421, Rev. 3, July 10, 1996. EDF-RWMC-421, Rev. 4, April 1, 1994.	This EDF identifies hazardous constituents that are contained in transuranic wastes stored at the INEEL RWMC. EPA HWNs are assigned for the constituents in each IDC. HWNs in this EDF are intended for wastes examined at SWEPP, to support shipments to ANL-W, and to support on-going environmental and waste characterization activities.	1990 November 21
P311	Statistical Sampling Plan for Verifying Characterization of Drums with "Unknown" Contents, EDF-RWMC-1051, Rev. 0.	This EDF defines a statistical basis for the sizes of random samples, calculates sample sizes, and lists the particular drums to be examined to verify the assignment of potential HWNs for drums with "Unknown" contents at the RWMC.	1999 April 8
P312	Characterization of Wastes Generated at Argonne National Laboratory-West with IDCs of 161, 162, and 163, INEEL/INT-99-00081, LMITCO, EDF-RWMC-1048 Rev. 0.	This EDF documents the reclassification of 59 waste containers from ANL-W in storage at the RWMC from "Unknown" for the HWN to "Rad-Only". Reclassification was based on meetings with and certification letters from ANL-W employees.	1999 April 7
P313	Characterization of Wastes Generated at Mound Laboratory with IDCs of 825, 847, and 848. INEEL/INT-99-00226, LMITCO, EDF-RWMC-1062, Rev. 0.	This EDF documents the reclassification of 372 waste containers from Mound Laboratory in storage at the RWMC that were classified as "Unknown" with respect to hazardous waste classification. It justifies process knowledge based arguments to apply HWNs from other Mound generated IDCs to the subject drums if the "Unknown" drums could possibly fit the description of the characterized IDCs.	1999 April 7

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P314	Retrieval and Disposition of United States Americium from Mexico. EDF-RWMC-452, Revision 0.	This EDF documents the retrieval and disposition of smoke detector components from Mexico after a failed business venture in which the workings of a smoke detector factory were transferred to Mexico. It is mainly a compilation of official documentation incorporated by reference.	1991 March 19
P315	TRU Waste Assessment (for the J. C. Haynes TRU Waste Classification). EDF-RWMC-332.	This EDF documents the chronology and pedigree of the J. C. Haynes americium-241 contaminated waste. It provides documentation pertaining to the safe handling, transportation, and disposition of the waste.	1988 August 10
P316	Characterization of Containers with Unknowns–Remnant Containers, Bechtel BWXT Idaho, LLC. EDF RWMC-1776, Rev. 0.	This EDF describes the information, logic, and decisions made in characterizing a set of containers with unknown wastes. Characterization was by expert committee evaluation and consensus. The containers were found to be rad only and no HWNs were required to be assigned.	2001 February 12
P317	Characterization of Containers with Unknowns–Phase IV, Bechtel BWXT Idaho, LLC. EDF RWMC-1615, Rev. 0.	This EDF describes the information, logic, and decisions made in characterizing a set of containers with unknown wastes due to uncertain IDC and/or waste generator. Characterization was by expert committee evaluation and consensus.	2000 October 2
P318	Characterization of Containers with Unknowns through Expert Committee Consensus, Bechtel BWXT Idaho, LLC. EDF RWMC-1579, Rev. 0.	This EDF describes the information, logic, and decisions made in characterizing a set of containers with unknown wastes. Characterization was by expert committee evaluation and consensus.	2000 October 2
P319	Idaho National Engineering Laboratory Stored Transuranic Waste Characterization: Nonradiological Hazards Identification. WM-F1-81-015.	This report summarizes the available information on the potential non-radiological hazards that might be included in the transuranic wastes stored at the INEEL. Characterization information includes process descriptions, types of waste, and management practices. Generic types of hazards are described.	1981 September
P320	Characterization Plan for Existing Contact-Handled Waste Containers of Unknowns in RWMC HWMA/RCRA Permitted Storage Inventory. INEEL/EXT-99-00575, Revisions 1 and 2.	The requirements of the HWMA storage permit for the RWMC are addressed. Specifically, Permit Condition II.K.1.b allows for the existing unknown CH waste inventory to be segregated into groups and for selection of subsets for analysis.	2000 August

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P321	Comparison of Real Time Radiography (RTR) and Visual Examination Results of the Stored Waste Examination Pilot Plant Certified Waste Sampling Program. EDF-2710; and the associated RTR-VE Database CD dated 12/11/02.	The comparison of RTR and VE results generated from the SWEPP Certified Waste Sampling Program from 1997 to the completion of the 3100 m^3 Project is documented.	2002 December
P322	Radioassay Data Collected During 3100 m^3 Project. EDF-3374, Rev. 0	The data presented in this EDF summarize the radioassay data stored in TRIPS. During the life of the 3100 m^3 Project, approximately 20,000 containers were assayed with an over all success rate of 82% of containers being labeled as "*WIPPOK*". More than 30,000 assays were performed among the radioassay systems. Three radioassay systems were in operation during this time period: the Passive-Active Neutron System (PAN), the Swepp Gamma-ray System (SGRS) and Waste Assay Gamma System (WAGS).	2003 January
P323	Summary RTR Data Collected During 3100 m^3 Project. EDF-3395, Rev. 0.	The data presented in this EDF is a summary of the Real Time Radioscopy (RTR) data stored in TRIPS. During the life of the 3,100 m^3 Project approximately 20,000 containers were examined by RTR. The approximate over all success rate, defined by a final, approved status of "*WIPPOK*" was 89%. Data in this EDF is organized and presented for the individual waste streams unless waste streams had not been planned for the project, in which case, the data is presented by Item Description Code (IDC).	2003 February
P324	Summary HSG Data Collected During 3100 m^3 Project. EDF-3396, Rev. 0.	The data presented in this EDF is a summary of the Headspace Gas (HSG) data generated by the Environmental Chemistry Laboratory (ECL) and stored in TRIPS. During the life of the 3,100 m^3 Project nearly 18,000 containers were sampled and the resulting samples analyzed. The over all success rate, defined by a final approved status of "*WIPPOK*" was 99.8%. Data in this EDF is organized and presented for the individual waste streams.	2003 February

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
P325	Identification of Transuranic Waste Streams. EDF-922, Rev. 2.	The method used to combine Rocky Flats Plant (RFP) wastes, previously identified by RFP item description codes (IDCs), into single waste streams is presented in this Engineering Design File (EDF). Wastes from one or more IDCs with similar physical composition and the same regulated constituents are grouped under single waste streams. The waste was grouped in this manner to reduce the number of samples that must be collected for Resource Conservation and Recovery Act (RCRA) characterization, to simplify processing during production operations, and to significantly reduce the cost of characterization and processing.	2003 January
P326	Chemical Constituents in Transuranic Storage Area (TSA) Waste. EDF-803, Rev. 0. June 12, 1995. EDF-803, Rev. 1, July 10, 1996. EDF-803, Rev. 2. August 12, 1997. EDF-803, Rev. 3. April 4, 1998. EDF-803, Rev. 4. October 30, 2000. EDF-803, Rev. 5. September 17, 2001. EDF-803, Rev. 6. August 1, 2002. EDF-803, Rev. 7. December 18, 2002.	A comprehensive list of chemical constituents determined, or suspected, to be present in TRU wastes stored at the TSA at RWMC.	1995 June 12
P327	Contact-handled TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant. WIPP/DOE-02-3122.	This document summarizes the waste acceptance criteria applicable to the transportation, storage, and disposal of contact-handled transuranic waste at the WIPP. Includes Revision 0 and Change Notice creating Revision 0.1.	2002 July 25
P328	Radiography and Visual Examination Results of the Stored Waste Examination Pilot Plant Certified Waste Sampling Program for Fiscal Years 1995 and 1996.	This document describes the results of the RTR and visual examinations (VE) performed for the SWEPP Certified Waste Sampling Program in FY 1995 and FY 1996. In FY 1995 and FY 1996 respectively, 23 and 46 drums underwent VE at the ANL-W HFEF. VE provided information to determine cumulative miscertification rates for sampling programs and to determine numbers of containers requiring VE in future years under the QAPP. VE and RTR results are presented in detail.	1997 August 28
U001	The Rocky Flats Historical Public Exposure Studies Phase II: Toxicity Assessment and Risk Characterization (Draft). Technical Memorandum. Task 2. An analysis of Historical Source Term Estimates for Carbon Tetrachloride at the Rocky Flats Plan.	Information on use and release of carbon tetrachloride at RFP.	1996

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U002	Rocky Flats Dose Reconstruction Project Phase II Toxicity Assessment and Risk Characterization (Draft). Task 2: The Rocky Flats Plant 903 Area Plutonium Source Term Development.	Description of storage of wastes at the 903 Area. Leakage of Pu-contaminated oil/solvent is estimated in this document.	1996
U003	(Draft) Rocky Flats Plant TRU Mixed Waste Plan.	Process information, inventory, and RCRA characterization for RFP transuranic wastes in 1989.	1990
U004	Evaluation of Residue Drum Storage Safety Risks. RO 93-002.	Evaluation of safety concerns with residues stored at RFP. Some of the residue IDCs are also generated as transuranic waste.	1993
U005	Results of the SWEPP Certified Waste Sampling Program for FY-1991. Engineering Design File. RWMC-563.	Results from a comparison of nondestructive and visual examination of drums at INEL.	1992
U006	Memorandum from F. G. Trevino to W. D. Reinhart. "Waste Shipment Summary for April Cost Month 1987."	Waste shipment records for April 1987.	1987 April 27
U007	VOC Gas Chromatography/Mass Spectrometry Results. WIPP Experimental Waste Characterization Program data printout.	Volatile organic headspace gas data from wastes stored at RFP.	1994 Query date June 3, 1994
U008	Improvements to a 55-Gallon DOT 17C Shipping Container for Alpha-Emitting Transuranium Waste. CRDL-950703-001.	Information on development of rigid liners for 55-gallon drums.	1972
U009	Characterization of Spent HEPA Filters from Rocky Flats Plant. PSD 86-056.	Information on certification of HEPA filters. The emphasis of the document is on particulate size analysis.	1986
U010	OASIS Solidification and Off Gas Analysis. PSD 88-038.	Study of volatile solvent off gas from OASIS drums.	1988
U011	Results of the SWEPP Certified Waste Sampling Program for FY-94 (Draft). Engineering Design File. RWMC-844.	Comparison of nondestructive examination at SWEPP to visual examination of waste at ANL-W.	1996
U012	Waste Processing Requests.	Form from waste generators requesting treatment of liquid waste. Treatment information is included in most cases.	1983-1984
U013	(Draft) Rocky Flats Plant Computer Simulation. User Requirements for Aqueous Recovery Operations Building 771. UNC-AL-TR-24-01.	In-depth descriptions of the Building 771 recovery processes.	1989
U014	Information and Brief History of Waste Content Codes Associated with the Rocky Flats Plant.	Description of revisions, deletions, and additions to RFP IDCs in the 1980s.	1995
U015	Results of the SWEPP Certified Waste Sampling Program for FY 1992 and FY 1993. RWMC-675.	Comparison of nondestructive examination to visual examination of RFP waste drums at INEL.	1993

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U016	Quantification of Radionuclides. WIPP-0217-RTS-0192.	Information on assay of special nuclear material at RFP including gamma and neutron methods.	1988
U017	J. K. Paynter personal log book excerpt.	Note regarding drum of tritium waste without an IDC record in SWIMS on the log book.	1987 July 7
U018	J. K. Paynter personal log book excerpt.	Note (2/8/89) for solvent substitution: trichloroethane - trichloroethylene; perchloroethylene - carbon tetrachloride.	1989 February 8
U019	J. K. Paynter personal log book excerpt.	Note regarding five drums of IDC 480 tritium-contaminated waste.	1987 August 28
U020	Analytical Report for Filter Plenum Samples. Lab Report No. AL586.0679.	Samples taken and analyzed to support that the HEPA filters from the Building 771 plenum were not ignitable, corrosive, or reactive.	1986 September 9
U021	History of RFP IDC Certification.	Chronology of transuranic waste certification activities at RFP.	Undated
U022	Analytical reports, documentation, and external letter from J. K. Paynter to Dale Wells, EG&G Idaho, Inc. "Additions to Rocky Flats Transuranic Waste Profiles." 89-RF-0713.	Waste profiles for IDC 342 and IDC 338 from RFP to INEL RWMC.	1989 February 27
U023	Waste profile statement sheets and external letter from J. K. Paynter to Dale Wells, EG&G Idaho, Inc. "Additions to Rocky Flats Transuranic Waste Profiles." 89-RF-1245.	Waste profiles for IDCs 809, 854, 855, and 856, from RFP to INEL.	1989 April 6
U024	RTR Weight Estimations data and internal correspondence from K. S. Kosco to Jerry O'Leary. "Waste Calculations for Bin-Scale Test."	Estimates of drum contents based on RTR examination.	1991 May 10
U025	Rocky Flats Environmental Technology Site Miscellaneous Aqueous Waste Handling and Solidification (Draft). 4-A73-POPM-774-WO-2005.	Draft operating procedure for IDC 802 waste.	1996
U026	"Rocky Flats Plant TRU Waste Thermal Power Characterization Incremented in 0.05 Watt Segments from 0.05 Watts through > 0.60 Watts." Data table produced from SWIMS Database.	Distribution of thermal wattage in transuranic waste. This data table was produced to assess the impacts of wattage limits within the TRUPACT II shipping container.	Undated
U027	"Rocky Flats Plant TRU Certified Containers." Data table from the SWIMS Database.	Tabulation of Transuranic waste containers shipped (9/85–8/89) and on hand (8/89).	Undated
U028	"X-Ray Radiography Station Data" and "WIPP Container Certification Document." Raw data. EG&G Idaho, Inc.	Example RTR data for waste examined at SWEPP.	1993 April 13 and April 14, respectively

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U029	Volatiles Report 374 and 774 sludge.	Volatile organic results for Building 374/774 sludges. Possible misidentification of samples based on 13% carbon tetrachloride in aqueous waste.	1988 October 23
U030	VOC Gas Chromatography/Mass Spectrometry Results. WIPP Experimental Waste Characterization Program data printout.	Volatile organic drum headspace data from RFP transuranic waste.	1996 Query date March 27
U031	Rocky Flats Radioactive Waste Flow diagram.	Flow chart (10/85) of RFP radioactive waste flow.	1985 October
U032	WSRIC Waste Streams sorted by IDC.WSRIC Database program. Report RWS09.	September 1992 sort of the WSRIC Database by IDC. Also, the line-/nonline-generation field is included.	1992 Query date September 29
U033	Building 774 First Stage Treatment Log Book.	Records of liquid transferred via pipeline from Building 771 to Building 774 in 1969.	1969
U034	Building 774 First Stage Treatment Log Book.	Records of liquid transferred from Building 771 to Building 774 in 1989.	1989
U035	Building 774 First Stage Treatment Log Book.	Records of liquid transferred from Building 771 to Building 774 in 1982.	1982
U036	Building 774 Water Results Log Book.	Information on incoming pipeline waste (other than first stage receiving) and outgoing transfers to the ponds and Building 374.	1980-1983
U037	Building 774 Second Stage Treatment Log Book.	Waste treatment information.	1981
U038	Building 774 First Stage Treatment Log Book.	Records of liquid transferred via pipeline from Building 771 to Building 774 in 1984 and 1985.	1984
U039	Building 774 First Stage Flocculator Samples Log Book.	First stage liquid samples and 2nd stage sludge samples.	1968-1970
U040	Building 774 Low Level Organic and TRU-Waste Organic Waste Log Book.	Records for pipeline- and container-received organic waste in Building 774 from various buildings.	1976-1990
U041	Building 774 Car Log Book.	Record of liquid waste transfers from various buildings to the 207 Ponds, Building 374, and Building 774 (during 1982).	1982
U042	Building 774 Record Book.	Log Book to trace estimated fissile contents within treatment tanks.	1985
U043	Building 774 Set Up Log Book.	List of containerized waste treated in Building 774 from 1973 to 1990.	1973-1990
U044	Building 774 Water Results Log Book.		1984-1995
U045	Monthly Report—Liquid Waste Operations.	Liquid waste processing records from CY 1988, 1989, 1990, and 1991.	1981-1991

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U046	Evaluation of the EPA Code D001, Ignitability; D002, Corrosivity; and D003, Reactivity; Designations for RFP IDCs that are Stored at the INEL.	Technical analysis of wastes assigned EPA Codes D001-D003 that are stored at INEL.	1996 February 29
U047	A History of the Rocky Flats Plutonium/Actinide Recovery Plant 1952 to 1991 (Draft 10/30/91).	Detailed description of the actinide recovery and waste treatment processes at RFP.	1991
U048	Building 374 Log Book for Time Period 12/24/86 to 12/29/88.	Log of waste volume, building of generation, radioactive contamination level (total alpha or Pu gram/liter), pH and beryllium results for incoming liquid waste.	1988
U049	Building 374 Log Book for Time Period 12/26/82 to 12/24/85.	Log of waste volume, building of generation, radioactive contamination level (total alpha or Pu gram/liter), pH, and beryllium results for incoming liquid waste.	1985
U050	Building 374 Log Book for Time Period 04/12/91 to 09/27/93.	pH and total alpha contamination results for decontaminated liquid leaving Tanks D826A and B (clarifier).	1993
U051	Building 371 Log Book for Time Period 04/07/82 to 12/29/85.	Log of waste volume, Pu content, and Am content for liquid waste from Building 371 shipped to Building 374.	1985
U052	"Graphite Waste—Rock Flats Environmental Technology Site."	Process summary of graphite waste from Rocky Flats.	Date Unknown
U053	"Building 374 Solidified Sludge, Rocky Flats Environmental Technology Site."	Process summary of Building 374 aqueous sludge.	Unknown
U054	Toxicity Characteristic Leaching Procedure Test Results of Cemented Surrogate Analytical Laboratory Solution Waste—Part 2.	Results of TCLP testing of solidified laboratory waste prepared with RCRA metal spiked, surrogate liquid waste.	1994
U055	Sorting of Radioactive waste at Rocky Flats	Segregating and Sorting of radioactive residues.	1970 February 11
U056	Rocky Flats History of Filter Changes and Plenum Modifications	Summary of filter changes and plenum modifications (1953-1975).	1975 September
U057	Building 881. Presentation by Ernie English.	Handout from a presentation by Ernie English of M. H. Chew & Assoc. describing historical processing operations in Building 881.	1996 July 3
U058	(This reference has been combined with P033).		
U059	Drum Prefix Numbers and Corresponding Material Balance Areas.	Drum prefix numbers with corresponding material balance areas (MBA) and MBA title. Provides the building and area from which wastes were generated.	1994, 1991

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U060	Chemical Constituents in Transuranic Storage Area (TSA) Waste.Engineering Design File. RWMC-EDF-803.	Provides chemical constituents that are contained in or are suspected to be contained in various wastes stored at the TSA of the RWMC.	1996
U061	Sampling and Analysis Plan for Pyrochemical Salts. 1-100000-EQA.	Sampling and analysis plan (draft) for pyrochemical salts; including inventory description and packaging.	1992 September 31
U062	Presence of Chromium Pyrochemical Salt.Residues at Rocky Flats Plant.	KMI Services report concluding that chromium will not be present at regulatory levels.	1993
U063	Laboratory Analysis Results for Electrorefining Salt.	Visual inspection and emission spectra results metals in ER salt samples.	1987 December
U064	Radioactive Materials Associated with Rocky Flats.	Table of radioactive materials.	1977 April 14
U065	Radioactive Materials Associated with Rocky Flats. Presentation Slides.	Presentation slides for radioactive materials.	1983 March
U066	Radionuclides Quantities Received and Dispatched from RFP from 1951 to Present. J003499.	Table of radionuclides.	Unknown
U067	881-CSL Physical Inventory of Radionuclides.	Table of radionuclide materials.	1990 August 14
U068	Analytical Data from Liquid Stabilization Database at Rocky Flats.	G/L, Cl, isotopic, and metals data for IDCs 070, 400, 401, 500, 503, 508, 527, 533, and 541 (also on disk in Excel spreadsheet).	1997 March 3
U069	Drum Prefix Issue Dates Log Book.	Shows drum prefix, corresponding MBA, and dates that a group of extended drum numbers were issued.	1987-1997
U070	Handbook of the Rocky Flats Plant Production Non-Destructive Assay Systems.	Radioassay systems used at Rocky Flats.	1984 June
U071	Material Balance for Size Reduction Vault.	Drums of Rocky Flats waste stored at INEL shipped back to Rocky Flats for visual examination. This material balance log shows the original drum number and new drum number after repackaging in size reduction vault. Repackaged drums were shipped back to INEL.	1984-85
U072	Waste Stream and Residue Identification and Characterization Building 371. September 1990.	Uncontrolled electronic copy of Version 2.0 WSRIC Program, Building Book 371.	1990 September
U073	Waste Stream and Residue Identification and Characterization Building 559. Volume I. September 1990.	Uncontrolled electronic copy of Version 2.0 WSRIC Program, Building Book 559.	1990 September
U074	Waste Stream and Residue Identification and Characterization Building 707. Volume I. September 1990.	Uncontrolled electronic copy of Version 2.0 WSRIC Program, Building Book 707.	1990 September

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U075	Waste Stream and Residue Identification and Characterization Building 771. Volume I. August 1990.	Uncontrolled electronic copy of Version 1.0 WSRIC Program, Building Book 771.	1990 August
U076	Waste Stream and Residue Identification and Characterization Building 774.August 1990.	Uncontrolled electronic copy of Version 1.0 WSRIC Program, Building Book 774.	1990 August
U077	Waste Stream and Residue Identification and Characterization Building 776. August 1990.	Uncontrolled electronic copy of Version 1.0 WSRIC Program, Building Book 776.	1990 August
U078	Waste Stream and Residue Identification and Characterization Building 777. Volume I. August 1990.	Uncontrolled electronic copy of Version 1.0 WSRIC Program, Building Book 777.	1990 August
U079	Waste Stream and Residue Identification and Characterization Building 779. Volume I. August 1990.	Uncontrolled electronic copy of Version 1.0 WSRIC Program, Building Book 779.	1990 August
U080	Waste Stream and Residue Identification and Characterization Building 886. August 1990.	Uncontrolled electronic copy of Version 2.0 WSRIC Program, Building Book 886.	1990 August
U081	Nuclear Material Transaction Report. Transfer Series: ARF-VAB-000197.	Form 741 shipping records showing IDCs and drum numbers shipped to the Nevada Test Site between 9/18/85 and 2/7/88.	1985-1988
U082	EG&G Rocky Flats Plant Radionuclide and Hazardous Constituent Reportable Quantity Determination Guide. 1-10000-RQ.	Reportable quantities of hazardous constituents and radionuclides per 49 CFR, Part 172.101, for radioactive wastes at Rocky Flats. Information is summarized by IDC.	1992 December 15
U083	Internal Memorandum from J. T. Gilmartin to J. K. Wrapp, Kaiser-Hill, "Redesignation of Item Description Code (IDC) 393." With unpublished document, "Analysis of IDC 393 for the RCRA Designation D007 Based on Process and Storage Conditions Necessary for Formation and Continued Existence of Hexavalent Chromium (CR+6)."	Justification for removing D007 from SS&C Heel (IDC 393).	1997 August 6
U084	Waste Stream and Residue Identification and Characterization Building 778. January 1991.	Uncontrolled copy of archived Version 3.0 WSRIC Building Book 778.	1991 January
U085	Analytical Data and Summary of Samples from IDC 310 and 312.	Analysis of analytical data (IDCs 310 and 312) demonstrating that graphite does not exceed TCLP limits.	1998 January 22
U086	Analytical Data for IDC 411. Includes external correspondence, “Assessment of RCRA Metal Contaminating Plutonium,” from Kevin Peters (KJP/108/0198) to Pam Edrich, RMRS Waste Systems.	Data packages and letter supporting that plutonium will not cause TRU and low-level wastes to be RCRA regulated for metals.	1998 January 29

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U087	Discrepancy Report from Kevin J. Peters to Sheila Hailey, LMITCO. "Graphite Waste." KJP/003/0298.	Determination that graphite wastes were not mixed with spent solvents and therefore do not meet the definition of an F-listed hazardous waste. Includes excerpts from various source documents.	1998 February 3
U088	Discrepancy Report from Kevin J. Peters to Sheila Hailey, LMITCO. "Evaluation of Potential Sources of RCRA Compounds Found in Graphite Waste Headspace." KJP/114/0298.	Assessment of historical use of solvents in the foundry and other potential sources, and RCRA assessment of solvents and metals. References excerpts from various source documents, and includes an interview about 1,4-dioxane, a 1970 report about organics in glovebox atmosphere, and analytical data paints and thinners	1998 February 25
U089	Discrepancy Report from Kevin J. Peters to Sheila Hailey, LMITCO. "Assessment of Graphite Waste Matrix and Solvent Usage." KJP/004/0398	Interview conducted to determine if other materials were mixed with graphite waste and how solvents were used in casting operations.	1998 March 3
U090	Letter from Alan D. Rodgers to Mr. Tom Clements, "CHARACTERIZATION OF GRAPHITE WASTE" – ADR-981-98.	Statement from Rocky Flats that graphite molds did not come into contact with hazardous waste. Includes numerous attachments from WSRIC.	1998 July 6
U091	Process Flow Diagrams for IDC 480, Rocky Flats Plant – Waste Stream & Residue Identification & Characterization.	Several process flow diagrams for IDC 480. The process flow diagrams pertain to several buildings and processes that generated IDC 480 waste. The diagrams are dated from September 1991 through September 1993. These diagrams may not be applicable to waste generated prior to the dates on the diagrams.	1991–1993
U092	Inventory values as generated by TRIPS Change Request (TCR) 1821.	Listing of Rocky Flats 55-gallon drums and original Rocky Flats package dates. The listing includes the drums in accessible storage and those that have been shipped to WIPP.	2001 May 22
U093	Backlog Waste Reassessment Rationale for Description Codes 001 and 800, Rev. 2. RFETS.	Task 7 description of IDC 001 and IDC 800 waste generation and characterization. Assumed to be "Event 13" referenced in the RFETS Backlog Waste Reassessment Baseline Book.	Not Dated
U094	Ledger of Acceptable Knowledge Source Documents.	Listing of all acceptable knowledge source documents accumulated for INEEL-stored Rocky Flats Plant Transuranic Waste. Summarizes the type of document, document name or title, the document number, author/responsible organization and date, if known, and description of the document subject.	2003 February 20

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U095	Radiochemistry Data Packages by Waste Form and SPO File Location.	Pointer to the radiochemistry data packages and their locations in the Site Project Office files. One of the uses is to provide a crosswalk to the total measurement uncertainty (TMU) reports.	2002 April 8
U096	EDF-1242 Supporting Data.Compiled by Cecilia R. Hoffman.	Supporting documentation used to determine mass ratios calculated in EDF-1242. Includes shipping records, G. W. Twedell notes summarizing shipping records used, plots of the analysis of the shipping records used, RWMC EDF-450 "Specification of Constants Utilized in the Calculation of FGE, PE-Ci, and Thermal Power," and memo to C. R. Hoffman from Y. Harker on performing MDC calculations.	2001 October 11
U097	Response to Inquiry Relating Directly to EDF-RWMC-942 Information and Additional Questions Associated with the EDF. White Paper prepared by Kenneth L. Gilbert, Ph.D., and Timothy E. Venneman, M.S.	Addresses earlier statements made in EDF-RWMC-942 relating to assignment of EPA hazardous waste numbers to certain Rocky Flats waste stored at the INEEL. Discusses and concludes that assignment of EPA HWN D001 is not applicable to combustible and plastic wastes and leaded gloves that came in contact with nitric acid.	2001 November
U098	Preliminary data for the IDC 003 waste stream.	Phase I and Phase II sampling data.	2001 October
U099	Draft Waste Stream Profile Form INW164.001-Solidified Organics, and Supporting Documentation.	Draft WSPF prepared by INEEL. Supporting documentation: Characterization of Rocky Flats Plant Solidified Organics Waste Stream (IDCs 700 and 801), INEEL/EXT-02-00028; Waste Stream Summary Sheet– Solidified Organics, EDF-2994.	2002 April 10
U100	Radiography and Visual Examination Results of the Stored Waste Examination Pilot Plan (SWEPP) Certified Waste Sampling Program for Fiscal Years 1997, 1998, 1999, and 2000.EDF-2710, DRAFT.	Documents the radiography and visual examination verification results for 298 drums that were visually examined from 1997 through 2000 at Argonne National Laboratory-West. Identifies and discusses drums (4 total) that were miscertified. Includes comparison of radiography and visual data on a drum-by-drum basis, as well as an analysis of weight distribution of contents by drum. This draft contains preliminary data that has not been reviewed and approved for release.	2001 June 21

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U101	Visual Data Packages for Miscertifications Due to Excess Liquids.	These are the Visual Data Packages for the VEs that resulted in miscertification determinations for five waste containers due to the presence of liquids in excess of WAC limits. The waste containers were IDRF741205657, IDRF074706786, IDRF741202328, IDRF074701967, and IDRF074704967.	1996 October 21
U102	Acceptable Knowledge (AK) Final Evaluation Checklist INW161.001-Fire Brick/Coarse Fire Brick.	This checklist documents assignment of EPA HWNs and resolution of any discrepancies identified between Acceptable Knowledge (AK) documents, and between AK and characterization/ sampling data during development of the WSPF for INW161.001.	2002 September 18
U103	Acceptable Knowledge (AK) Final Evaluation Checklist INW252.001-Leaded Rubber Gloves and Aprons.	This checklist documents assignment of EPA HWNs and resolution of any discrepancies identified between Acceptable Knowledge (AK) documents, and between AK and characterization/sampling data during development of the WSPF for INW252.001.	2002 October 25
U104	Acceptable Knowledge (AK) Final Evaluation Checklist INW216.002 – First and Second Stage Sludge Subpopulation.	This checklist documents assignment of EPA HWNs and resolution of any discrepancies identified between Acceptable Knowledge (AK) documents, and between AK and characterization/ sampling data during development of the WSPF for INW216.002.	2002 October 25
U105	Apparent Cause Report: Solidified Waste Residual Liquid De-watering Investigation Not Referenced in Acceptable Knowledge Document.CAR-02-078.	This is the apparent cause report about the investigation of why acceptable knowledge (AK) summaries for three sludge waste streams did not contain information related to the solidified waste residual liquid de-watering issue.	2002 September
U106	Delegation of Site Project Manager Responsibility for Assessment of Flammability for Containers – 3100 m^3 Project. CNN 35661.	This checklist documents the delegation of Site Project Manager responsibility for the flammability assessment of containers using ETRAMPAC. NCR-29047 is included to support this document.	2002 September
U107	Draft Characterization Report: Characterization of Rocky Flats Plant Special Setups Sludge Waste (IDCs 004, 802)	This document summarizes INEEL's characterization data for IDCs 004 and 802. It incorporates acceptable knowledge, physical characterization, waste form sampling, chemical analyses, and headspace gas data.	2002

REF #	TITLE/DESCRIPTION	SUMMARY	DATE
U108	RTR/VE Comparison Database for 1983 to 1994.	A database was created to record the comparison of RTR and visual examinations performed from 1983 to 1994. Rationale used to develop the database and data and limitations are described.	2003 January
U109	SDVO RCRA Tracking Database (CD-R)	This document consists of three related databases (SDVO RCRA Tracking Database, Drumdata, and Coredata–IDC) that are compilations of information on drums included in the core sampling program conducted by INEEL for TRU waste characterization. Format is MS Access on a CD.	2003 February
U110	MTD-Drum Experiment System (CD-R)	This document consists of an old Headspace Gas Database. Format is a FoxPro database on a CD. Data are from the Bin Test Program and the Transuranic Waste Characterization Program (TWCP). (Description supplied by S. Hailey.)	2003 February

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