EG&G Idaho, Inc.

Report No: WM-F1-81-015

Date: September 1981

PATENT CLEARED

INTERNAL TECHNICAL REPORT

Title: IDAHO NATIONAL ENGINEERING LABORATORY STORED TRANSURANIC WASTE CHARACTERIZATION: NONRADIOLOGICAL HAZARDS IDENTIFICATION

Organization: Waste Programs Division

Author: T. L. Clements, Jr.

Checked By: [signature]   Approved By: [signature]

PATENT CLEARED

[redacted]

PATENT CLEARED

WM-F1-81-015

IDAHO NATIONAL ENGINEERING LABORATORY STORED TRANSURANIC WASTE CHARACTERIZATION: NONRADIOLOGICAL HAZARDS IDENTIFICATION

Prepared by:

Thomas L. Clements, Jr.

Waste Programs Branch
Waste Programs Division

September 1981

Prepared for:

NUCLEAR FUEL CYCLE DIVISION
U.S. Department of Energy
Idaho Operations Office

PATENT CLEARED

ABSTRACT

This report summarizes the available information concerning identification of potential nonradiological hazards included in transuranic (TRU) contaminated wastes stored at the Idaho National Engineering Laboratory (INEL). Waste characterization information includes process descriptions, type of waste generated, and waste management practices. This report covers both offsite-and site-generated wastes.

The generic types of nonradiological hazards found in the stored wastes include inorganic and organic chemicals, biological wastes, and mechanical hazards. These types of waste may have an impact on future management alternatives for transuranic wastes stored at the INEL.

CONTENTS

APPENDIXES

FIGURES

TABLES

IDAHO NATIONAL ENGINEERING LABORATORY

STORED WASTE CHARACTERIZATION:

NONRADIOLOGICAL HAZARDS IDENTIFICATION

1. INTRODUCTION

The Radioactive Waste Management Complex (RWMC) encompasses approximately 144 acres in the southwestern corner of the Idaho National Engineering Laboratory (INEL). The RWMC was established in 1952 as a controlled area for burial of solid radioactive wastes generated by INEL operations. In 1954, the burial ground was designated as a solid transuranic (TRU) waste disposal site. Until 1970, all TRU waste was buried below grade at the RWMC. In November 1970, the Transuranic Storage Area (TSA) was established for retrievable storage of waste contaminated with greater than 10 nCi of transuranic activity per gram of waste. The waste is stored above-ground on asphalt pads at the TSA. After a section of a pad has been filled with waste containers, successive layers of plywood, nylon-reinforced polyvinyl sheeting, and approximately 3 feet of soil is placed over the waste containers.

Transuranic wastes stored at TSA are generated by operations conducted for the U.S. Atomic Energy Commission and its successor agencies, now the U.S. Department of Energy (DOE). The following facilities have generated the majority of TRU wastes placed in storage at TSA: Mound Laboratory, Miamisburg, Ohio; Battelle Columbus Laboratories, Columbus, Ohio; Bettis Atomic Power Laboratory, West Mifflin, Pennsylvania; Argonne National Laboratory-East, Argonne, Illinois; and the Rocky Flats Plant, Golden, Colorado. Small volumes of TRU wastes have also been generated by INEL operations. In addition, the INEL Initial Drum Retrieval (IDR) and Early Waste Retrieval (EWR) projects have contributed wastes placed in storage at TSA. The total volume of TRU waste placed on TSA from November 1970 through December 1980 was 1,495,660.9 ft^3.

The purpose of this report is to identify potential nonradiological hazards included in transuranic wastes stored at the INEL-TSA.

Nonradiological hazards may include inorganic and organic chemicals, biological wastes, and mechanical hazards (pressurized gas cylinders, etc.). These materials not only are radiologically contaminated but also represent a nonradiological hazard due to associated chemical, biological, or mechanical properties. Available INEL waste shipment records are not complete in listing potentially hazardous materials in stored TRU wastes. Identification of potential hazardous materials will assist in ensuring personnel and environmental protection through adequate engineering design of retrieval, processing, and shipping facilities used in future stored TRU waste management alternatives.

During the course of this project, identification of nonradiological hazards required an understanding of each waste generator's operations, processes, type of waste generated, material usage, waste management practices, and any significant changes occurring since storage of TRU wastes began. This waste characterization information is included in this report to assist readers in gaining a more complete understanding of the different types of operations that generate TRU wastes shipped to the INEL for storage.

2. ESTABLISHING CONTACTS AND OBTAINING DATA

2.1 Initial Contact

Initial contact was established with each offsite waste generator by letter from the Waste Programs Division, EG&G Idaho, Inc. The letter briefly explained the purpose of the study and requested that a contact individual be designated from each offsite waste generator. The contact individual was to assist in characterization of stored waste and identification of potential nonradiological hazards included in the waste.

2.2 Formal Contact

Formal contact was established by telephone with the contact individual identified by offsite generators responding to the initial letter. The purpose of the study was explained in greater detail to the contact individual, and attempts were made to determine the availability of information concerning wastes shipped to the INEL. A waste questionnaire (Appendix A) was designed to provide a general format for systematically characterizing the waste. INEL waste generators were contacted directly for information concerning waste placed in storage at TSA.

2.3 Visitation

A personal visit was made to each offsite waste generating facility, except for the Bettis Atomic Power Laboratory. Permission to visit the Bettis facility was denied by DOE-Pittsburgh Operations Office. During visits to the other waste generators, available records detailing waste shipments and facility operations were reviewed. Personnel having knowledge of operations, processes, experiments, waste handling procedures, etc., were interviewed to obtain information concerning nonradiological hazards that may exist in stored TRU wastes.

2.4 Report

The information contained in each section of this report, concerning waste characterization and identification of nonradiological hazards, was reviewed by the appropriate waste generating facility. This review was conducted to ensure the completeness and accuracy of the characterization information.

3. OFFSITE-GENERATED WASTES

3.1 Mound Laboratory

The Mound Laboratory is operated by the Monsanto Research Corporation for the U.S. Department of Energy. The function of this facility is to manufacture components for use in the weapons program and produce plutonium dioxide ($^{238}PuO_2$) heat sources for commercial and military applications. Transuranic (TRU) wastes sent from the Mound Facility to the INEL are generated by ^{238}Pu heat source operations only. Waste originating from manufacture of weapons components and associated research and all <10 nCi/g waste from plutonium areas are disposed at commercial and other government disposal sites. Heat source programs have generated transuranic wastes from chemical purification, fabrication, recovery, analytical activities, decontamination and decommissioning (D&D) activities, and waste treatment facilities. Mound waste shipments to the INEL began in February, 1975. The yearly volumes and number of waste containers received were as follows:

Year	Volume (m^3)	Volume (ft^3)	Drums	Boxes
1975	604.4	21,344.4	2207	48
1976	193.8	6,844.0	931	-
1977	310.9	10,979.4	762	48
1978	180.7	6,381.4	868	-
1979	394.1	13,917.6	1352	32
1980	192.3	6,791.1	318	23
TOTALS:	1876.2	66,257.9	6438	151

The following individuals provided information concerning wastes shipped to the INEL: R. K. Blauvelt, D. R. Hopkins, R. L. Deaton, A. B. Combs, A. R. Campbell, R. Goss, T. Elswick, and D. R. Fidler.

3.1.1 Plutonium Processing Building

The Plutonium Processing (PP) Building at the Mound Laboratory processes $^{238}PuO_2$ received from the Savannah River Plant (SRP) and fabricates ^{238}Pu heat sources for commercial and military applications.

Heat sources fabricated at Mound have been used in the Apollo lunar project, planet Mars Viking program, Pioneer spacecraft program, cardiac pacemakers, milliwatt generators, and multihundred watt sources for space communication satellites. An estimated 70% of Mound-generated TRU waste originates from the PP Building.

3.1.1.1 Production. Prior to 1979, $^{238}PuO_2$ received from SRP was chemically purified by dissolution in a mixture of nitric/hydrofluoric (HNO_3/HF) acid and then precipitated with ammonium hydroxide (NH_4OH) forming plutonium hydroxide ($Pu(OH)_4$). The $Pu(OH)_4$ self-calcined to PuO_2 and was ground to various particle sizes, depending on program requirements. After grinding, the PuO_2 particles were sintered and then sent to a heat source fabrication line. The ratio of isotopes in the final product was as follows: 80%-^{238}Pu, 16%-^{239}Pu, 3%-^{240}Pu, 0.8%-^{241}Pu, and 0.2%-^{242}Pu. In the glovebox fabrication lines, the particles were either coated with a metal, usually molybdenum, or pressed into spheres or disks and then triple encapsulated. Encapsulation materials included iridium, graphite, Hastelloy, tantalum, and titanium. Solid wastes generated by production efforts included paper, rags, plastics (polyethylene, polypropylene), carbon die parts, hand tools, glass, lead-lined gloves, some asbestos gloves, molybdenum and tantalum foils, graphite, and metals (iron, stainless steel, aluminum, iridium, etc.). Small in-line generated wastes were placed in 1/2-gallon (metal) or 1-gallon (plastic coated cardboard) cartons; the carton was then placed in a polyethylene bag and transferred to the assaying station. Any cartons containing recoverable amounts of $^{238}PuO_2$ were sent to recovery for processing. Cartons containing below-discard amounts of $^{238}PuO_2$ were bagged out of the glovebox into polyethylene "tube" bags (several cartons/bag) and placed in 17C 55-gallon drums. Each drum had a 90-mil polyliner and a plastic bag lining the polyliner. The cartons were segregated into combustible and noncombustible fractions. Larger waste items (tools, motors, etc.) were double-contained in polyethylene before placement in drums or boxes, depending on size. The drums were sent to T Building for assaying by segmented gamma scan. Boxes are assayed by gamma scan at the PP Building.

Since 1979, $^{238}PuO_2$ has been received from SRP in a purified, encapsulated form. Because chemical purification is no longer required, the volume of wastes generated by production efforts has been greatly reduced. In addition, heat source production operations have been gradually phased out since 1978. Currently, most of the production lines are undergoing D&D. Several encapsulation and assembly lines are still in operation.

3.1.1.2 Plutonium Recovery. Recovery operations served to recover and purify $^{238}PuO_2$ from above-discard-level wastes (term means the waste is contaminated with recoverable amounts of special nuclear material) generated by production, research (R Building), and analytical programs. Recovery operations at Mound ceased in late 1975. Since then, wastes contaminated with recoverable amounts of $^{238}PuO_2$ have been sent to SRP for processing. Solid wastes generated by recovery operations were included in early Mound waste shipments to INEL. Liquid wastes were processed at the Waste Solidification (WS) facility in the PP Building.

Plutonium was recovered from waste items by several processes that included incineration, fluorination, and fusion. The resulting residues were processed by dissolution, leaching, concentration of the leachate, ion exchange, and precipitation of plutonium nitrate ($Pu(NO_4)_2$) with oxalic ($H_2C_2O_4$) acid. Chemicals used in recovery operations included nitric and hydrofluoric acids, hydroxylamine nitrate, sodium carbonate, ferrous sulfamate, and sodium hydroxide.[1] Listed below are recovery methods used for various waste items:

Content Code	Material	Method
801	rags, paper	incineration, followed by dissolution
802	glovebox gloves, rubber	leach
803	metals, equipment, pipes	leach
804	plastics, tygon	leach
805	asbestos filters	leach
810	glass, flasks	leach
813	glass filters and fiberglass	HF fluorination

After processing, the remaining residue (gloves, glass, filters, metals, sludge, etc.) was dried and packaged as solid waste. Most of these wastes were packaged in cartons (as previously described), labelled for content, reassayed, segregated into combustible and noncombustible fractions, and placed in waste drums. Evaporator and dissolver sludge (content code 811) was generated from processing various wastes. The sludge contained $^{238}PuO_2$, iron (Fe), calcium (Ca), sodium (Na), chromium (Cr), and other chemical residues from recovery efforts. Two-hundred-and-twenty-one 1/2-gallon (metal) cartons of sludge were included in waste shipments. Spent ion exchange resins (Dow series) were also included in early waste shipments. The resins were packaged in cartons (28 total) and labelled as content code 812.

3.1.1.3 Analytical. The analytical laboratories at Mound support production, recovery, and waste treatment operations and participate in the Safeguards Analytical Laboratory Exchange (SALE) program. The purpose of the SALE program is to verify radioisotope inventory and standard analytical techniques used by other labortories. The analytical laboratories periodically participate in weapon components surveillance programs.

The volume of waste generated by analytical operations is small. Solid wastes (glass, paper, plastic) are contaminated with ^{239}Pu, ^{238}Pu, ^{238}U, ^{235}U, and beryllium (Be). Beryllium-contaminated wastes (glass, gloves, paper, and sample precipitates) originate from analyses of weapon components. Approximately one to three 1-gallon cartons of Be-contaminated wastes are generated each year. Sample precipitates are labelled as content code 811. Each carton contains <0.05 g (estimated) of Be. All cartons are labelled as containing Be.

Contaminated elemental mercury (Hg) has also been generated by analytical operations. The Hg is contained in plastic bottles (probably pint size) inside 1/2-gallon (metal) cartons. Sixty-one cartons of Hg were included in waste shipments and were labelled as content code 832. In-line generated liquid wastes are processed by the WS facility. Low-level alpha-contaminated liquids are processed at the Waste Disposal (WD) building.

3.1.1.4 Waste Solidification. The Waste Solidification (WS) facility processes contaminated acid and caustic liquid wastes generated primarily by production, recovery, and analytical operations. Trace amounts of liquid wastes are generated by cleaning heat source hardware and research programs. Prior to 1979, production operations generated HNO_3/HF wastes from the dissolution of $Pu(NO_4)_2$ and hydroxide filtrates from precipitation of $Pu(NO_4)_2$. Recovery operations, which ended in late 1975, generated HNO_3, HF, and oxalic acid wastes. Solutions of hydroxylamine nitrate, sodium carbonate, sodium hydroxide, and ferrous sulfamate were also generated by recovery operations. The volume of liquid waste contributed by the analytical laboratories is small and consists of HNO_3, HF, H_2SO_4, and HCl. Overall, an estimated 95% of the acidic waste was HNO_3 with trace amounts of HF, HCl, H_2SO_4 and oxalic acids. The primary source of caustic liquid waste is the corrosive vapor scrubber system. This system is charged with a caustic solution (sodium hydroxide) to scrub acidic fumes from all PP operations. Production operations generated small volumes of caustic waste (hydroxide filtrates) from the precipitation of $Pu(NO_4)_2$ with NH_4OH.

Prior to December 1976, the acidic (content code 834) and caustic (content code 835) liquid wastes were processed in separate systems. After recovery operations ended in late 1975, the volume of acidic liquid waste was greatly reduced, and separate processing systems were no longer required. Since December 1976, any acidic liquid wastes have been combined with caustic liquid wastes for processing. Almost all liquid processed since then should be basic. A program was initiated in December 1979 to ensure that all liquids were basic before processing. Before processing, each liquid batch is sampled for analytical determination of normality and ^{238}Pu content. All solutions were required to contain less than 0.012 mg/ml of ^{238}Pu until 1979 when the limit was raised to 0.025 mg/ml. After the analytical results are obtained, the liquid is transferred to a holding tank. The holding tank is vacuum or air "sparged" to ensure suspension of the plutonium throughout the liquid batch. After sparging, 10 gallon aliquots are transferred into a calibrated tank and gravity-fed into a 17C 55-gallon drum, with a 90-mil polyethylene drum liner and a plastic bag lining the 90-mil drum liner, filled with 150 lbs.

of diatomaceous earth particles (Floridin Company product Florco) to absorb the liquid. After being filled, the drums are kept under negative pressure for a minimum of 16 hours for off-gassing before sealing the drum.

Acidic waste drums have been shipped to the INEL since 1976. These drums were generated during 1974-1975 but were stored at Mound for repackaging due to pressurization. Drum pressurization problems occurred from the use of a diatomaceous earth absorbent (tradename Auto-Dri and/or Dri-Rite) that contained calcium carbonate ($CaCO_3$). Reaction between $CaCO_3$ and the acidic liquid waste resulted in the production of carbon dioxide (CO_2). After the pressurization problem was identified, use of Auto-Dri and/or Dri-Rite was suspended and use of Florco, which does not contain $CaCO_3$, began in July, 1975. Drums suspected of being pressurized were repackaged by dividing the contents of a drum into two drums, storing the drums for approximately 3 months, rechecking for pressurization, and dividing the drum contents again if necessary. The last acid drums (content code 834) were shipped to INEL in December 1980. An estimated 20 acid drums may have been shipped to INEL (~1975) before the pressurization problem was identified. These drums may be pressurized.

3.1.1.5 Decontamination and Decommissioning. Decontamination and decommissioning (D&D) of PP recovery, analytical, and production glovebox lines began in late 1977. Since then, most of the solid waste generated by PP Building has been from D&D operations. At present, one analytical laboratory and several heat source assembly lines are still in operation, but the volume of waste generated by these operations is small.

Before a D&D operation begins in a section of the PP Building, all non-glovebox line associated items (furniture, electronic equipment, etc.) are removed. All small, loose in-line equipment (flasks, hand tools, paper, rags, etc.) are placed in plastic bags and then into 1/2-gallon metal or 1-gallon cardboard cartons, assayed, and bagged out of the glovebox in double plastic bags. Larger pieces of equipment, such as tanks, are dissassembled, if possible, bagged out of the glovebox in double plastic bags, and placed in drums or standard size waste boxes. External piping and service lines into the glovebox are removed and packaged. After all equipment has been removed from the glovebox, the glovebox interior is coated with approximately 2-3/4 in. of polyurethane foam to "fix" the contamination. The glovebox is then cutup, or if possible, unbolted from the glovebox line. If the glovebox was cut from the main line, a piece of 16-gauge sheet metal is sealed to the exposed end of the glovebox with rubber cement (trade name RTV) and tape. Each glovebox is usually wrapped in one or more layers of plastic before placement into a standard or over-sized waste box. Polyurethane foam is used for shoring. No waste items are placed inside the gloveboxes. The following information concerning equipment and materials removed during PP Building D&D operations was provided:

- 616 linear feet of stainless steel gloveboxes, 7 ft high by 3 ft wide; removed in sections
- 80 linear feet of fiberglass gloveboxes, 4 ft high by 3 ft wide; removed in sections
- Plexiglas windows from the gloveboxes
- Stainless steel fume hoods
- One machining lathe, 2 ft high by 3 ft long
- Tantalum tanks (evaporators, dissolvers, precipitators)
- Polyethylene tanks (1 to 8 gal)
- Stainless steel tanks (3 to 40 gal)
- Approximately 20 large (132 to 160 gal) stainless steel tanks
- Six resistance furnaces, 18-in. diameter by 18-in. high
- Small amounts of fiberglass and asbestos insulation from furnaces, etc.

- Two vacuum pump presses; each press has a large spherical chamber made of 1-in. thick stainless steel; oil was drained from each press.

- Three stainless steel diffusion pumps, largest pump is 3 ft long by 18-in. diameter; oil was drained from each pump.

- Numerous Welsh pumps; oil was drained from each pump.

- Manipulators and manipulator boots

- Lead-lined glovebox gloves and some asbestos gloves

- Glassware

- Wrenches and other hand-tools

- Graphite molds and crucibles

- Duct work

- Small amounts of lead shot

- Paper, rags, plastic

- Stainless steel and black iron piping, 3/8-in.to 1-in. diameter

- Welding equipment (electrodes, cables)

- Conduit

- Concrete, floor tile

- Approximately 900 linear feet of fiberglass conveyor system, 2 ft wide by 3 ft high, will be sent during FY-82.

3.1.2 Research Building

The Research (R) Building supported production operations conducted at the PP Building. The R Building was responsible for developing process technology for the fabrication of $^{238}PuO_2$ heat sources. These processes included heat source coatings, encapsulation research, shaping and pressing heat sources, and other metallurgical research. Decontamination and decommissioning of most R Building laboratories (glovebox lines) began in 1978.

Solid wastes generated by the research programs (1975-1978) were similar to wastes generated by PP Building production operations. The wastes consisted of paper, rags, plastic, lead-lined gloves, graphite, molybdenum and tantalum foils, glassware, and metals. Small in-line generated wastes were placed in 1/2-gallon (metal) or 1-gallon (cardboard) cartons, then bagged out of the glovebox into a plastic bag, and taken to PP Building for assay. Any wastes containing recoverable amounts of $^{238}PuO_2$ were processed at the PP Building. Larger waste items were contained in at least two plastic bags. Low-level alpha-contaminated liquid wastes were processed at the WD Building.

Seven R Building laboratories will eventually be decommissioned. At present, four laboratories have been completed. The procedures used for D&D operations are similar to those used in D&D operations at the PP Building. The following information concerning D&D waste from R Building was provided:

- 414 linear feet of stainless steel gloveboxes, 4 ft high by 3 ft wide
- Vacuum heat press, partially dismantled; press contained a spherical chamber, 3 ft diameter with approximately 1-in. thick stainless steel walls
- Three stainless steel diffusion pumps, largest pump is 3 ft high by 18-in. diameter; oil was drained from each pump

- Numerous Welsh vacuum pumps, 18-in. diameter by 22 in. long; oil was drained from each pump
- One machining lathe, 2 ft high by 3 ft long
- Several stainless steel tanks
- Two fumehoods, 4 ft high by 3 ft long, made of 1/2-in. thick stainless steel
- Copper and stainless steel piping
- Hot plates, hand tools
- Glassware (flasks, beakers)
- Crucibles (graphite and tantalum)
- Lead-lined glovebox gloves
- Plastic, paper, rags, etc.

3.1.3 Waste Disposal Building

The Waste Disposal (WD) Building processes all low-level alpha-contaminated liquid wastes from the PP, R, H (laundry), and WD Buildings. The following materials make up the bulk of liquid waste influent to WD Building:[1]

- Shower water and soap
- Decontamination water
- Cooling water
- Detergents

- Alcohols--trace amounts of methanol, ethanol, propanol
- Acids--HNO_3, H_2SO_4, HF, HCl, etc.
- Caustic--primarily NH_4OH
- Janitorial wastes--wax, wax stripper, bowl cleaner, etc.
- Paint
- Sawdust
- Acetone, trichloroethylene--trace amounts.

Trace amounts of solid chemical wastes are included in the liquid waste. The following estimated quantities of chemical wastes are included yearly in the liquid waste stream:[1]

Chemical	Quantity (lbs.)
Potassium carbonate (K_2CO_3)	4.0
Potassium sulfate (K_2SO_4)	1.0
Copper sulfate ($CuSO_4$)	1.0
Calcium carbonate ($CaCO_3$)	3.0
Oxalic acid ($H_2C_2O_4$)	1.0
Lithium chloride (LiCl)	2.0
Zirconium oxide (ZrO_2)	2.5
Sodium carbonate ($NaCO_3$)	0.25
Caustic soda and lime	60.0
Potassium pyrosulfite ($K_2S_2O_5$)	5.0
Potassium bromide (KBr)	2.5
Nickel sulfate ($NiSO_4$)	4.0
Asbestos fiber	1.0
Methylene blue	1.0
Mercury (Hg), Lead (Pb)	Trace
Beryllium (Be), cyanides	Trace

All liquid wastes are collected in four 30,000-gallon interconnected influent tanks. The water is sampled for radioactivity and prepared for treatment. The primary contaminant is ^{238}Pu, with trace amounts of ^{233}U, ^{237}Np, and ^{241}Am. The trace nuclides originate from bench-scale R&D projects on processing liquid wastes contaminated with other radionuclides. This work is conducted by WD development groups. After the analytical results are obtained, treatment chemicals are added to the influent tank. An average treatment[1] consists of 7 to 10 bags (100 lb each) of calcium chloride ($CaCl_3$) and 2 to 4 bags (55 lb each) of amorphous carbon and sodium hydroxide (NaOH) for pH adjustment. The treated waste water is pumped into a clariflocculator where the major portion of radionuclides are removed by coprecipitation and absorption. The precipitate is collected from the bottom of the clariflocculator as a sludge. The supernatant water overflows the clariflocculator and passes through sand filters for removal of any remaining particulates or precipitate. The sand filter effluent water flows through a bone char adsorption column and a micropolishing filter and is collected in one of four interconnected 30,000-gallon tanks. The water is sampled prior to discharge. If the water does not meet discharge requirements, it is recycled through the treatment process.

The clariflocculator sludge, which contains the radionuclides and residual treatment chemicals, is pumped to holding tanks. For general sludge properties see Appendix B[1]. The sludge is dewatered and sampled for % solids (range = 25-30%) and ^{238}Pu content. After sampling, the sludge is prepared for disposal by solidification. Approximately 40 gallons of sludge is homogenously mixed with 2 to 2-1/2 bags of Portland cement in 17C 55-gallon drums (with a 90-mil polyethylene drum liner). The sludge/cement mixture (content code 836) is cured for 24 hours before the drum is sealed. This waste category represents approximately 50% of all Mound-generated waste drums.

3.1.4 Waste Management Practices

Operations and D&D personnel are responsible for packaging all waste items. Information sheets are filled out on each waste container. The information includes the container identification number, container content, fissile content, etc. The container information sheets are transferred from operations to Nuclear Accountability/Waste Management for record keeping purposes and final preparation of the waste container for shipping. The Nuclear Materials Assurance Group conducts periodic compliance audits of all waste management practices.

3.1.4.1 Waste Drums. All waste drums used by Mound are 17C 55-gallon drums with a 90 mil polyethylene drum liner. All 90 mil liners, except for the sludge/cement drums (content code 836), are lined with a plastic (polyethylene) bag. Solid waste items are contained in at least two layers of plastic (polyethylene) before placement in a waste container. Small in-line generated wastes (rags, paper, glass, filters, etc.) are contained in cartons and each carton is double contained in plastic before placement in a waste drum. Very little polyvinyl chloride (PVC) plastic is used at Mound.

Mound stored waste drums are labelled with a unique drum identification number, waste designator code, and year of manufacture of the drum (example: 13602 CD 74). The following discussion addresses the waste designator codes.

1. Canned Drum (CD): This code represents a drum containing small in-line generated wastes contained in 1/2-gallon (metal) or 1-gallon (plastic coated cardboard) cartons. Each carton is labelled for content, placed in a polyethylene bag, and sealed with tape.

   The following content codes are used for labelling each carton:

Combustible		Noncombustible	
Content Code	Description	Content Code	Description
801	Rags, paper, wood	803	Metal
802	Dry box gloves, O-rings	805	Asbestos filters
804	Plastic, Tygon, etc.	810	Glass, flasks, etc.
812	Ion exchange resin	811	Evaporator and dissolver sludge
		813	Glass filters
		814	Graphite
		826	Rust, floor sweepings
		832	Contam. mercury

   The labelled cartons are assayed and segregated into combustible and noncombustible fractions. Each carton is bagged out of the glovebox into a polyethylene tube bag (up to 5 cartons per bag); the tube bag is cut, sealed with tape, and placed in a CD waste drum. The content code assigned to each drum (801, etc.) by Nuclear Accountability represents the major portion of cartons in the drum labelled with the same content code. For example, a drum labelled as content code 803 will contain a majority of cartons labelled the same, but other cartons containing noncombustible wastes (content code 805, 810, etc.) will also be included. Several content codes (812, 826) do not appear in INEL records due to the small number of cartons generated in these waste categories. Since 1977, all content code 801 wastes have been incinerated and the ash sent to SRP for processing.

The following information concerning the total number of cartons was provided for the period of February 1975 to February 1980:[1]

Content Code	Description	Total Cartons
801	Paper, rags, etc.	147
802	Gloves and O-rings	1366
803	Metal	1328
804	Plastics	2077
805	Asbestos filters	1108
810	Glass	788
811	Evap. and dissolver sludge	221
812	Spent ion exchange resin	28
813	Glass filters	228
814	Graphite	8
826	Floor swps/rust	34
832	Contam. mercury	61
		7393

2. Acid/Caustic (AC) Drums: This code represents acidic (content code 834) or caustic (content code 835) liquid wastes absorbed on Florco, as previously described. The drum designator code was recently changed to CA, and describes caustic wastes only. Acidic waste drums are no longer generated by Mound.

3. Equipment (EQ) Drums: The EQ designator code represents drums containing small equipment items (content code 825). The equipment waste includes small tanks, presses, piping, etc. The waste drums contain mostly noncombustible items. A small percentage of the drums contain combustible wastes. One equipment drum shipped in 1976 contained americium sources. The sources were placed in a metal can, and the can was placed in the middle of a drum filled with Florco.

4. Compacted (LD) Drums: The LD designator code represents drums containing compacted combustible wastes contaminated with <100 nCi/g (content code 847). A large percentage of the combustible waste is large pieces of polyethylene plastic used in D&D operations. A smaller percentage of the waste includes wet and dry rags, shoecovers, and rubber gloves. The compaction ratio is approximately 4:1. Florco (5-10 lbs) is placed in the bottom of each drum for absorption of any free liquids.

5. Noncompacted (LS) Drums: The LS designator represents drums containing combustible waste (content code 847) or noncombustible waste (content code 848) contaminated with <100 nCi/g. These drums are not compacted. Florco (5-10 lbs) is placed in the bottom of each drum for absorption of any free liquids.

6. Sludge (SL) Drums: The SL designator is used for the sludge/cement (content code 836) drums. The sludge is produced by treatment of all low-level alpha contaminated liquid wastes. The sludge is solidified with Portland cement, as previously described.

3.1.4.2 Waste Boxes. Standard and oversize boxes are used for packaging larger waste items. All boxes are coated with fiberglass reinforced polyester (FRP). Standard FRP boxes (4 by 4 by 7 ft) are used for packaging equipment (content code 824), such as vacuum presses, tanks, manipulators, fumehoods, etc. The waste items are contained in at least two layers of plastic. Standard boxes are also used for packaging contaminated soil (content code 842). The soil is packaged in smaller (2 by 3-1/2 by 3 ft) boxes and sealed, and then four smaller boxes are placed in each standard box.

Eighteen standard boxes were identified as containing 55-gallon drums (up to 5 per box), see Section 3.1.5.4. The drums were placed in boxes because of high ^{238}Pu content or because the drum or drum liner was rejected by quality assurance. The content of these drums might represent any waste category.

Oversize FRP boxes are generally used for packaging glovebox sections or large equipment (content code 824) that will not fit into standard boxes. Four different sized boxes are used. The dimensions are as follows:

Oversize Box Type	Width	Height	Length
I	5 ft 11-1/2 in.	9 ft	11 ft 4-1/2 in.
III	5 ft 1/2 in.	8 ft 8-1/2 in.	9 ft 1/2 in.
IV	4 ft	5 ft 6 in.	8 ft
V	5 ft 1/2 in.	5 ft 2-1/8 in.	8 ft 7-1/2 in.

Double height gloveboxes are packaged in Type I or III boxes. Type IV boxes are used to package glovebox sections from R Building. Standard sized gloveboxes on stands are packaged in Type V boxes. Gloveboxes are constructed of stainless steel or fiberglass with plexiglas windows, as previously described. The interior of the glovebox is coated with approximately 2-3/4 in. of polyurethane foam to fix the contamination. Each glovebox is contained in two layers of polyethylene plastic. Polyurethane foam is sprayed into the corners of each box to provide shoring for the glovebox.

3.1.5 Nonradiological Hazards

3.1.5.1 Mercury. Sixty-one cartons of contaminated elemental mercury (Hg) have been included in waste shipments. The mercury is contained in plastic bottles (probably pint size) inside of 1/2-gallon metal cartons. If all pint bottles were filled with mercury (specifics are unknown), this would represent a maximum of 7.63 gallons or 864 lbs of mercury. The INEL Transuranic Contaminated Waste Container Information System (TCWCIS) indicates that two 55-gallon drums of Hg were placed in storage. Information provided by Mound indicates that these drums, labelled as content code 814, actually contain cartons of graphite waste. A record search conducted by Mound located the 61 cartons of mercury (content code 832) in the following drums:

Drum Identification Number	Hg Cartons/Drum	Shipment Number
13714 CD 76	2	36
13593	1	
13594	2	
13597	2	
13601	3	
13603	2	
13610	3	
13615	1	
13620	5	
13637	5	
13579 CD 76	6	39
13632	1	
13746	1	
13766	3	
13767	2	
13791 CD 76	1	42
13783	1	
13786	1	
13805	1	
13740 CD 76	2	43
13865	1	
13866	5	
13606 CD 76	3	46
13631	1	
13720	3	
13910 CD 76	1	49
13914	1	
13990 CD 76	1	57
TOTAL:	61	

Mound is currently determining a method to solidify waste mercury. A promising solidification method is amalgamation with lead. Approximately

60 lbs of waste mercury will be processed after a final solidification method has been determined. Any mercury contaminated with <10 nCi/g will be disposed of at the Nevada Test Site.

3.1.5.2 Beryllium. Small amounts of beryllium (Be) contaminated wastes have been shipped to INEL. One to three 1-gallon cartons of Be waste are generated by analytical operations each year. The weight of Be in each carton is estimated to be <0.05 grams.

3.1.5.3 Pressurized Drums. An estimated 20 drums of absorbed acidic wastes (content code 834) shipped to INEL (~1975) may be pressurized, as previously described in Section 3.1.1.4.

3.1.5.4 Gas Generation. Radiolytic production of hydrogen gas may occur in certain waste drums. Suspect drums would be in-line generated combustible wastes (content codes 801, 802, 804 and 812) and <100 nCi/g combustible waste drums (content code 847 and 848).[1] Since 1975, all combustible waste drums have been required to contain <1 g ^{238}Pu.

A total of 74 55-gallon drums that exceed the 1 g limit of ^{238}Pu have been shipped to INEL (shipment numbers 37 and 38). The drums were packaged in 18 standard size boxes (up to 5 drums/box). The drums contain cartons of combustible and noncombustible (unsegregated) in-line generated wastes. The drums were packaged before the 1 g limit was established in 1975.

3.1.5.5 Ion Exchange Resins. Twenty-eight cartons of spent ion exchange resins from recovery operations have been shipped to INEL. The resin is an organic-based polymer produced by Dow Chemical Company. During recovery operations, the resins are exposed to various concentrations of nitric acid. Nitrated resins may become highly flammable and/or explosive if the resin is allowed to dry.

It is believed all resin waste (content code 812) included in Mound waste shipments was washed with water before packaging. It is not known how completely the resins were denitrated. As a safety precaution, the following containers were identified as containing resin waste:

Shipment Number	Container Identification	Resin Cartons/Container
34	Drum 13667 CD 76	9
36	Drum 13562 CD 76	1
	Drum 13689 CD 76	1
37	Box 76	4
	Box 109	2
38	Box 113	9
43	Drum 13856 CD 76	1
49	Drum 13965 CD 76	1
	TOTAL:	28

Drum 13667 CD 76 (shipment 34) was mistakenly labelled as content code 801. The drum contained only the resin waste. The content code should be changed to 812.

3.1.5.6 Asbestos. As of February 1980, 1108 cartons of asbestos filters (content code 805) have been included in waste shipments. The filters are usually packaged in cartons, and the cartons are double-contained in plastic. In addition, some asbestos gloves have been included in waste shipments.

3.1.5.7 Organic Wastes. All organic wastes, such as oil removed from equipment during D&D operations and scintillation vials, are stored at Mound. Some of the oils are contaminated with polychlorinated biphenyl (PCB). At present, a method for processing the organic waste has not been determined.

3.1.5.8 Other. No known mechanical or biological hazards exist in Mound waste shipments. Any gas cylinders from D&D operations are depressurized before placement in waste containers.

3.2 Battelle Columbus Laboratories

The Battelle Columbus Laboratories (BCL), a part of the Battelle Memorial Institute, is a not-for-profit organization that conducts contract research and development. At present, all transuranic contaminated wastes shipped to INEL have been generated by decontamination and decommissioning (D&D) of the BCL Plutonium Laboratory only. Research operations in the Plutonium Laboratory ceased in late 1977, and D&D operations began in early 1978. The following volumes of waste and number of waste containers have been received:

Year	Volume (m^3)	Volume (ft^3)	Drums	Bins
1978	15.82	558.7	76	--
1979	81.56	2880.3	--	24
1980	40.78	1440.2	--	12
	138.16	4879.2	76	36

Information concerning transuranic wastes shipped to INEL for storage was provided by: D. G. Freas, T. R. Emswiler, H. M. Foust, and D. McCarty.

3.2.1 Plutonium Laboratory

Research projects conducted by the Plutonium Laboratory included fuel production and special properties measurements, fabrication of $^{238}PuO_2$ heat sources, and chemistry/metallurgy operations supporting the laboratory.

A majority of projects conducted at the Plutonium Laboratory involved manufacturing and testing enriched $^{235}U/^{239}Pu$ fuel pins as part of the advanced alternative fuels program for breeder reactors. The fuel was processed by weighing out specific quantities of each metallic fuel and melting and alloying the fuels. The alloyed fuel was crushed into small pieces, hydrated, nitrated, and reduced to the nitride form (UN, PuN). The nitride fuel was pressed into pellets, sized, weighed, and loaded into fuel pins. The fuel pins were then analyzed for dimensions, nitride content, etc.

The Plutonium Laboratory was also involved in commercial development of $^{238}PuO_2$ heat sources for cardiac pacemakers and development of larger sources for use in the space program. Purified $^{238}PuO_2$ was pressed into pellets and sintered in the presence of $^{16}O_2$ for reduction of neutron radiation. The pellets were encapsulated with tantalum-tungsten and Hastelloy C.

Chemistry and metallurgical operations served to support various Plutonium Laboratory projects. Operational support included chemical analyses, destructive and nondestructive assay of products, and periodic support to the weapons program (component analyses). A variety of plutonium and uranium isotopes was used by support operations.

3.2.1.1 Decontamination and Decommissioning. Decontamination and decommissioning of glovebox lines in the Plutonium Laboratory began in 1978. All TRU contaminated wastes presently shipped to INEL have been generated by D&D activities only. All radionuclide contaminants should be in the oxide form. Before a D&D operation begins, a nylon-reinforced polyethylene (4-mil thick) plastic tent is constructed around several gloveboxes for contamination control. Initial D&D operations involve removal of all loose unneeded items (glass, tools, crucibles, etc.) in the gloveboxes. These waste items are bagged out of the glovebox into 14-mil thick polyvinyl chloride (PVC) plastic bags. Sharp objects, such as glass and tools, are placed in 1/2-gallon metal cans and bagged out of the glovebox into a PVC bag. The PVC bag containing the waste is cut and sealed with tape. Each PVC bag is then placed in two more PVC bags (each bag is sealed with tape), or is wrapped in two layers of nylon-reinforced polyethylene plastic before placement in a waste container. The estimated percentage of plastic usage is 80% polyethylene and 20% PVC.

After all unneeded items have been removed, the interior of the glovebox is washed three times to remove loose contamination. The wash solution (water and detergent) is collected and processed by solidification. After the glovebox has dried, three coats of polyurethane paint are applied to the interior to "fix" remaining contamination. The glovebox plexiglas windows are removed, and the glovebox is usually cut up into small pieces. The average estimated weight of a metal piece is 100 lbs. Several waste bins contain half-sections of gloveboxes. After the glovebox has been removed, any equipment inside the glovebox (lathes, furnaces, etc.) is disassembled or cut up, if possible. Machining and lubricating oil is drained from all equipment. Sharp or jagged edges on waste items are taped. All waste items are smeared for determination of fissile content. Large waste items, such as glovebox pieces, parts of lathes, etc., are triple-contained in nylon-reinforced polyethylene plastic. Each waste item is weighed before placement in a waste container. The following information concerning D&D wastes is intended to give a general idea of the waste content:

- Approximately 40 stainless steel gloveboxes
- Plexiglas windows
- Small equipment, tools, and materials, such as tongs, copper crucibles, hot plates, glassware, molybdenum and tantalum foil, etc.
- One Leblonde machining lathe, disassembled
- One small Southbend lathe, disassembled
- One Western sintering and pelletizing press, partially disassembled
- Two vacuum high-temperature presses, not disassembled. Each press was 5 ft high by 3 ft wide and contained a 3-ft-diameter stainless steel tank.
- Three small Carver presses, disassembled
- One hydraulic press, disassembled except for the stainless steel hydraulic cylinder. The cylinder weighed between 500-600 lbs.

- Five vacuum/controlled atmosphere furnaces; several of the furnaces were not disassembled
- One arc-melt furnace, disassembled
- One centerless grinder
- Nine-inch-diameter sheet metal ducting, cut to 4 ft lengths
- Filter housings (4 by 4 by 3 ft) and 24 in. square absolute (HEPA) filters
- Numerous 7-in. diameter by 7-in. tall inline absolute filters
- Approximately 20 12-volt lantern batteries
- Lead bricks used for shielding
- Copper piping and valves
- Stainless steel piping and valves
- Approximately 30 to 35 steel Maxitrol valves; each valve weighed ~150 lbs
- D&D wastes include nylon-reinforced polyethylene tent structures, 2 by 4 in. wood supports, plastic suits, booties, air hose, rubber gloves, wrenches, hammers, saw blades, etc.

Future wastes generated by D&D activities will include sandblasting grit, bricks, dirt, and sections of sheet metal walls from final D&D efforts.

3.2.2 Waste Management Practices

D&D operations personnel are responsible for packaging waste items. Except for content code 203 (paper, glass, metal), all wastes are segregated into noncombustible and combustible fractions. Quality assurance and safety procedures do not allow inclusion of liquid or chemical wastes in waste containers. All wastes are triple-contained in plastic before placement in waste containers (drums or bins). Loading travelers are filled out for each waste container. The traveler contains information concerning each waste package, such as type of waste (glass, metal, etc.), individual package weight, and smear count. The travelers are transferred from D&D to Nuclear Materials Accountability and Nuclear Packaging and Transportation for record keeping purposes and final preparation of the waste containers for shipment to INEL.

3.2.2.1 Waste Containers. All waste drums shipped to INEL are 17C 55-gallon drums with a 90-mil polyethylene liner. Except for a few drums in early waste shipments, polyethylene bags are not used to line the inside of the 90-mil drum liner.

All waste bins used by BCL are M-III type metal bins. The bins are used to contain large pieces of noncombustible items (glovebox pieces, presses, furnaces, etc.) and combustible wastes generated by D&D activities. Each bin contains a plywood box (1/2-in. thick plywood) that serves as a bin liner. Waste is placed inside the plywood box. The box is not removable.

At present, waste drums have not been packaged in waste bins. A future (FY-81) waste shipment will include four M-III bins containing a total of 32 55-gallon waste drums (8 drums/bin). Twenty-two waste drums are 17H waste drums that do not meet present INEL waste container criteria. The 17H drums contain a mixture of noncombustible and combustible wastes generated by fuel fabrication projects. Some of the drums were packaged five years ago. The contents of these drums are believed to include paper, rags, plastic, graphite and copper crucibles, foil (aluminum, tantalum, molybdenum, etc.), tools, and other wastes associated with fuel fabrication. All fissile material should be in the oxide form. It is not believed any hazardous wastes were included in these drums. Specific information on the content of these drums is not available. The remaining 10 drums will be the 17C type containing D&D wastes. These drums will be used to fill void spaces in the bins.

3.2.2.2 Content Code Description. The following content code descriptions are provided:

1. Content code 200 (americium sources): Based on BCL records, no americium sources have been included in waste shipments to INEL.

2. Content code 201 (noncombustible solids): Noncombustible wastes are packaged in drums and bins. These wastes include tools, crucibles, piping, valves, pieces of equipment (gloveboxes, lathes, furnaces, etc.), lead bricks, plexiglas, etc.

3. Content code 202 (combustible solids): Combustible waste items are packaged in drums and bins. The wastes include nylon-reinforced tent structures, wood, plastic suits, shoe covers, rubber gloves, air hose, etc.

4. Content code 203 (paper, glass, metal): Wastes are packaged in drums and bins. Waste containers will contain a mixture of combustible and noncombustible wastes.

5. Content code 204 (solidified solutions): Solutions (water and detergent) from washing the interior of gloveboxes were solidified in 55-gallon drums. Approximately 30 gallons of liquid waste was placed in a drum; then 250 lbs. of patching cement was added and mixed with a stick. After mixing, the cement mixture was allowed to cure for 2 to 3 days. After curing, the stick was cut off and the drum was sealed.

3.2.3 Nonradiological Hazards

3.2.3.1 Polychlorinated Biphenyls (PCB). Oils removed from various equipment pieces (lathes, presses, etc.) during D&D operations were absorbed in Oil-Dri in 1-gallon metal cans. The oils may be contaminated with PCBs of unknown concentrations. An estimated 20 metal cans will contain the absorbed oil. The cans were placed in content code 203 waste containers.

3.2.3.2 Other. No mechanical (gas cylinders, etc.) or biological hazards were included in waste shipments to INEL.

3.3 Bettis Atomic Power Laboratory

Information concerning wastes generated by the Bettis Atomic Power Laboratory (BAPL) was supplied to EG&G Idaho, Inc. in Westinghouse Electric Corporation report WAPD-DLO(FO)E-150, July 13, 1981. The characterization study was conducted by BAPL because permission for EG&G Idaho, Inc. personnel to visit BAPL for the purpose of waste characterization was denied. The following information was provided in the report.

The BAPL, operated for the U.S. Department of Energy by Westinghouse Electric Corporation, designs and develops nuclear reactors for the Naval Nuclear Propulsion Program and for central power stations. All research and development programs conducted at BAPL are performed under the direction of the DOE Division of Naval Reactors. BAPL waste shipments to the INEL began in 1973. The yearly volumes and number of waste containers received were as follows:

Year	Volume (m^3)	Volume (ft^3)	Drums
1973	33.67	1,189.1	119
1974	92.86	3,279.3	446
1975	122.40	4,322.5	588
1976	113.1	3,994.1	543
1977	8.745	308.8	42
1978	8.121	286.8	39
1979	11.66	411.8	56
1980	31.65	1,117.7	89
TOTAL	422.15	14,910.1	1922

Transuranic wastes shipped to the INEL were generated by the following facilities: Fuel Manufacturing Facility (L-Building), Experimental Physics Facility and TRX Facility (C-Area), Environmental and Radiochemistry Analyses (N-Building), and Analytical Chemistry (L-Building).

3.3.1 Fuel Manufacturing Facility (L-Building)

The Fuel Manufacturing Facility manufactures and assembles fuel rods. Processes performed by this facility include mixing fuel powders and sintering of fuel into pellets, loading fuel into fuel rods, and sealing the rods by welding. Materials associated with manufacturing operations include $^{233}UO_2$, ThO_2, $^{233}UO_2$-ThO_2 alloys, $^{235}UO_2$, $^{238}UO_2$, ZrO_2, CaO, Carbo Wax 6000 (polyethylene glycol), zirconium, carbon-steel, stainless steel, etc. Wastes generated by manufacturing operations include contaminated combustibles such as gloves, plastic, paper, filters, oil absorbed with "Absorbal" (diatomaceous earth), Carbo Wax, etc. Noncombustible wastes include contaminated metal scrap (carbon and stainless steel), zirconium tubing, sludge from grinding and polishing operations, etc. An estimated 85% of waste shipped to the INEL was generated by manufacturing operations.

3.3.2 Experimental Physics and TRX Facilities (C-Area)

The function of the Experimental Physics group was to evaluate the nuclear physics characteristics of fuel rods. Wastes generated by this group consisted of $^{233}UO_2$ and ThO_2 contaminated combustible, (rags, gloves, paper, filters, and plastic) and noncombustible (metal scrap, glassware, binary scrap powder, and fuel rods and pellets) wastes. During 1980, 77 modified 6M 100-gallon drums and 12 6M 55-gallon drums containing kilorods (critical facility fuel rods) were shipped to the INEL from the Tri-Regional Experimental (TRX) Facility. An estimated 8% of waste shipped to the INEL was generated by the Experimental Physics and TRX Facilities.

3.3.3 Environmental and Radiochemistry Analyses (N-Building)

Environmental and Radiochemistry conducted isotopic and isotopic dilution analyses of nuclear fuels. Materials associated with analytical operations included fuel samples, acids, and normal chemical laboratory equipment. The type of acids used in fuel analyses were sulfuric (H_2SO_4) and phosphoric (H_3PO_4). Wastes generated by analytical operations were contaminated with $^{233}UO_2$, $^{235}UO_2$, depleted and normal U, and ThO_2. Combustible wastes included rags, paper, filters, gloves, poly, rubber, etc. Noncombustible wastes included glassware, metal, neutralized chemical solutions, and chemical residues. An estimated 3% of BAPL waste was generated by these operations.

3.3.4 Analytical Chemistry (L-Building)

The Analytical Chemistry laboratory performed chemical analyses of fuel mixtures for verification of content. Analytical operations included dissolution of fuel samples in acid (H_2SO_4, H_3PO_4) as part of the procedure. Wastes generated by the operations were similar to wastes described in Subsection 3.3.3, and were contaminated with $^{233}UO_2$ and ThO_2. An estimated 4% of BAPL waste was generated by analytical chemistry operations.

3.3.5 Waste Management Practices

The content code assigned to a waste drum was selected on the basis of the major type of waste contained within the drum. Drums can be expected to contain limited amounts of materials other than the assigned content code indicates. For example, a combustible waste drum may contain noncombustible wastes. However, drums labelled as content code 40, solid binary scrap powder (fuel mixture powder), usually do not contain wastes from another content code.

3.3.5.1 Waste Packaging Methods. Wastes generated by BAPL facilities were usually packaged as follows:

1. Content code 10 (combustibles): Small waste items were wrapped in plastic and placed into a 3-1/4 inch diameter by 7-inch high tin plated steel can with a screw-on lid. This can was then placed in a "juice can" and the juice can top was sealed to the can with a roll seam.

   Larger waste items were wrapped in plastic and placed into a 4-3/8 inch diameter by either 20- or 24-inches-high tin-plated steel can. After the can was loaded, the can top was placed on, and the entire can was wrapped in plastic before placement in a type 17C or 6M waste drum with other cans of waste.

2. Content code 20 (noncompressible, noncombustible): Small and larger waste items that would fit into cans were packaged as described for combustible wastes. Larger metal wastes that would not fit into the cans were wrapped in plastic before placement into a type 17C waste drum.

3. Content code 30 (solidified grinding sludge): Grinding sludge, which was generated by fuel manufacturing grinding and polishing operations, was dried in a CO_2 (carbon dioxide) atmosphere at a temperature of 950°C, cooled, and packaged into 3-1/4 inch diameter by 7-inch high tin-plated steel cans. The cans were then wrapped in plastic before placement in a waste drum.

4. Content code 40 (solid binary scrap powder): Binary scrap powder was packaged in 3-1/4 inch diameter by 7-inch high tin-plated steel cans or 4-3/8 inch diameter by either 20- or 24-inch-high tin-plated steel cans. The cans were wrapped in plastic before placement into type 6M waste drums.

   Kilorods (critical facility fuel rods) were placed into a plastic-lined 5-inch diameter pipe installed within a type 6M drum with either 55- or 100-gallon capacity.

Polyethylene and PVC plastic was used for packaging waste items. An estimated 90% of the plastic used for packaging was polyethylene, and 10% was PVC. Two layers of plastic were usually used to wrap the cans containing waste items before placement in a waste drum.

3.3.5.2 Absorbed Liquids. Liquid waste, such as oil, water, and neutralized chemical solutions, was absorbed on "Absorbal" (diatomaceous earth). Acidic wastes (H_2SO_4, H_3PO_4) were neutralized to a pH of 6 to 8 with either sodium hydroxide (NaOH) or hydrated lime (CaO). Acids neutralized with NaOH were mixed with Absorbal contained in polyethylene bottles. The bottles were packaged in metal cans, and each can was wrapped in polyethylene before placement in a waste drum. Acids neutralized with hydrated lime were mixed in a metal can to form a neutralized solid. The can was sealed and wrapped in plastic before placement in a waste drum. Waste oil was mixed with Absorbal and packaged in metal cans before placement in waste drums.

Containers of absorbed liquid wastes were placed in waste drums labelled as content code 10 (combustibles) or content code 20 (noncombustibles).

3.3.6 Nonradiological Hazards

3.3.6.1 Acids. All acidic wastes were neutralized and absorbed prior to shipment to the INEL and should not represent a hazard. The volume of this waste is unknown.

3.3.6.2 Oils. It is believed any absorbed oils, such as hydraulic oil, grinding oil, etc., included in waste shipments will not contain chlorinated hydrocarbons, such as PCBs. The volume of oil included in waste shipments is unknown.

3.3.6.3 Carbo Wax 6000 (Polyethylene Glycol). Carbo Wax in the form of solid powder or flakes was packaged in metal cans before placement in waste drums. Metal cans containing this material were placed in combustible (content code 10) and noncombustible (content code 20) waste drums. The volume of material included in waste shipments is unknown.

3.3.6.4 Other. It is believed no mechanical or biological wastes were included in waste shipments to the INEL.

3.4 Argonne National Laboratory-East

The Argonne National Laboratory-East (ANL-E) is operated by the University of Chicago and the Argonne Universities Association for the U.S.

Department of Energy. The ANL-E is involved in a broad range of programs including fundamental research in the physical, biomedical, and environmental sciences, and also serves as a major energy research and development (nuclear and nonnuclear) center. Radioactive wastes shipped to INEL from ANL-E include beta-gamma, intermediate level transuranic, and low-level transuranic wastes. Characterization of ANL-E generated wastes was conducted for stored (low-level) transuranic wastes only. Transuranic waste shipments to the INEL began in September, 1974. The yearly volumes and number of waste containers received were as follows:

Year	Volume (m^3)[a]	Volume (ft^3)	Drums	Bins
1974	163.1	5,759.9	-	48
1975	118.9	4,198.9	-	35
1976	147.2	5,198.4	40	42
1977	125.7	4,439.1	30	36
1978	107.6	3,799.9	50	30
1979	183.5	6,480.3	-	54
1980	210.1	7,419.7	29	60
TOTALS:	1,056.1	37,296.2	149	305

The following individuals provided information concerning transuranic wastes shipped to the INEL: C. L. Cheever, L. F. Coleman, E. R. Taylor, W. H. Kline, J. R. McCreary, C. E. Pietri, C. C. Jierree, R. A. Mason, M. K. Holland, H. J. Howard, R. G. Damm, W. H. Livernash, R. R. Heinrich, and D. R. Schmitt.

3.4.1 Chemical Engineering Division (Building 205)

Transuranic contaminated wastes generated by the Chemical Engineering Division (CEN) originate primarily from decontamination and decommissioning

a. Volumes include wastes placed in storage at the INEL Intermediate Level Transuranic Storage Facility (ILTSF).

(D&D) of the plutonium laboratory. Plutonium laboratory operations ceased in 1972 after a hydrogen explosion occurred in the glovebox line. The plutonium laboratory conducted a variety of research projects (chemical purification and processing) using various plutonium compounds, such as oxides, carbides, etc. Small volumes of TRU wastes are also generated by Building 205 analytical chemistry groups.

3.4.1.1 Decontamination and Decommissioning. Initial D&D of the plutonium laboratory began in 1972. At present, cleanup of the laboratory is near completion. All D&D operations are conducted by the Reclamation group. During initial D&D of a glovebox line, all unneeded items, such as tools, crucibles, and equipment, are removed. The waste items are bagged out of the glovebox into a 20-mil-thick PVC bag, and the bag is dielectrically (heat) sealed. Sharp objects, such as glassware, are placed in polyethylene bottles or taped before bagging out of the glovebox. Heavy waste items are double contained in PVC bags. Most of the equipment removed from the gloveboxes fits into unlined 17H 55-gallon drums. Machining and lubricating oil is drained from all equipment.

After all unneeded items have been removed, the interior of the glovebox is washed three times to remove loose contamination. The wash solution (water and detergent) is collected and absorbed on vermiculite contained in double polyethylene bags. After the glovebox has dried, four to five coats of latex (water-based) paint are applied to the interior to fix remaining contamination. The glovebox windows (safety glass) and neoprene glovebox gloves are removed, and the glovebox is ready for size-reduction. Each window is placed in a polyethylene bag, and then two windows are placed inside a PVC bag and dielectrically sealed. A glovebox is reduced in size to fit either a full size plywood box (53 by 44 by 72 in.) or a half size box (53 by 44 by 36 in.). The boxes, which are constructed with 3/4-in. plywood, are placed in M-III waste bins. One full-size box, or two half-size boxes will fit into a waste bin. Depending on contamination levels, the gloveboxes will be wrapped in one or more layers of polyethylene plastic. Other wastes generated by D&D activities are placed inside a glovebox for space utilization. Segregation of combustible and noncombustible wastes began in 1974. The following information concerning D&D wastes gives a general idea of the waste content:

- Approximately 11 carbon steel glovebox lines
- Glovebox safety glass windows
- Equipment such as scales, hot plates, hand presses, etc.
- Glassware
- Crucibles (Be, Th, and graphite)
- Four stainless steel sintering furnaces
- Three centrifuges
- One small machining lathe
- Copper, aluminum, and stainless steel piping
- Vacuum pumps
- Approximately four small gas cylinders; each cylinder was depressurized
- Cinderblock and asphalt floor tile
- D&D wastes include paper, rags (dry and damp), polyethylene tent structures, plastic suits, latex gloves, etc.

3.4.1.2 Analytical Chemistry. The analytical chemistry group supports CEN and other ANL-E projects. Chemical operations include irradiated and nonirradiated actinide separations, chemical purification, isotope identification (mass spectrometry), and other radiometric determinations. The volume of transuranic contaminated solid wastes generated by analytical chemistry operations is small. Most of the waste is glassware (pipettes, beakers, etc.) and paperwipes. Occasionally metal wastes, such as hot plates, and spent ion exchange resins are included.

The resins are usually rinsed with water or a dilute mixture of HCl/HF acid before disposal. Wastes generated in fumehoods are disposed of in unlined 5-gallon paint cans (PC5). Wastes generated by glovebox operations are bagged out of the glovebox into a PVC bag. The PVC bag is heat sealed and placed in a PC5. After a PC5 is filled, the metal lid is crimped on, and the can is collected by the Reclamation group. All liquid wastes, such as mineral acids, chemical wastes, and caustic scrubber solutions, are collected and processed by the Reclamation group.

3.4.2 Materials Science Division (Building 212)

The Materials Science Division plutonium laboratories are multi-purpose laboratories designed for conducting research with a variety of special nuclear materials such as plutonium and uranium. The laboratories are equipped for fabrication (melting, casting, and machining), metallographic examinations, physical and mechanical properties measurements, passivation, x-ray analysis, and conducting heat treatment and corrosion tests supporting reactor-related projects.

The volume of transuranic waste generated by this facility is small. All fissile material should be in the oxide form. Wastes generated by the plutonium facility include paper wipes, neoprene glovebox gloves, and metal waste (aluminum, stainless steel, brass, etc.). Wastes are placed in aluminum cans (4-in. diameter by 8-in. length) and bagged out of the glovebox into a 20-mil thick PVC bag. The bag is dielectrically sealed and placed in a 17H 55-gallon drum. Since 1974, periodic D&D work has been conducted by the reclamation group. The D&D wastes include approximately six gloveboxes, vacuum pumps, equipment, paper, rags, and plastic.

3.4.3 Special Materials Division (Building 212)

The Special Materials Division (SPM) is responsible for managing all special nuclear (Pu, U, Th, etc.) materials for ANL-E. Responsibilities include receiving, storing, shipping, scrap recovery, incineration of pyrophoric fissile materials, and accountability. Recoverable amounts of fissile material are processed at other government facilities. Wastes generated by SPM operations include various sizes of metal cans, plastic, glass vials and bottles, paper wipes, and small pieces of equipment (tools, balances, etc.). Most of the waste is packaged in aluminum cans, as previously described, and bagged out of the glovebox into a PVC bag. The bag is dielectrically sealed and placed in a 17H 55-gallon drum. Larger waste items are contained in at least double PVC bags before placement in a waste drum. Sharp or jagged edges are taped. The wastes are not segregated.

3.4.4 Building 350

3.4.4.1 New Brunswick Laboratory. The New Brunswick Laboratory (NBL), operated by the U.S. Department of Energy, conducts a variety of chemical analyses for DOE and the Nuclear Regulatory Commission (NRC). Transuranic contaminated wastes are generated by the NBL plutonium laboratories. These laboratories support the U.S. Nuclear Safeguards Program, with some involvement in the nuclear fuel cycle and weapons programs.

Analytical operations conducted by the plutonium laboratories include sample dissolutions, chemical purification by ion exchange, plutonium and uranium assay, isotope identification, isotope abundance determination, etc. Solid wastes generated by analytical operations include paper wipes, latex gloves, polyethylene pipettes and bottles, small plastic ion exchange columns (~5 mL resin/column), glassware, HEPA filters with steel frames, and tools. Sharp objects, such as glassware, are packaged in 1/2-gallon metal cans. Ion exchange resins are washed with dilute HCl/HF acid and packaged in metal cans. All waste items in the glovebox lines are contained in two polyethylene bags. The polyethylene bags are bagged out of the glovebox into a PVC sleeve bag. After filling, the PVC bag is dielectrically sealed and placed in a 17H 55-gallon waste drum (up to 15 PVC bags/drum). All liquid and chemical wastes are processed by the Reclamation group.

3.4.4.2 Decontamination and Decommissioning. Decontamination and decommissioning of the ANL Plutonium Fabrication Facility (PFF) began in

1974 to provide space for the NBL. The PFF was involved with fabrication of mixed $^{239}Pu/^{235}U$ fuel elements (metallic, oxide, and carbide forms) supporting ANL reactor research programs. Fissile material used for fuel production did not require chemical purification.

Small volumes of waste generated by production operations may have been included in early ANL-E waste shipments to the INEL. The wastes would include glass tubes, graphite and magnesium oxide (MgO) crucibles, scrap aluminum, polyethylene plastic, paper wipes, neoprene glovebox gloves, and empty tin cans used for transporting fissile material. Most of the waste was packaged in small steel cans and sealed (similar to a fruit or vegetable can). The cans were bagged out of the glovebox into a PVC bag and the bag was dielectrically sealed. The sealed PVC bags were placed in 1-gallon metal cans, sealed, and placed in 17H 55-gallon drums. Larger waste items were double-bagged in PVC and placed in waste drums.

Decontamination and decommissioning operations, which initially began in 1974, are conducted by the Reclamation group. During a D&D operation all unneeded items, such as tools, balances, overhead hoists, furnaces, presses, vacuum systems, piping, HEPA filters, etc., are removed from the glovebox. Wastes are bagged out of the glovebox into a PVC bag and the bag is dielectrically sealed. Waste items are generally placed in either full- or half-size plywood boxes, and the plywood boxes are placed in M-III bins. After the waste items have been removed, the glovebox is washed and the interior is painted (two to three coats) to fix remaining contamination, as previously described. A section of glovebox is disconnected and moved to a D&D tent for size reduction. Gloveboxes are reduced in size to fit a plywood box. Approximately 80% of the waste generated by Building 350 D&D efforts is placed in half-size plywood boxes and 20% in full-size boxes. All small and large waste items placed in plywood boxes are contained in at least one layer of plastic (PVC or polyethylene). Machining and lubricating oil is drained from pumps and other equipment and absorbed on vermiculite contained in small metal cans. The following information concerning D&D wastes was provided:

- Approximately 400 linear feet of aluminum gloveboxes, 4 ft wide by 6 ft high
- Plastic glovebox windows
- Neoprene glovebox gloves
- Three vacuum furnaces, each 30-in. diameter by 36-in. high
- One heavy-duty resistance tube furnace, 2 ft diameter by 6 ft length
- Two Stanat rolling mills
- One Hardinge Tool-Makers lathe, 5 ft long by 3 ft high
- One 250-ton capacity vertical press
- One 50-ton capacity button-breaking press, 30-in. square by 30-in. high
- One Heald milling machine
- One foil shear
- One Cincinnati shear with 6 ft wide blades
- One ball mill
- Two swaging machines
- One Sutton 600-ton capacity extrusion press; the press may not come to INEL depending on contamination levels
- Numerous vacuum pumps

- Copper tubing and conduit

- Wiring

- Several small 1-ton capacity hoists and steel rails

- Graphite insulating blocks and crucibles

- Small handtools and equipment (wrenches, scales, etc.)

- Plastic, paper, wet and dry rags, etc.

3.4.5 Chemistry Division (building 200)

The Chemistry Division conducts a variety of analytical and research and development programs using small (<mg) quantities of various transuranic isotopes. Projects include liquid-liquid extraction experiments, high pressure chromatography, laser isotope separations, laser spectral determinations, ion exchange resin experiments, and radionuclide migration and leach tests.

Most of the waste generated by chemistry operations consists of paperwipes, latex gloves, and glassware. Other wastes include small plastic ion exchange columns (10-15 mL resin/column); dried sample precipitates contaminated with transuranics in the form of fluorides, chlorides, and nitrates; and rock samples from leach tests. Ion exchange resins (Dow-X series organic polymer) are rinsed with oxalic acid to remove fissile material and denitrate the resin. Recoverable amounts of fissile material are processed by the Special Materials Division. Sample precipitates are packaged in 1-quart polyethylene bottles. All solid wastes are packaged in unlined 3-gallon or 5-gallon paint cans (PC3 or PC5). After a can is full, the metal lid is crimped on, and the cans are packaged in 17H 55-gallon waste drums. Segregation of solid wastes into combustible and noncombustible fractions began in late 1978.

Aqueous liquid wastes are absorbed on vermiculite contained in 1-gallon polyethylene bottles and allowed to dry. Until January 1981, organic scintillation liquids were also absorbed on vermiculite and allowed to dry. This practice ceased because of concern that peroxide formation could occur from decomposition of ether-based scintillation liquids. Bottles containing absorbed liquids were segregated from other wastes. The sealed bottle was placed in a PC3, and then the can was filled with vermiculite, sealed, and placed in a 17H 55-gallon waste drum (several cans/drum). It is believed any waste drums containing absorbed chemical wastes were so labelled. Currently, all TRU-contaminated organics are stored at ANL-E for future processing by incineration. All mineral acid wastes and solid chemical wastes are processed by the Reclamation group.

3.4.6 Waste Management Practices

3.4.6.1 Reclamation Group. The Reclamation group, which reports to the Waste Operations Manager, is currently responsible for management of all radioactive wastes. Organizational changes were recently made to ensure compliance with INEL waste acceptance criteria. Reclamation responsibilities include waste collection, final preparation of waste containers for shipment, record keeping, D&D activities, and processing chemical and liquid wastes.

Operations and D&D personnel in each waste generating area are responsible for segregating and packaging waste items. Wastes are packaged in 3- and 5-gallon paint cans, 17H 55-gallon drums, and plywood boxes. These waste containers are placed in M-III bins for shipment to the INEL by the waste generators or the Reclamation group. Because of the difference in waste packaging, the M-III bins should be considered as the second level of containment. Transuranic wastes are assayed by segmented gamma scan by the Special Materials Division and the Health Physics Division (D&D wastes only). Information sheets are prepared for each waste container by the waste generator. The sheets include information concerning radiation level, fissile content, waste content (combustible or noncombustible), etc. Segregation of wastes into combustible and noncombustible fractions generally began in 1974. Several waste-generating areas do not segregate wastes due to the low volume of waste generated. The information sheets and waste containers are transferred to the Reclamation group for processing and preparation of the waste for shipping.

Transuranic contaminated liquid wastes, such as mineral acids and spent caustic scrubber solutions, are processed by neutralization and absorption on vermiculite. The liquids are analyzed for fissile content and collected in a holding tank. The liquid waste is made basic with sodium hydroxide (NaOH) to a pH of 8 to 10. A 17 gallon aliquot of liquid waste is then absorbed on vermiculite contained in a 17C 55-gallon drum with a 90-mil polyethylene liner. The first shipment of absorbed liquid wastes (content code 102) was sent to INEL in 1980. Empty bottles (glass and polyethylene) used to transport liquid wastes are filled with vermiculite and packed in 17C 55-gallon waste drums, with a 90-mil polyethylene liner, and the drum is filled with vermiculite (content code 105).

Prior to January 1981, other liquid wastes, such as aqueous solutions, machining and pump oils, and other organic wastes (scintillation liquids, etc.) were absorbed on vermiculite contained in various size metal cans and polyethylene bottles. These wastes were generally processed by the waste generating area. Currently, all liquid wastes are processed by the Reclamation group. Organic wastes, such as scintillation liquids, are stored for future processing by incineration.

3.4.6.2. <u>Waste Description</u>. All wastes generated by ANL-E, including NBL, are shipped to the INEL in M-III bins. Currently, NBL liquid wastes are being segregated from ANL-E wastes for future shipment to the Nevada Test Site. The waste bins shipped to the INEL contain either half- or full-size plywood boxes or 17H 55-gallon drums and metal paint cans (PC5, PC3). The M-III bin should be considered as the second level of containment. The following content code descriptions were provided:

<u>Content code 100 (General plant waste)</u>: M-III bins contain wastes in 17H 55-gallon drums and metal paint cans. The wastes are generated by various ANL-E buildings as previously described. Segregation of

wastes into combustible and noncombustible fractions began in 1974, except for several low-volume generators that do not segregate the waste.

Content code 101 (Cut-up gloveboxes): Generally, the M-III bins contain half- or full-size plywood boxes. The boxes contain glovebox sections and other equipment generated by D&D activities.

Content code 102 (Absorbed liquids): The 17C 55-gallon drums containing absorbed liquids, as previously described, are shipped to INEL in M-III bins. The drums are unloaded at the Radioactive Waste Management Complex (RWMC), and the bins are returned to ANL-E.

Content code 104 (Alpha hot-cell waste): Alpha hot-cell wastes are packaged in 17C 30-gallon drums and shipped to the INEL in lead-shielded casks. The drums are unloaded at the RWMC and placed in storage at the Intermediate Level Transuranic Storage Facility (ILTSF). The wastes include noncombustible and combustible waste items generated by post-irradiation fuel examinations.

Content code 105 (Empty bottles): Empty glass and polyethylene bottles used to transport liquid wastes to the Reclamation group are packaged in 17C 55-gallon drums as previously described. The drums are shipped to the INEL in M-III bins and unloaded at the RWMC.

3.4.7 Nonradiological Hazards

3.4.7.1 Beryllium. Small amounts of beryllium in the form of crucibles, rods, etc. have been shipped to the INEL. These wastes were removed from glovebox lines during D&D operations. The volume of beryllium is unknown.

3.4.7.2 Organic Wastes. Organic wastes absorbed on vermiculite contained in metal cans and polyethylene bottles have been included in waste shipments. The organic wastes include scintillation liquids, alcohols, and machining and pump oils. Information provided by ANL-E personnel indicates that some of the scintillation liquids contained ether. The scintillation liquids were absorbed on vermiculite and allowed to dry. The ethers, upon standing, may form peroxides and would represent a potential explosion hazard. The number or volume of cans or bottles containing absorbed scintillation liquids included in waste shipments is unknown. Chemical bottles containing low-carbon aliphatic (generally butyl) alcohols were filled with vermiculite by D&D personnel. The alcohols were used by Building 350 for reacting waste sodium (Na) used in fuel pin fabrication. No unreacted sodium was included in waste shipments to INEL.

Machining, lubricating, and pump oils generated during D&D operations were absorbed on vermiculite contained in metal cans and polyethylene bottles. It is unknown if any of the oils contained polychlorinated biphenyls (PCB).

3.4.7.3 Ion Exchange Resins. Small plastic ion exchange columns, containing 5 to 15 mL of organic-based resin, are used by several ANL-E areas for isotope separation and recovery experiments. The resins are exposed to various concentrations of nitric acid. The resins are usually rinsed with either oxalic acid or a mixture of HCl/HF acids before disposal. Information provided by ANL-E personnel indicates that the resins rinsed with oxalic acid should not represent a hazard. Oxalic acid denitrates the resin and removes most of the fissile material. Resins rinsed with HCl/HF may be in the nitrate form. Nitrated organic resins, if dry, may represent a flammability and/or explosion hazard. The overall volume of ion exchange resins generated by ANL-E operations is believed to be small. Specific information is not available.

3.4.7.4 Other. No known mechanical or biological hazards were included in ANL-E transuranic waste shipments to the INEL.

3.5 Rocky Flats Plant

The Rocky Flats Plant (RFP) is operated by the Rockwell International Energy Systems Group for the U.S. Department of Energy. The function of this facility is to fabricate plutonium and other components for use in the weapons program. Radioactive wastes generated by RFP operations originate primarily from foundry operations, component fabrication, plutonium recovery and purification operations, analytical research and development activities, and waste treatment facilities. In addition to wastes originating from these operations, wastes from the fabrication facility fire in May 1969 have been included with other RFP stored wastes. Storage of RFP transuranic wastes began in November, 1970. The yearly volumes and number of waste containers received were as follows:

Year	Volume (m^3)	Volume (ft^3)	Drums	Boxes[a]
1970	1,420.0	50,147.3	3,676	196
1971	7,142.0	252,219.7	19,336	960
1972	5,944.0	209,912.4	17,598	729
1973	5,775.0	203,944.1	9,165	1221
1974	3,778.0	133,773.2	6,042	792
1975	2,538.0	89,629.5	4,723	488
1976	647.6	22,870.0	2,848	16
1977	2,144.0	75,715.4	2,240	528
1978	662.1	23,382.1	2,584	38
1979	2,605.0	91,995.6	2,369	678
1980	1,778.0	62,790.1	1,960	431
Totals	34,443.7	1,216,379.4	72,541	6,077

a. Prior to November 1979, waste boxes were not entered on the INEL Waste Management Information System (WMIS) until the boxes were placed in their final storage location. This is the reason for fluctuations in the number of boxes and volume of waste stored on a yearly basis.

Information concerning radioactive wastes shipped to INEL was obtained in three visits to RFP during FY-80 and one visit in FY-81. The visits were extended over this time due to the complexity of characterizing RFP generated wastes. Information contained in this report, for stored waste only, was obtained during the FY-81 visit and from EG&G Report WM-F2-81-001, Waste Characterization of Rocky Flats Plant Waste Shipped to Idaho National Engineering Laboratory 1954-1980, G. R. Darnell, T. L. Clements, Jr., and R. R. Wright, unpublished. Information, such as fire wastes and nonradiological hazards, developed in the referenced report is used, where applicable, in the stored waste characterization for RFP. The objective is to compile, in this document, information necessary to identify nonradiological hazards in all TRU waste shipped to the RWMC for retrievable storage. The following individuals provided information concerning wastes during the FY-81 visit to RFP: J. A. Hayden, D. Strangfeld, T. E. Boyd, R. L. Kochen, M. E. Killion, R. Giebel, B. E. Griffin, A. E. Hodges III, W. Scheuerman, H. L. Wells, R. P. DeGrazio, D. L. Baaso, R. G. Leebel, W. H. James, P. T. Godesiabois, F. A. Guerrieri, G. Tuck, K. J. Grossaint, L. DiGiallonardo, E. Sutton, S. Hoover, and J. Dallarosa.

3.5.1 Plutonium Operations

3.5.1.1 Plutonium Fabrication Facilities. The plutonium fabrication facilities are located in Buildings 707 and 776/777 (a combined complex). These facilities contain foundry, rolling/forming, machining, storage, inspection, nondestructive testing and assembly operations. Plutonium feed material, in the form of scrap, buttons, and briquettes, is melted in a tantalum crucible in a vacuum induction furnace and poured through a tantalum funnel into a coated graphite mold to form an ingot of the required shape and alloy content. Metallurgical operations include casting, rolling, blanking, forming, and heat treating the ingots. Engine lathes, jig borers, and numerical control machines are used in machining operations. Hydraulic oil is used as machining coolant. Plutonium parts (components), tools, gloves, and machines are degreased with carbon tetrachloride (CCl_4). Finished plutonium parts are further cleaned, inspected, and assembled with other components.[2]

Two general types of waste are produced by plutonium fabrication facilities: line-generated and nonline-generated wastes. Line-generated wastes consist of any materials exposed to plutonium in the glovebox lines. Examples of this type of waste include paperwipes, rags, plastic, rubber, tantalum crucibles and funnels, empty small glass vials wrapped with lead tape, lead-lined glovebox gloves, latex gloves, filters (HEPA[a], CWS[b], Ful-Flo), insulation, graphite molds, oil filters, aluminum foil, tools (stainless steel and aluminum), gloveboxes, and equipment such as furnaces, lathes, drill presses, etc.

Nonline-generated wastes consist of materials that are not in the glovebox line and are not in contact with plutonium. Because these materials are in a plutonium processing area, they are treated as transuranic (TRU) waste. Examples of nonline-generated wastes include office equipment, waste paper, roughing filters on ventilation inlets, electronic equipment, lead shielding, lead glass, Benelex shielding, cinderblocks, sheetrock, ceiling panels, electrical cords, structural metal, and conduit.

Depending on size, wastes are packaged in either 55-gallon drums or standard size (4 by 4 by 7 ft) boxes. Line-generated and nonline-generated wastes in 55-gallon waste drums are sent to Building 771 for nondestructive assay. Any drums containing fissile material above the economic discard level are retained for plutonium recovery. The economic discard level, which is the level at which it is determined to be economically acceptable to discard plutonium, varies depending on the type of waste. Drums containing fissile material below discard levels are sent to Waste Management (Building 776) for final preparation for shipping. Large waste items (both line-generated and nonline-generated) are packaged and sent directly to Waste Management for assay, washing, size reduction, and final preparation for shipping.

---

a. High Efficiency Particulate Air

b. Chemical Warfare Service

Liquid wastes, such as machining oils and degreasing solvents, are processed at the Aqueous Waste Treatment Facility (AWTF), Building 774.

3.5.1.2 Fire Waste. On May 11, 1969, a fire oc ... the plutonium production area of Building 776. The fire started in a can of plutonium chips stored in the foundry area and progressed through the conveyor glovebox lines. A total of 2600 linear feet of gloveboxes, including machining and fabrication stations, was externally contaminated or damaged by the fire. Some of the Plexiglas windows and Benelex shielding (2-inch thick, high-density redwood masonite) on the gloveboxes melted or burned, allowing escape of contaminants to the building. A total of 230,000 ft^2 of floor space, including areas of Building 777, was contaminated by the release. In addition to gross contamination of the production facility, the heat from the fire warped some vertical structural columns and overhead beams. The fire cleanup resulted in removal of all equipment, machinery, gloveboxes, piping, HVAC ducting, wiring, conduit, tools, parts of the roof, and some walls and structural components.

Most of the fire cleanup operation was conducted by Rocky Flats personnel. The final cleanup operation was conducted by Swinerton & Walberg (S&W), the maintenance contractor for RFP. Generally, all fire wastes were contained in double layers of plastic (polyethylene and PVC), taped closed, and placed in waste drums or boxes. Waste boxes were usually 4 by 4 by 7 ft, although larger and smaller boxes were used when needed. Wooden shoring and bracing were used to support heavy items in approximately 10% of the waste boxes. Large quantities of absorbent (tradename Oil-Dri) were placed in gloveboxes and on machines to absorb free liquids.

The total volume of fire cleanup waste shipped to the INEL was approximately 300,000 ft^3. An unknown volume of this waste was placed in storage at the RWMC by direct shipment from RFP and from the INEL Initial Drum Retrieval (IDR) project. The following information concerning the equipment and materials removed during cleanup operations gives a general idea of the waste content and waste packaging method, as remembered by workers involved with cleanup operations.

Foundry Area

- Sixteen steel vacuum induction furnaces, 6 ft diameter by 2 ft deep each. The furnaces were cut in half for a total of 32 pieces and put in 4 by 4 by 7 ft wooden waste boxes for disposal.

- Eight vacuum pumps, heavy cast iron with motor, pulleys, and oil were packed in boxes. Each pump had an exterior glovebox which was cut up and placed in 4 by 4 by 7 ft boxes.

- One Marform press, 60 ft high by 10 by 10 ft on the base, with a 3-ft diameter hydraulic cylinder. The press was constructed of cast iron and steel and weighed hundreds of tons. Oil was drained from the unit. The press was cut up and put in 4 by 4 by 7 ft boxes.

- One Hydroform press, 4 by 4 by 10 ft high, plus power pac. Cut up and placed in 4 by 4 by 7 ft boxes

- One HPM press, 4 by 4 by 20 ft high. Cut up and placed in 4 by 4 by 7 ft boxes

- One 4-high rolling mill, 8 by 8 by 10 ft high with two 10-in. and two 30-in. diameter hardened steel rolls, each 54-in. long. The machine had a large separate drive (gearbox and motor) unit. The rollers were the heaviest single components and were reduced in size to meet the 5000 lb/box limit. The rollers were exceedingly hard and took several days to cut through. Many saw blades were consumed during each working shift.

- One 2-high rolling mill, 5 by 5 by 6 ft high with two hardened steel rolls 24-in. diameter, 3 ft long. The rolling mill may not have been cut up but was partially disassembled. The mill was partially contained in a glovebox. The glovebox was included in the waste.

- One shear, 6 by 6 by 5 ft high, not cut up

- One circle shear, 4 by 7 by 5 ft high in glovebox, not cut up

- Two small vacuum induction furnaces in gloveboxes. Each glovebox was 3 by 3 by 6 ft.

- Neutron shields constructed of 2-inch thick benelex. The shields were in the form of a fence (approximately 30 by 40 by 6 ft high) and surrounded casting furnaces. The shields were dismantled and placed in waste boxes during early cleanup operations.

<u>Machining Area</u>

- A large number of gloveboxes containing machining equipment and tools were disconnected from the main conveyor glovebox line and boxed whole for shipment. The dimensions of the waste boxes varied, depending on the size and weight of the glovebox and associated equipment. All visible plutonium was removed from easily accessible locations on the machines. However, since the machines were not dismantled, there were hidden pockets of plutonium chips in some machines, possibly kilogram quantities. The general opinion of RFP personnel was that no pieces of plutonium larger than machining chips or lathe turnings would be found. It was believed all plutonium should be in the oxide form. However, it is possible that small amounts of unoxidized (metallic) plutonium or plutonium suboxides may be found trapped in the machine cooling oil, such as in the vacuum pots connected to each machining station.

- Twenty Monarch engine lathes, 5-ft high headstock, 16-in. swing, 7-ft lathe bed, and 10-ft overall length. All tools, jigs, chucks, fixtures, motors, coolant pumps, and exterior gloveboxes were included in the waste. Each glovebox was approximately 4 by 14 by 8 ft high. During initial cleanup operations, waste boxes were constructed around the lathes and exterior gloveboxes. During later cleanup operations, the lathes and gloveboxes were reduced in size to fit 4 by 4 by 7 waste boxes. Each lathe weighed approximately 4.25 tons. Generally, lubricating oil was not drained from the lathe gearboxes. There may be 4 to 8 gallons of oil in each machine. Large quantities of Oil-Dri were placed in the gloveboxes and on the machines to absorb free liquids.

- o Four radius generators, 6 by 3 by 5 ft high, including exterior glovebox. Two generators were cut up to fit 4 by 4 by 7 ft boxes.
- o One jig borer, 3 by 4 by 7 ft high, plus exterior glovebox
- o One two-spindle automatic lathe, 7 by 4 by 5 ft high, plus exterior glovebox
- o One four-spindle automatic lathe, 8 by 5 by 7 ft high, plus exterior glovebox, dismantled before shipping
- o Two Excello tape machines, 6 by 6 by 7 ft high, plus exterior gloveboxes, not cut up
- o One Bridgeport mill with 7 by 6 by 7 ft high glovebox, cut up to fit waste box
- o Two 16-in. optical comparators, 3 by 3 by 4 ft, with exterior gloveboxes
- o One double-spindle bench drill press, 2 by 2 by 4 ft high, with exterior glove[illegible] [illegible]ut up to fit waste box

- One lapping machine, 4 by 4 by 3 ft high, win exterior glovebox

- Each of the above machines (machining area only) was equipped with a vacuum pot and pump unit. Each unit was 2 by 3 by 2 ft high and was separate from the glovebox. The vacuum pots contained a mixture of highly contaminated machining oil, carbon tetrachloride, and sludge generated by each machining station. These units were not drained before shipment to the INEL.

- Approximately 300 linear feet of elevated (on legs) conveyor line gloveboxes, approximately 4 ft high by 3 ft wide

- Each machining station was equipped with a CO_2 fire extinguisher. The fire extinguishers were included in wastes sent to the INEL. It is believed all extinguishers were depressurized prior to shipment; however, this cannot be confirmed.

- One 25-ton bridge crane, 20-ft span, plus rails

- Several 24- and 14-in. wide flange beams, reduced in size

- Numerous electric motors and pumps

- Large quantities of sheetrock and chipboard

- Large quantities of light gauge ductwork, smashed and placed in 4 by 4 by 7 ft waste boxes

- Approximately 10 boxes of Schedule 120 hydraulic piping, 3-inch diameter

- Two large arc welders

- Five 2 by 4 by 7 ft boxes of concrete with 5/8-in. rebar, concrete cut to 1 ft thick pieces

- Most of the building roof, 240 by 520 ft with 1/8-in. butyl sheet cover and 4- to 5-in. thick fiberglass insulation. A total of 40 to 50 boxes were shipped.

- Dirt and asphalt.

- Transite (asbestos-cement) wall and steel supports. Approximately 12 boxes were shipped during 1972.

- Whole tool boxes, instruments, gauges, micrometers, jigs, drills, wrenches, etc. Packaged in 4 by 4 by 7 ft waste boxes.

Fire Cleanup Wastes

The fire cleanup operation required the use of size-reduction equipment to perform cutting and equipment removal operations. The tools, equipment, and materials used in these operations became part of the waste and are listed below.

- One 54-in. diameter Trennieyer saw; assumed to have been cut up at end of cleanup operations

- Six Fein hand-held reciprocating saws

- Hundreds of saw blades

- Movie and still cameras

- Two power-lift scaffolds

- Thousands of sets of anticontamination clothing

- Large quantities ("acres") of polyethylene sheet plastic

- One 4000-lb capacity forklift with batteries; it is not known whether the forklift was reduced in size before shipping.

3.5.1.3 Plutonium Analytical Laboratory. The Plutonium Analytical Laboratory (Building 559) conducts chemical analyses supporting various RFP transuranic operations (fabrication, recovery, waste treatment, etc.). Analytical capabilities include measuring plutonium content, impurities, and alloys in metals, liquids, and oxides, and performing analyses of gases and liquids (aqueous and non-aqueous) by mass spectometry, gas chromatography, infrared spectroscopy, and thermal techniques.

Solid wastes generated by laboratory operations include paperwipes, rags, plastic, rubber gloves, ion exchange resins, glassware, metal waste (tools, files, etc.), and ceramic (Leco) crucibles. Depending on the laboratory area, line-generated waste items are either single-contained in a large PVC bag or double-contained in a polyethylene and PVC bag before placement in waste drums. Sharp objects such as glassware are taped or placed in polyethylene bottles. Ion exchange resins are either processed by Plutonium Recovery (Building 771) or burned in the laboratory. All waste drums are sent to Building 771 for nondestructive assay. Drums containing fissile material above the discard-level are retained for plutonium recovery. Below-discard-level drums are sent to Waste Management (Building 776) for inspection and final preparation for shipment. Depending on plutonium content, all liquid wastes are processed through either the Plutonium Recovery Facility (Building 771) or the Aqueous Waste Treatment Facility (AWTF), Building 774.

3.5.1.4 Chemical and Metallurgical Research and Development. A variety of research and development programs in the chemical and metallurgical fields are conducted in Building 779. These programs include evaluation of field return units, determining processes for recovering and purifying transuranic elements from waste streams, improving processes for recovering and purifying plutonium by chemical, pyrochemical, and hydriding techniques, beryllium machining research, product integrity surveillance, and metallurgical (metallography, x-ray defraction, etc.) examinations.

Solid wastes generated by Building 779 operations have included paperwipes, rags, plastic, glassware, lead-lined glovebox gloves, latex gloves, miscellaneous laboratory equipment (ringstands, tools, etc.), 1-gallon metal containers of halide salt mixtures, such as $CaCl_2$, $ZnCl_2$, KCl, NaCl, and $MgCl_2$, from pyrochemical (direct oxide reduction, pyroredox, electrorefining, salt cleanup, etc.) recovery research, tantalum crucibles and stirring rods, high-density magnesium oxide crucibles, sandpaper, and small amounts of beryllium contaminated wastes. Generally, all waste items are double-contained in plastic (polyethylene and PVC) and segregated by content code before placement in waste drums. Nonline-generated combustible wastes (laboratory trash, etc.) are compacted in waste drums. All waste drums are sent to Building 771 for nondestructive assay. Any drums containing fissile material above the discard level are retained for plutonium recovery. Below-discard-level liquid wastes are processed at the AWTF. Above-discard-level liquid wastes are processed by plutonium recovery.

In April 1973, an inadvertent tritium (^3H) release occurred in a glovebox line located in the Plutonium Hydriding Laboratory. The cleanup operation generated approximately 15 to 20 drums of highly contaminated ^3H wastes. The wastes include vacuum pumps, plastic, paperwipes, tools, hoses, copper tubing, and small metal containers of aqueous solutions solidified in Portland cement. It is believed all wastes were at least triple-contained in polyethylene or PVC plastic before placment in the waste drums. All drums were labelled as containing ^3H.

3.5.1.5 General Laboratory. The General Laboratory in Building 881 conducts a variety of trace contamination analyses supporting RFP operations. Small volumes of wastes contaminated with low-level transuranic isotopes are generated by these operations. Wastes include paperwipes, process paper, latex gloves, plastics, glassware, small ion-exchange columns, stainless steel plancnets, soil and evaporator salt samples, and laboratory equipment such as hot plates, etc. All waste items are contained in a polyethylene bag before packaging in a waste container. Combustible wastes are packaged in waste drums and sent to Waste Management where the drum contents are emptied into a 4 by 4 by 7 ft waste box. Noncombustible waste items are packaged in 4 by 4 by 7 ft waste boxes and sent to Waste Management for inspection and final preparation for shipment to the INEL.

3.5.1.6 Criticality Research. Small volumes of waste are generated by the critical mass laboratory in Building 886. Criticality studies have been conducted with metallic ^{239}Pu and low- and high-enriched ^{235}U compounds. Wastes generated by criticality studies included paperwipes, rags, latex gloves, experiment handling tools, jigs, and fixtures. Wastes are packaged in drums and occassionally, boxes. Waste drums are sent to Building 771 for nondestructive assay. Drums containing >10 nCi/g fissile material are sent to Waste Management where the wastes are removed from the drum and repackaged in 4 by 4 by 7 ft waste boxes for shipment to the INEL.

3.5.1.7 Process Chemistry and Engineering Research and Development. The Process Chemistry and Engineering R&D Division conducts special-order work and component fabrication supporting weapon tests programs. Wastes generated by these programs are contaminated with a variety of special isotopes including ^{233}U, ^{237}Np, ^{241}Am, ^{242}Pu, and ^{244}Cm. Wastes contaminated with special isotopes are not processed by plutonium recovery operations. These wastes are not segregated due to the low volume of waste generated by R&D efforts.

3.5.1.8 Molten Salt Extraction. The molten salt extraction process (Building 776) separates americium (primarily ^{241}Am) from plutonium metal. A halide salt mixture (NaCl, KCl, and $MgCl_2$) is used to extract americium from molten plutonium. The salt residue is processed for recovery of americium and plutonium. Small amounts of below-discard-level salt residue have been shipped to INEL. The salt residue is packaged in 55-gallon waste drums.

3.5.2 Plutonium Recovery Facility

The Plutonium Recovery Facility (Building 771) receives and processes plutonium-contaminated residues from various RFP operations and some residue from other Department of Energy facilities. The majority of RFP residues processed in this facility originates from plutonium foundry and machining operations (Buildings 707 and 776/777). The purpose of the recovery facility is to extract plutonium from the residue material so that the final waste product will contain plutonium at or below the economic discard level and to produce weapon and research-grade plutonium metal.

Plutonium-contaminated solid residues (drums only) generated by various RFP operations are sent to Building 771 for nondestructive assay for determination of fissile content. If the waste contains fissile material below the economic discard level, the waste is sent to Waste Management (Building 776) for inspection, repackaging if necessary, and final preparation of the waste for shipment to the INEL. Drums of residue containing fissile material above the economic discard level are retained at Building 771 for processing. Any RFP-generated liquid wastes containing above-discard-level amounts of plutonium are also processed. Recovery operations are divided into two separate processes: special recovery and production recovery operations.

3.5.2.1 Special Recovery Operations. Special recovery operations process plutonium residues that can not be processed by production recovery.These residues are contaminated with uranium or other radionuclides which would interfere with production plutonium recovery processes. A tributyl phosphate (TBP) solvent extraction process is used to remove the radionuclide contaminants. Waste residue generated by special recovery operations includes paperwipes, rags, plastics, HEPA filters, polypropylene filters, glassware, metal waste such as stainless steel, aluminum, etc., lead-lined glovebox gloves, ion exchange resins, and equipment (hotplates, furnaces, etc.). Most of the residue is then processed by production recovery operations. Large waste items are sent to Waste Management (Building 776) for washing and size reduction.

3.5.2.2 Production Recovery Operations. Production recovery operations are divided into two categories called "slow" and "fast" recovery. Slow recovery operations process residues containing high and low concentrations of plutonium but require extensive processing and purification to obtain a suitable plutonium nitrate solution. Fast recovery operations process plutonium residues that are relatively pure and require a minimum of processing to produce a plutonium nitrate solution. Pure plutonium metal is extracted from fast and slow nitrate solutions by further processing.[2]

Production recovery operations currently process 81 different categories of plutonium-contaminated materials. These materials include paper, rags, plastic, rubber, glass, graphite molds, tantalum crucibles and funnels, metal, filters, insulation, molten salt and electrorefining residues, spent ion-exchange resins, impure plutonium, and laboratory solutions. Examples of slow recovery techniques include incineration of combustible wastes, scraping or grinding graphite and tantalum waste to remove adhered plutonium, dissolution of various residues (incinerated ash, grindings, filter media, etc.) with nitric acid to remove the plutonium, and ion-exchange procedures to purify plutonium nitrate solutions. Purified plutonium nitrate solutions from slow and fast recovery operations are concentrated and precipitated to form plutonium peroxide. Plutonium peroxide is calcined to plutonium oxide and hydrofluorinated to form plutonium tetrafluoride. Plutonium tetrafluoride is reduced with calcium to plutonium metal. Solid wastes generated by recovery operations are reassayed to ensure the waste meets plutonium discard requirements. Any wastes not meeting discard requirements are reprocessed. Wastes such as incinerator ash heel[a], graphite heel, insulation heel, and filter sludge are packaged in 1-gallon polyethylene bottles. Glass, graphite molds, etc. are packaged in 2- or 5-gallon size fiberpaks (cardboard cartons). Some wastes are wet or damp when packaged. Waste packages are bagged out of glovebox lines into a PVC bag before placement in a waste drum. Wastes are segregated into specific content codes. Liquid effluents from recovery operations are analyzed to determine fissile content. Above-discard-level effluents are reprocessed. Below-discard-level effluents are sent to the Aqueous Waste Treatment Facility for processing.

Present plutonium recovery operations will be transferred in the future to the new plutonium facility (Building 371) currently under construction.

3.5.3 Aqueous Waste Treatment Facility

The Aqueous Waste Treatment Facility (AWTF), Building 774, treats all liquid process wastes from the Plutonium Recovery Facility (Building 771) and all other plant liquid wastes that do not meet RFP onsite impoundment requirements. The following information concerning treated wastes was provided.

3.5.3.1 First Stage Sludge (Content Code 1). First stage sludge (prefix 741) is generated by processing liquid wastes, such as ion-exchange column effluent, distillates, caustic scrub solutions, etc., from plutonium recovery operations in Building 771. The liquid wastes are made basic and combined, and the radioactive elements, such as plutonium and americium, are chemically precipitated from the liquid waste. Treatment chemicals used are ferric sulfate, calcium chloride, magnesium sulfate, and

a. Heel is the remaining waste residue after the leaching process.

coagulating agents. The resulting precipitate, or sludge, is filtered and packaged in 55-gallon waste drums. See Figure 1 for sludge packaging methods. First stage sludge drums have periodically been lead-lined, when necessary, to reduce radiation levels to or below the 200mR/h limit. Increased radiation levels are usually associated with high americium concentrations in the sludge. Prior to 1972, fully lead-lined drums (top, bottom, and sides) were used. A lead-lined drum would contain 1/16-inch thick lead sheeting. After use of the 90-mil polyethylene drum liner began in 1972, lead sheeting could not be used and was replaced with approximately 5-mil thick lead tape. After a drum is filled with sludge and the 90-mil drum liner is sealed, the drum is inverted and pulled off of the liner. The liner is wrapped with lead tape and the drum is then placed back over the liner.

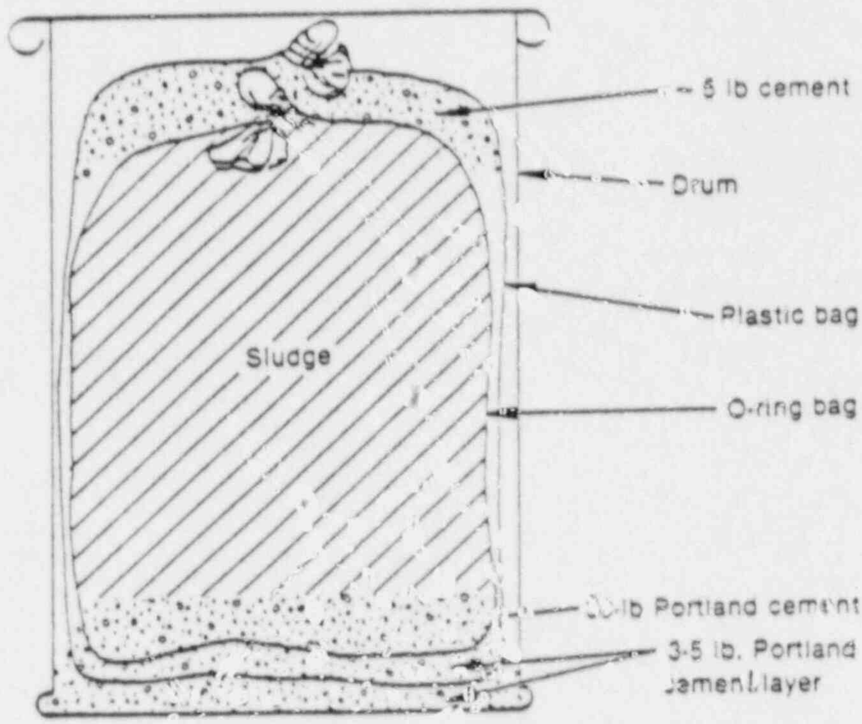
3.5.3.2 Second Stage Sludge (Content Code 2). Second stage sludge (prefix 742) is produced from treatment of all other plant liquid wastes requiring treatment and further treatment of the first stage effluent. The second stage treatment process uses the same chemicals used in the first stage treatment. See Figure 2 for sludge packaging methods.

Second stage sludge drums packaged before 1973 may contain other waste items such as electric motors, glass or polyethylene bottles of chemical (usually liquid) wastes, mercury and lithium batteries, and small amounts of contaminated mercury in pint bottles. Specific information concerning the type or volume of chemical wastes included in second stage sludge drums is not available. Radioactive sources have also been periodically included in second stage sludge drums through 1979.

3.5.3.3 Combined Sludges (Content Code 1). Since the fall of 1979, the first and second stage sludges have been combined to reduce the radiation levels associated with first stage sludge. The sludge mixture (prefix 7412) is shipped to the INEL as content code 1 sludge. See Figure 3 for sludge packaging method.

The water content of sludge waste (content code 1 and 2) ranges from 50 to 70% by weight. The sludges contain a variety of residual chemicals

1970 - 1972:



Note: Rubber surgical gloves were periodically placed in the bottom of the drum before filling with sludge.

1972 - 1979: In 1972, use of the 90-mil polyethylene drum liner began.

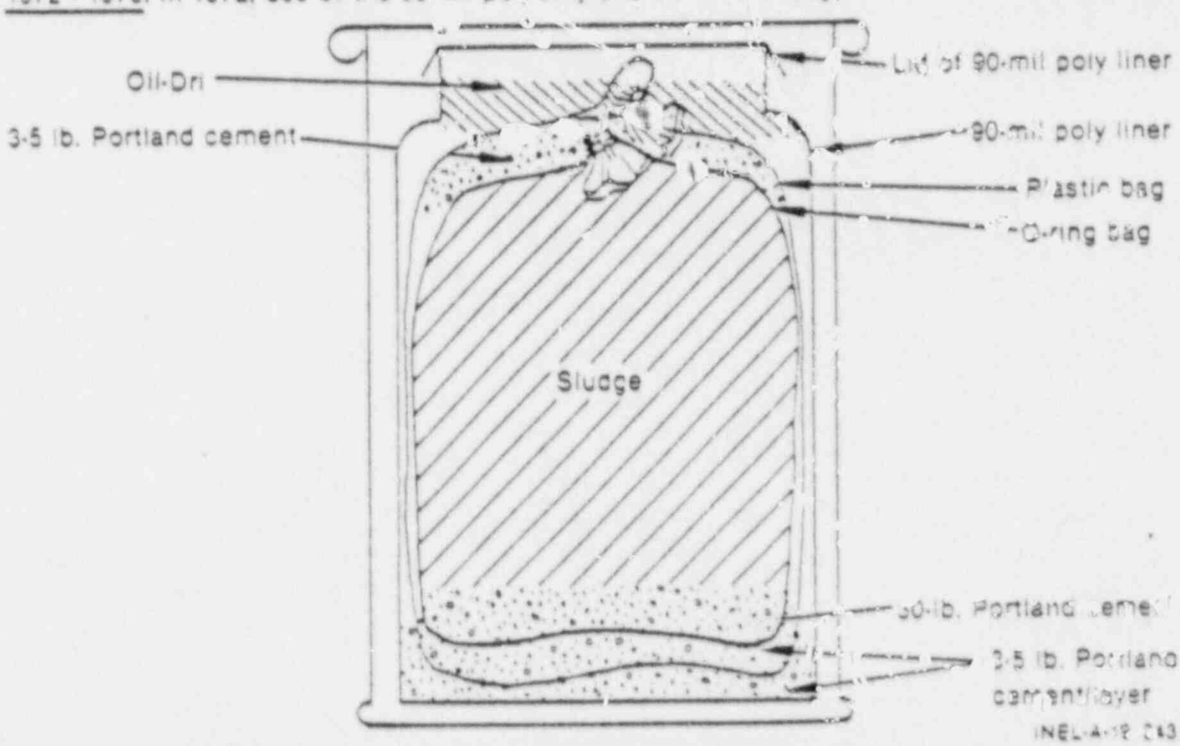
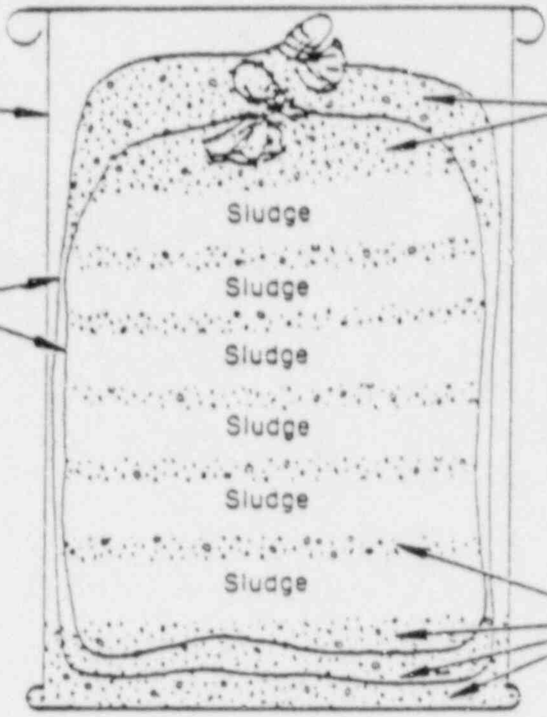
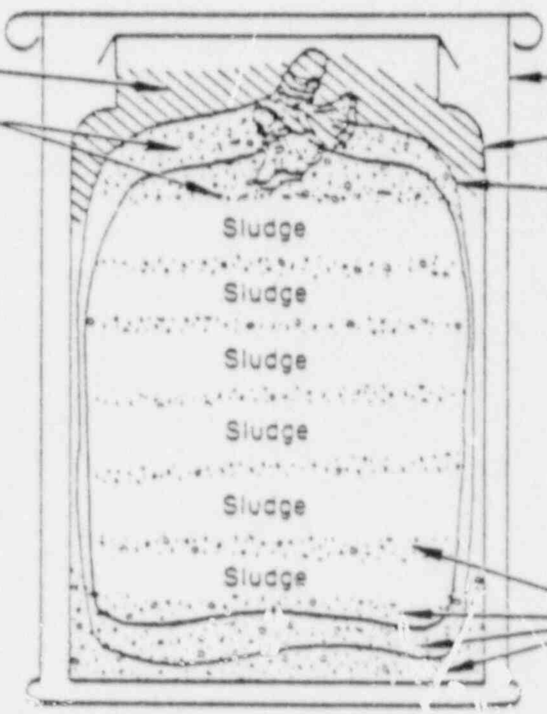


Figure 1. First stage sludge packaging methods.

1970 - 1972:



1972 - 1979: In 1972, use of the 90-mil polyethylene drum liner began.



Note: Sludge drums packaged prior to 1973 may contain other wastes such as batteries, bottles of chemical wastes, etc. Radioactive sources have also been placed in sludge drums through 1979.

INEL-A-19 244

Figure 2. Second stage sludge packaging methods.

1979 - Present: Since 1979, the first stage and second stage sludges have been combined.

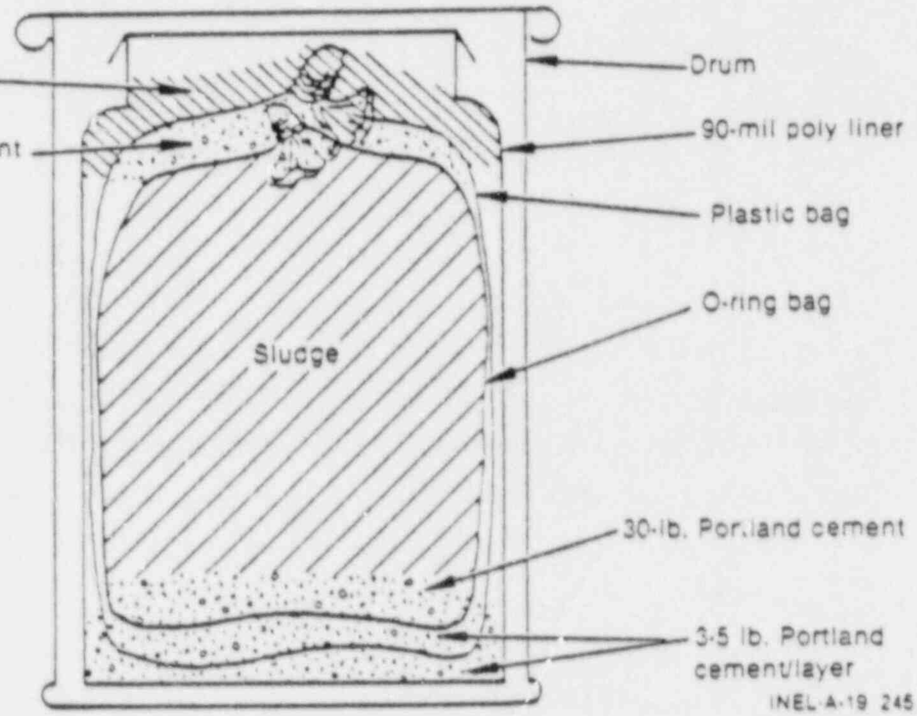


Figure 3. Combined sludge packaging method.

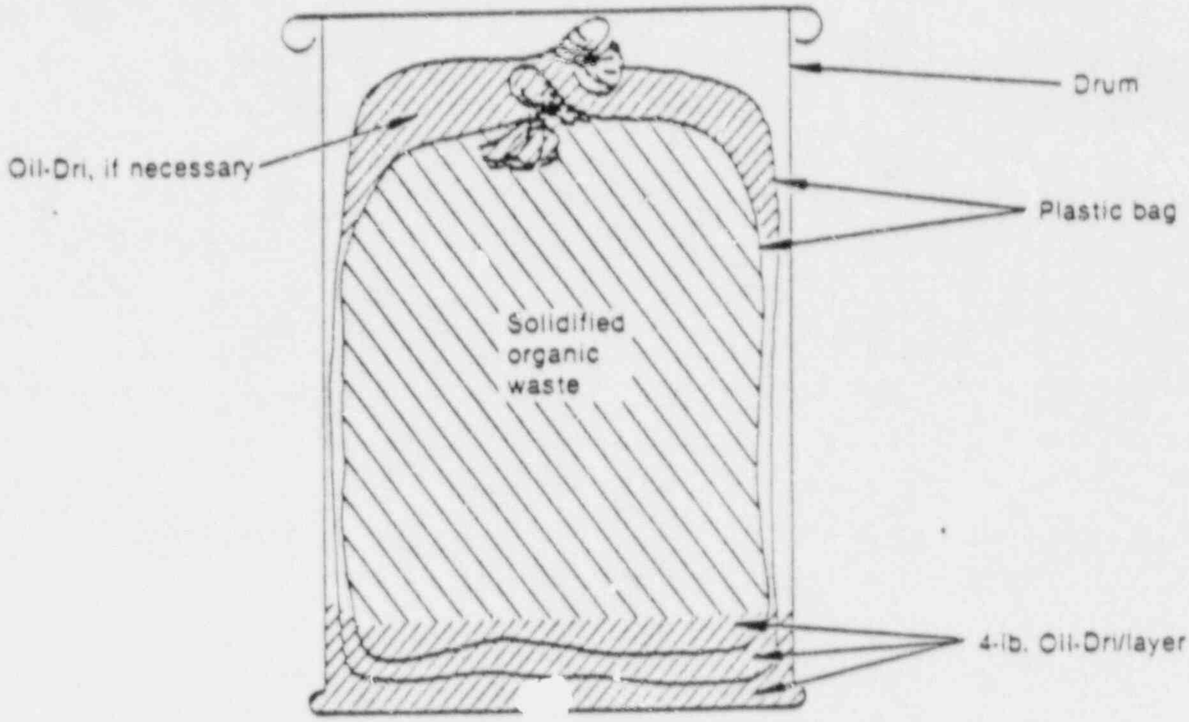
from liquid wastes generated by the processing plant. Analytical reports concerning sludge properties were provided by RFP and are included in Appendix C.

3.5.3.4 Solidified Organics (Content Code 3). Solidified organics (prefix 743) are produced from treatment of liquid organic wastes generated by various plutonium and non-plutonium operations. Organic wastes such as degreasing agents, lathe coolant (machining oil and carbon tetrachloride), and hydraulic oils are generated primarily by plutonium fabrication operations. Organic wastes include trichloroethane; carbon tetrachloride; trichloroethylene; tetrachloroethylene; hydraulic, gearbox, and spindle oils; and trace concentrations of miscellaneous organic (organophosphates, nitrobenzene, etc.) laboratory wastes. In addition, unknown volumes of oil containing polychlorinated biphenyls (PCB) were processed with other organic wastes until 1979. Degreasing solvents generated by Building 444 operations are contaminated with beryllium.

Liquid organic wastes are collected by pipeline for processing in a common tank or are received in batch quantities contained in bottles or drums. The liquids are processed by blending approximately 30 gallons of organic wastes with 100 lbs. of calcium silicate (Johns-Manville product Microcel E) in a continuous mixer to form a solid-like paste or "grease". See Figure 4 for waste packaging methods. The following information concerning major organic liquids and quantities processed each month was provided by RFP:[3]

Organic Liquid	Gallons/Month	% of Total
Lathe coolant--60% Texaco Regal oil, 40% carbon tetrachloride	700	47
Trichloroethane	150	10
Miscellaneous--hydraulic oil, gearbox oil, spindle oil, Freon, Varsol, etc.	650	43
Total	1500	100%

1970 - 1972: In most waste drums, approximately 10-20 lbs. of Oil-Dri was mixed in with the organic wastes and calcium silicate.



1972 - Present: Use of the 90-mil polythylene drum liner began. The inner plastic bag was replaced with an O-ring bag. Oil-Dri is usually mixed in with the waste.

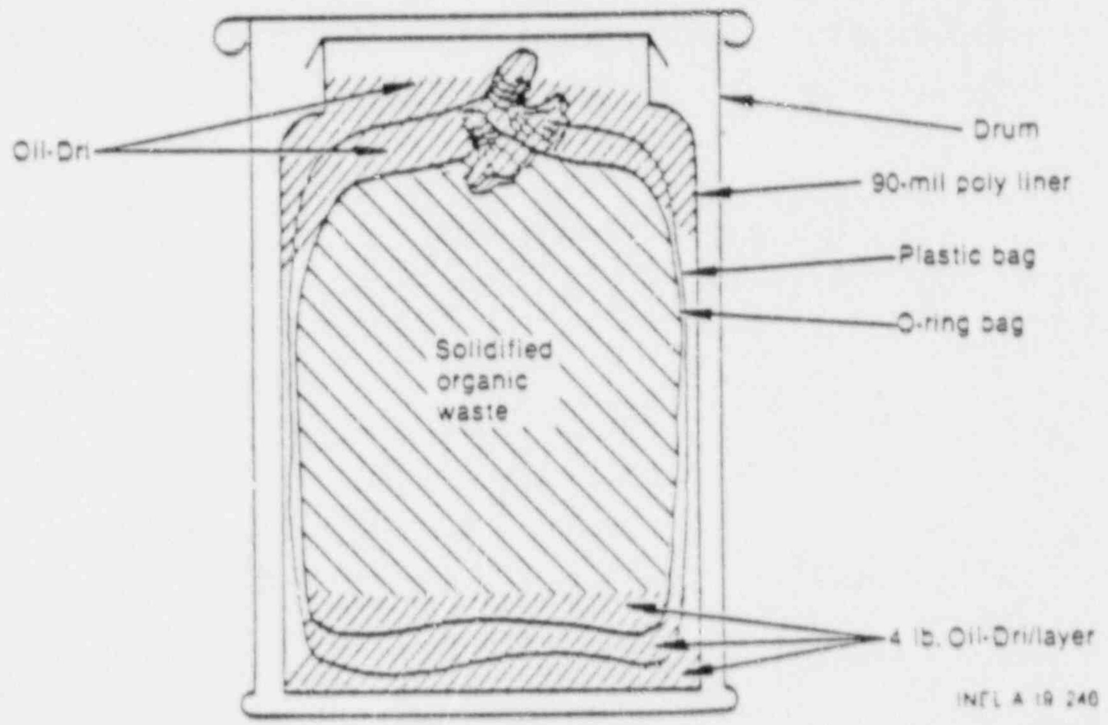


Figure 4. Solidified organic waste packaging methods.

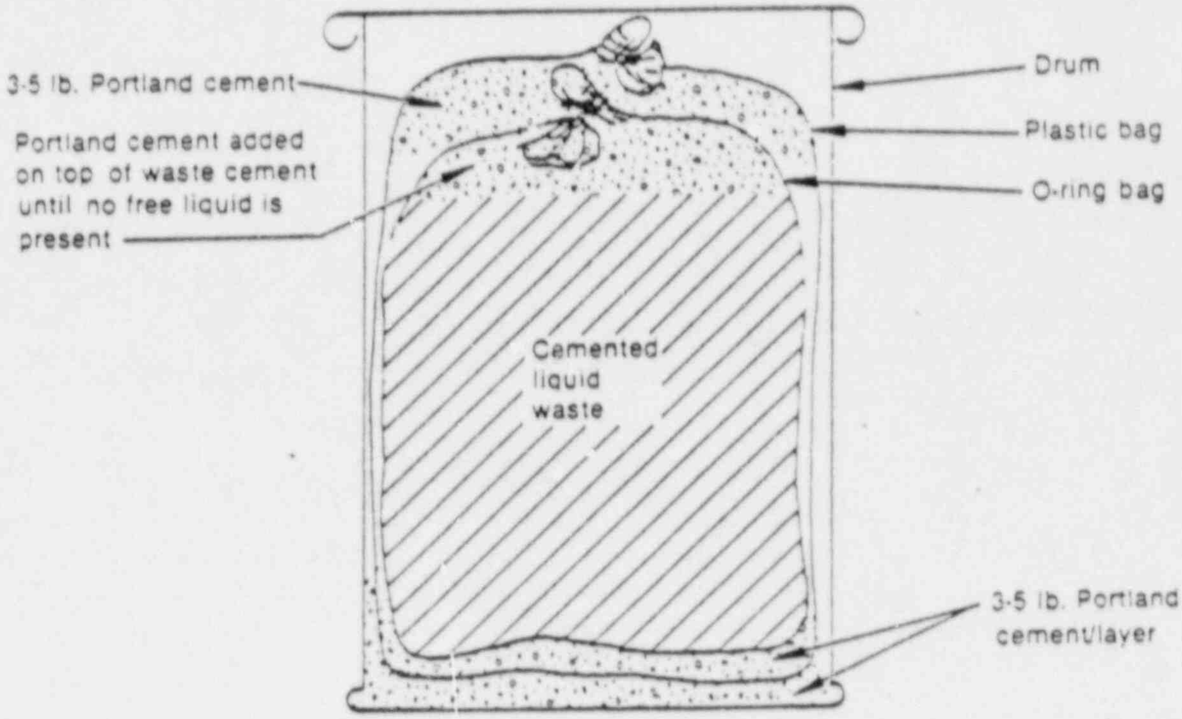
3.5.3.5 Special Set-Ups (Content Code 4). Liquid wastes that are not compatible with chemical precipitation treatments are treated separately due to the plutonium complexing nature of the waste. Complexing chemicals include some alcohols, organic acids, and Versenes [trademark for a series of chelating agents based on ethylenediaminetetraacetic acid (EDTA)]. The liquid waste is processed by blending two bags of Portland cement and one bag of insulation or other absorbing material in a waste drum, and the liquid waste is then added to the mixture and allowed to set up. See Figure 5 for waste packaging methods.

3.5.3.6 Evaporation Salts (Content Code 5). Liquid effluent from the second stage treatment process and other RFP-generated liquid wastes not requiring treatment are concentrated in solar evaporation ponds. The concentrated liquids are pumped from the ponds to the Building 774 evaporator. The evaporator concentrates and dries the liquid waste, forming a salt residue. The approximate chemical makeup of the salt is 60% sodium nitrate ($NaNO_3$), 30% potassium nitrate (KNO_3), and 10% miscellaneous.

Prior to September 12, 1975, evaporator salts were packaged in 55-gallon waste drums (see Figure 6) and after this date, in 4 by 4 by 7 ft wooden boxes for disposal at the INEL. Between November 1970 and September 1972, salt wastes were stored at the INEL Transuranic Storage Area (TSA). Between September 1972 and April 1978, salt wastes were placed in the INEL Transuranic Disposal Area (TDA). During the INEL Initial Drum Retrieval (IDR) project, any drums identified as containing salt waste were placed in TDA. Since April 1978, all salt waste has been sent to the Nevada Test Site (NTS) for disposal.[4,5]

3.5.3.7 New Aqueous Waste Treatment Facility. Construction of the new Aqueous Waste Treatment Facility, Building 374, was recently completed. The new facility is currently processing <10nCi/g wastes, which are shipped to NTS for disposal. The facility will begin processing some >10nCi/g wastes in the near future. Information concerning new waste forms was not available since modifications to the treatment processes are currently being incorporated.

1970-1972:



1972 - Present: Use of the 90-mil poly liner began in 1972.

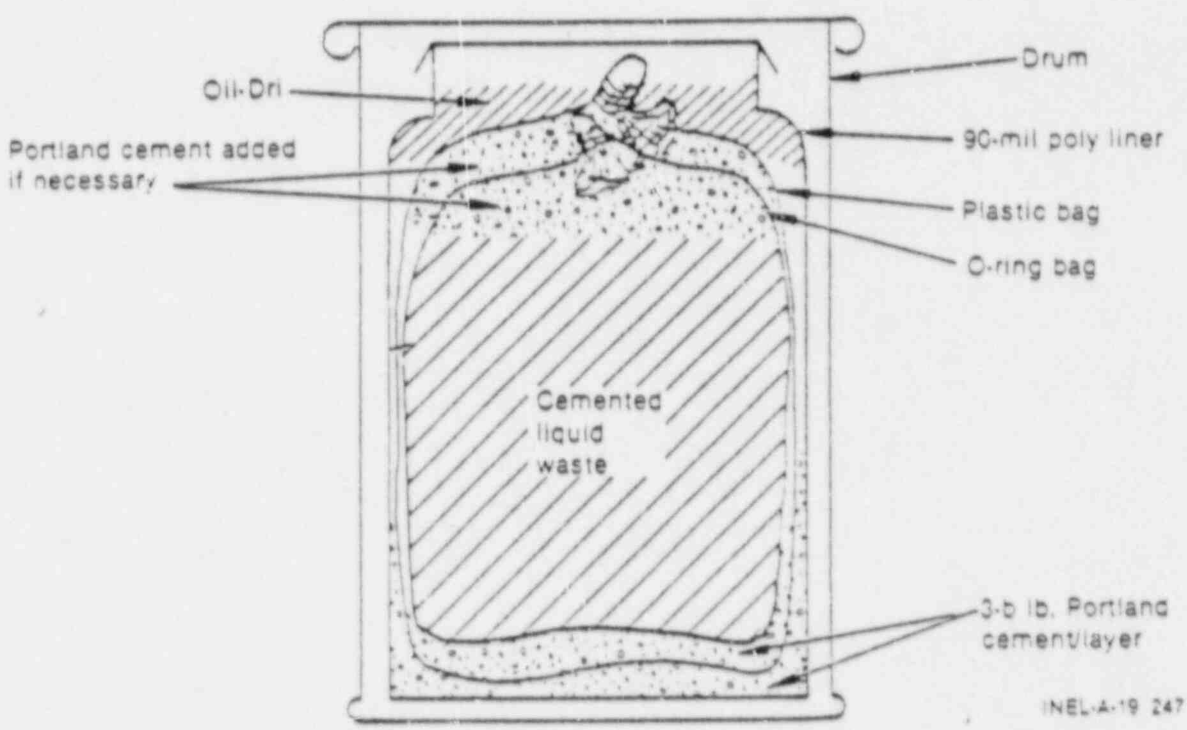
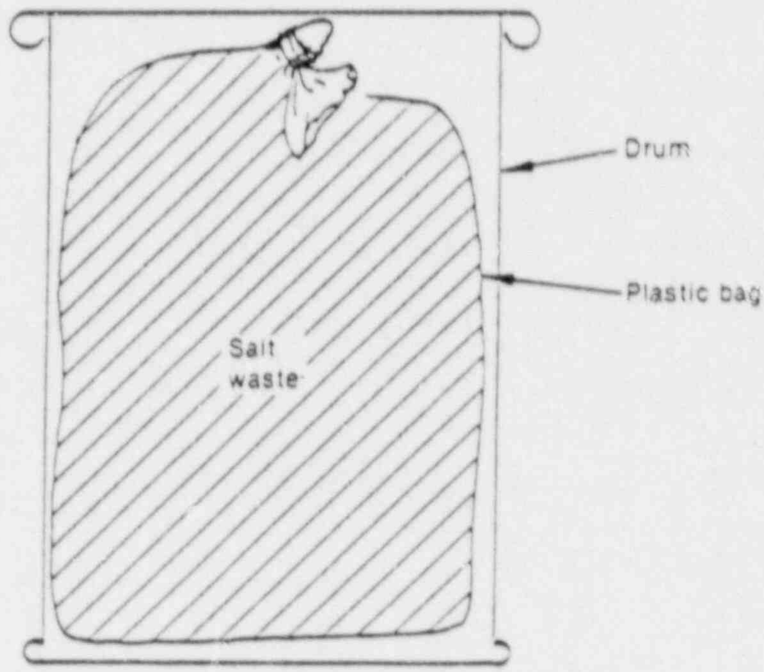


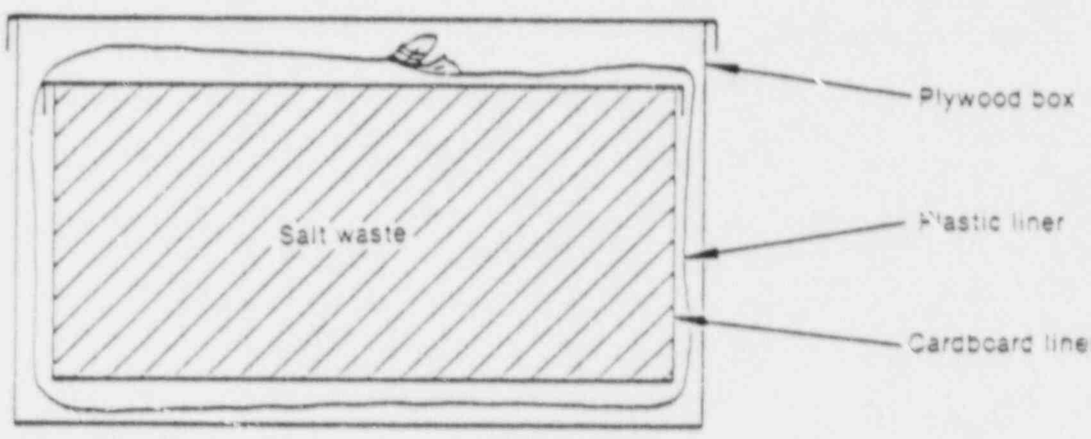
Figure 5. Special set-ups packaging methods.

1970 - 1975:



Note: During 1972, approximately 1000 drums were lined with a plastic bag and a crepe paper bag. After this time, drums were lined with either one or two plastic bags.

1975 - 1978: In 1975, use of the 4x4x7 ft waste box began. After April 1978, salt wastes were shipped to the Nevada Test Site for disposal.



Note: On occasion, Portland cement was added to the salt mixture as moisture absorbent.

INEL-A-19 248

Figure 6. Evaporator salt packaging methods.

3.5.4 Nontransuranic Operations

The preceding text has discussed the principal plutonium operations conducted at the Rocky Flats Plant. The following discussion addresses non-plutonium operations that generate nontransuranic radioactive and nonradioactive wastes. Generally, it is believed all RFP nontransuranic wastes were disposed of separately from transuranic wastes shipped to INEL for disposal. This excludes any uranium or beryllium wastes generated by transuranic operations. Between November 1970 and September 1972, depleted uranium and beryllium wastes were disposed of at the INEL Subsurface Disposal Area (SDA), in Pits 10, 11, or 12. Any depleted uranium and beryllium wastes (drums only) in Pits 11 and 12 were retrieved and placed in storage at the Transuranic Storage Area (TSA-1 or TSA-R) with other transuranic wastes retrieved during the INEL Initial Drum Retrieval (IDR) project. In addition, uranium and beryllium wastes retrieved with transuranic wastes during the INEL Early Waste Retrieval (EWR) project were placed in storage at TSA-R. Between September 1972 and April 1978, depleted uranium and beryllium wastes were placed in the INEL Transuranic Disposal Area (TDA). Since April 1978, these wastes have been sent to NTS for disposal.[4,5]

3.5.4.1 Building 444/447. Operations conducted by this facility include foundry and machining operations for fabrication of beryllium (Be) and depleted uranium components. Machining of other metals such as stainless steel, aluminum, titanium, copper, etc., is also conducted in support of test operations.

The beryllium foundry operation generates Be and BeO (beryllium oxide) contaminated wastes in the form of paperwipes, plastic, graphite molds and crucibles, small tools, and casting "sculls" (casting residue). During production foundry operations, it was estimated by foundry personnel that the casting process alone would generate 20 to 30 lbs./day of Be and BeO sculls. Since 1970, the overall average production rate was estimated at 125 days/year. The estimated average weight of sculls generated each year would be 2500 to 3750 lbs. The sculls may be in solid (Be metal) or powder (BeO) forms. In addition to sculls, impure or damaged castings that could not be salvaged were periodically included with other foundry wastes. A beryllium casting may weigh up to 125 lbs. Beryllium wastes are usually packaged in a cardboard container and then placed in a waste drum lined with two polyethylene bags. Wastes are usually segregated into combustible and noncombustible fractions. Some beryllium wastes may have been packaged in 4 by 4 by 7 ft boxes. The specific quantity of Be or BeO shipped to the INEL is unknown.

Wastes generated by Be machining operations include paperwipes, plastic, HEPA filters laden with Be or BeO dust, lathe oil, and degreasing agents, such as trichloroethylene, etc. All clean beryllium turnings and scrap pieces are recovered and processed for reuse or sold as scrap. Solid wastes are contained in a polyethylene bag before placement in plastic-lined waste drums. Organic liquid waste contaminated with Be is processed through the AWTF (Building 774) and becomes part of the solidified organic wastes (content code 3).

The depleted uranium foundry operation is conducted in the same area as the Be foundry operation. Wastes generated by this operation are similar to wastes generated by Be foundry operations. Depleted uranium casting sculls and machining chips, metal turnings, and fines from machining operations are incinerated to convert the pyrophoric metal to a stable oxide (U_3O_8) prior to shipment to the INEL. The practice of incinerating this type of waste has always been used by RFP but does not preclude the possibility that pyrophoric metal could be present in the waste, as indicated by the June 1, 1970 fire[6] that occurred at the RWMC. Incinerated uranium, called roaster oxide, is packaged in a 30-gallon drum and sealed, the drum is placed inside of a 55-gallon drum, and the annular space is filled with vermiculite. Other solid wastes, such as paper, metal, etc., are segregated into combustible and noncombustible fractions. Combustible wastes are contained in a polyethylene bag, packaged in a 55-gallon drum lined with a plastic bag, and compacted. Noncombustible wastes are contained in a polyethylene bag and packaged in 4 by 4 by 7 ft boxes. Liquid wastes such as machining oil, coolant, and degreasing agents are processed by the AWTF as solidified organic wastes (content code 3).

Depleted uranium and beryllium wastes, primarily from the foundry area, may be intermixed in the waste containers. Large machining equipment is usually decontaminated for reuse in other plant operations. All waste containers from Building 444/447 operations are labelled as containing Be or BeO contamination.

3.5.4.2 Building 883. Processing, rolling, and forming operations for depleted uranium and beryllium have been conducted in this facility since 1954. Beryllium operations ceased in 1973. Solid wastes generated by this facility are similar to wastes generated at Building 444/447 and include paper, equipment, furnaces, and firebrick. Waste-depleted uranium was oxidized prior to shipment to the INEL. Liquid wastes are processed by the AWTF.

3.5.4.3 Building 865. This facility was constructed in 1970 for the purpose of conducting metallurgical research and development projects with depleted uranium. Waste-depleted uranium was oxidized prior to shipment to the INEL.

3.5.5 Waste Management Practices

The Rocky Flats Waste Management group was formed in late 1970 as an outgrowth of the 1969 fire. The establishment of this group started a trend toward better waste management practices. During 1971, efforts to segregate various wastes into specific categories began. In addition, inspections of all waste containers by Waste Management personnel were initiated to ensure compliance with packaging regulations. Segregation and packaging of the waste is the responsibility of personnel in each waste generating area. If inspection of a waste container by Waste Management personnel reveals improper segregation, packaging, or presence of free liquids, the container is returned to the waste generator for correction. The changes in waste management procedures took several years to implement, and the procedures are continually being improved.

All drums containing line- and nonline-generated wastes (transuranic operations only) are assayed by gamma scan for determination of fissile content at Building 771. Drums containing plutonium above the discard level are retained for processing and plutonium recovery. Below-discard-level drums are sent to Waste Management (Building 776) for inspection and final preparation for shipping. Large waste items are individually surveyed before placement in a waste box at the waste generating area. The quantity of fissile material is calculated from the survey results. In 1980, a box counter was built in Building 664. After a waste box has been surveyed and sealed at the waste generating area, it is sent to the box counter for assay (gamma and neutron). If any significant anomalies occur between data obtained by survey and the box counter, the box is returned to Waste Management, opened, and resurveyed.

The Waste Management Size Reduction Facility (Building 776) began operation during late 1971 or early 1972. This facility reduces large waste items, such as gloveboxes, piping, and lathes, in size to fit 4 by 4 by 7 ft waste boxes. In 1974, washing highly contaminated large metal wastes for plutonium recovery began. These waste items are too large to be processed by the Plutonium Recovery Facility (Building 771). Since 1974 or 1975, drums of below-discard-level combustible wastes have been repackaged in 4 by 4 by 7 boxes to improve packaging uniformity. Contaminated drums are crushed and placed in waste boxes. The wastes are initially packaged in drums for assaying purposes.

3.6.5.1 <u>Waste Drums</u>. Both 30- and 55-gallon size waste drums have been shipped to INEL for storage. Use of the 30-gallon waste drums was discontinued in the early 1970's. During 1972, the use of a 90-mil thick polyethylene drum liner for 55-gallon drums began. A polyethylene bag is usually used to line the inside of the 90-mil liner. Prior to the change to the 90-mil drum liner, one or two polyethylene bags were used to line the inside of a waste drum. The level of waste item containment varies, depending on the area in which the waste is generated. Waste items generated by plutonium operations are usually double-contained in polyethylene and PVC plastic before placement in a waste drum. In other areas such as a laboratory, a waste item may be dropped directly from the glovebox into the large polyethylene bag that lines the inside of the 90-mil polyethylene drum liner. Since the early 1970's, approximately 5 to 7 lbs. of Oil-Dri (absorbent) has been added on top of the outer sealed plastic bag of all waste drums before the 90-mil drum liner lid is sealed. The Oil-Dri is added by Waste Management personnel after drum inspection.

3.5.5.2 <u>Waste Boxes</u>. Prior to early 1973, 27 larger-than-standard-sized (4 by 4 by 7 ft) waste boxes were shipped to INEL for storage.[7] Large boxes were usually used to contain large pieces of waste from the 1969 fire. After the Size Reduction Facility began operation, only 4 by 4 by 7 ft boxes have been used to package large waste items. Smaller waste boxes, generally 2 by 4 by 7 ft, were received through the mid-1970's. These boxes were used to package small, heavy waste items and soil. All waste boxes are constructed of plywood. During 1972, procedures for spraying waste boxes with a fiberglass reinforced polyester (FRP) coating were established. The FRP boxes have a plastic and cardboard liner. The level of containment for individual waste items before placement in a box may range from none, such as washed metals from size reduction operations, to double-containment (polyethylene, PVC) of waste items, such as fire wastes.

3.5.5.3 <u>Content Code Description</u>. The INEL Transuranic Contaminated Waste Container Information System (TCWCIS), which identifies a content code for each waste container, did not begin until fall of 1971. Consequently, container content codes are not available for RFP wastes placed on TSA-1 during the first year of storage. The number of waste containers not included in the TCWCIS is estimated at 22,783 drums and

648 boxes. In addition, TCWCIS content code 0 includes 11 drums of waste placed in storage from RFP and 18,961 drums of waste placed in storage from INEL retrieval projects.[8] The majority of the 18,961 drums, for which no content description is available, are believed to contain wastes generated by RFP operations.

Information provided by RFP personnel and contained in RFP waste characterization and categorization reports,[9,10] indicates that content codes are not reliable especially during the years of 1971 to 1975. The following information concerning content code descriptions was provided by knowledgeable RFP personnel and available reports:[11]

- o Content code 1 (first stage sludge): See Section 3.5.3.1
- o Content code 2 (second stage sludge): See Section 3.5.3.2 and 3.5.3.3
- o Content code 3 (organic set-up): See Section 3.5.3.4
- o Content code 4 (special set-up): See Section 3.5.3.5
- o Content code 5 (evaporator salts): See Section 3.5.3.6
- o Content code 90 (dirt): Believed to be dirt from cleanup around Building 776/777 after the fire. Shipped during 1971 and 1972 only
- o Content code 95 (sludge): Unknown, shipped during 1972
- o Content code 241 (Am process sludge): Unknown, shipped during 1971-1973
- o Content code 290 (filter sludge): One drum shipped in 1971, sludge believed to be residue from the incinerator drum filter

- Content code 292 (cemented sludge): Sludge (grease, dirt, scrappings, etc.) produced from various cleanup operations such as filter plenums, incinerator drum filter residue, etc. Below-discard sludge is usually packaged in 1-gallon polyethylene bottles with cement added as absorbent.

- Content code 300 (graphite molds, crucibles): Graphite molds and crucibles are used by the plutonium foundry. The graphite is scraped or ground to remove adhered plutonium, which is called "scarfings". The scarfings are further processed by plutonium recovery. The leftover graphite mold or crucible (below discard level) is broken up and placed in 2- or 5-gallon size fiberpaks, bagged-out of the glovebox, and placed in a waste drum.

- Content code 301 (graphite cores or cases): Part of the mold used by the foundry for casting plutonium metal. Procedure for disposal is same as content code 300.

- Content code 302 and 464 (Benelex and Plexiglas): Benelex (redwood masonite) and Plexiglas are used as neutron shielding around gloveboxes in all plutonium areas.

- Content code 310 (graphite scarfings or fines): Graphite scarfings are usually highly contaminated and are further processed by plutonium recovery. It is believed these scarfings contained discard level amounts of plutonium and were not processed (see content code 311). Scarfing waste was received in 1972 and 1975.

- Content code 311 (graphite heels): Graphite scarfings or fines are processed by acid dissolution in the plutonium recovery area. After processing, the residue, called graphite heels, is dried and packaged in fiberpaks before placement in a waste drum.

- Content code 320 (heavy non-SS[a] metal): Mainly consists of used tantalum crucibles, funnels and inserts from casting plutonium metal. Other metals may include tungsten, platinum, etc. Waste originates from Pu foundry and molten salt operations.

- Content code 330 (dry combustibles): Dry combustibles mainly consist of rags and paper generated by all plutonium areas.

- Content code 335 (absolute filters): Filters consist of an 8" x 8" wooden frame with an asbestos filter media. Filters are used to remove airborne particulates in the glovebox lines and are generated by all plutonium areas.

- Content code 336 (wet combustibles): Wet combustibles are generated by all plutonium areas. The waste consists of paper and rags saturated with decontamination solutions. Waste may also contain absorbed nitric acid.

- Content code 337 (non-leaded rubber and plastics): This category consists of plastic (Teflon, PVC, polyethylene) items such as bags, sample vials, and sheeting generated by all plutonium areas.

- Content code 338 and 360 (insulation and CWS filter media): Waste category includes asbestos gloves, fire blankets, pipe insulation, and asbestos filter media generated by all plutonium areas. Insulation or filter media containing above-discard-level amounts of plutonium is processed by plutonium recovery (acid leach). The residue is packaged in 1-gallon size polyethylene bottles before placement in a waste container.

- Content code 339 (leaded rubber gloves and aprons): Wastes include lead-lined rubber (neoprene) glovebox gloves, aprons, and other leaded materials generated in all plutonium areas.

---

a. Special source material such as uranium or plutonium.

- Content code 361 (insulation heel): Insulation heel is generated from processing insulation containing above-discard amounts of plutonium by the plutonium recovery operation. This content code was only used in 1972. It is believed insulation heel is included in wastes labelled as content code 338 or 360.

- Content code 370 (Leco crucibles): Leco crucibles are small ceramic crucibles used by the Plutonium Laboratory for sample analyses.

- Content code 371 (firebrick): This category consists of plutonium-contaminated firebrick used to line the plutonium recovery incinerator and construction brick from the 1969 fire. The incinerator processes combustible wastes containing above-discard amounts of plutonium. The firebrick is periodically replaced.

- Content code 372 (grit): Small abrasive material, or grit, was used by plutonium recovery operations to "grit-blast" non-SS metals for recovery of adhered plutonium. This method is no longer used. Grit waste was shipped to INEL during 1974 and 1975 only.

- Content code 374 (concrete, dirt, sand, and blacktop): This waste category originates from cleanup operations conducted at any plant site.

- Content code 375 (Oil-Dri residue): Oil-Dri (tradename) is an absorbent material used in a majority of RFP waste packages for absorption of any free liquids. It is believed these waste drums contain Oil-Dri residues that required processing in the plutonium recovery incinerator.

- Content code 376 (cemented insulation and filter media): During 1976, procedures to cement insulation and filter media began. The procedure was establisned to prevent moisture and pressurization problems from occurring in waste containers.

- Content code 391 (unpulverized sand and crucible): Waste consists of magnesium oxide crucibles and sand generated by the plutonium recovery reduction furnaces where plutonium tetrafluoride (PuF_4) is reduced to metallic plutonium.

- Content code 392 (unpulverized sand, slag, and crucible): Waste consists of sand, slag, and magnesium crucibles generated by the same operation as described for content code 391. This category of waste was shipped to INEL in 1972 only.

- Content code 393 (sand, slag, and crucible heel): Sand, slag, and crucibles containing above-discard amounts of plutonium are processed by acid leaching and dissolution. The remaining residue, termed heel, is dried and packaged in 1-gallon polyethylene bottles before placement in a waste drum.

- Content code 410 (molten salt): The halide salt mixture (NaCl, KCl, $MgCl_2$ (30%), etc.) is used to pyrochemically remove americium from plutonium metal.

- Content code 411 (electrorefining salt): Salt mixture is similar to content code 410, except that the $MgCl_2$ concentration is 8% (other salt concentrations are unknown). The salt is used to pyrochemically remove all types of impurities from plutonium metal.

- Content code 420 (virgin incinerator ash): Combustible wastes containing above-discard amounts of plutonium are incinerated in the plutonium recovery incinerator; the ash is ground and processed by acid dissolution. Content code 420 ash contains below-discard level plutonium and was not further processed. The ash was sent to INEL during 1972 only.

- Content code 421 (ash heel): Ash heel is the remaining residue after incinerator ash has been processed by acid dissolution. The ash is dried and packaged in 1-gallon polyethylene bottles before placement in a waste drum.

- Content code 422 (soot): Fly ash from the plutonium recovery incinerator accumulates in the incinerator offgas system. The fly ash, or soot, is generated when the offgas system is disassembled and cleaned.

- Content code 430 (unleached ion exchange resin): Resin waste originates from ion-exchange columns used to purify plutonium nitrate solutions produced from processing waste residues by plutonium recovery operations. The resin was not leached before disposal. INEL records indicate this waste was received during 1972 only.

- Content code 431 (leached ion-exchange resin): Same as content code 430 except the resin was leached with water to recover the plutonium. INEL records indicate the waste was received during 1972 only.

- Content code 432 (cemented ion-exchange resins): During 1972, the procedure for processing resin waste was changed. Since then, the resins have been rinsed with water and solidified in 1-gallon polyethylene bottles with Portland cement before placement in a waste drum.

- Content code 440 (glass, except Raschig rings): Glassware such as beakers, flasks, and glass vessels, is generated primarily by plutonium recovery operations. All plutonium areas generate glassware waste.

- Content code 441 (unleached Raschig rings): Raschig rings are glass rings with a high boron content. The rings are used as a neutron poison in storage tanks containing plutonium solutions. The rings have not been leached to remove residual plutonium. All plutonium areas generate this waste category.

- Content code 442 (leached Raschig rings): Same as content code 441 except the rings have been leached with nitric acid to remove residual plutonium.

- Content code 460 (washables, rubber, plastics): Information was not available. Content code 460 waste was sent to INEL during 1972 only.

- Content code 463 (drybox gloves): This content code has been incorporated into content code 339 since 1972.

- Content code 464 (Benelex and plexiglas): Content code incorporated into content code 302 since 1973.

- Content code 480 (unleached light non-SS metal): Unleached light non-SS metals include iron, copper, aluminum, and primarily stainless steel. The waste is generated by all plutonium areas and has not been leached.

- Content code 481 (leached light non-SS metal): Same as content code 480, except the metal waste has been cut into smaller pieces and washed for plutonium recovery. The Size Reduction Facility processes these wastes.

- o Content code 490 (HEPA or CWS filters): High efficiency particulate air (HEPA) and chemical warfare service (CWS) filters are used in the exhaust systems of all plutonium areas to remove airborne particulates. From 1971 to 1975, the filters were packaged in drums and boxes. Since 1975, the filters have been packaged in boxes only.

- o Content code 900 (low specific activity (LSA) paper and plastic): Consists of LSA paper and plastics that have been contaminated as follows:

  a. Uranium, thorium, or their chemical concentrates

  b. Material in which the activity is essentially uniformly distributed and in which the estimated average concentration per gram of contents does not exceed the following amounts:

     1. 0.0001 millicuries of Group I radionuclides (e.g., Am, Pu, ^{232}U); or

     2. 0.005 millicuries of Group II radionuclides (e.g., ^{230}U, ^{233}U, ^{234}U, ^{236}U); or

     3. 0.3 millicuries of Group III or IV radionuclides (e.g., Tritium, ^{235}U, ^{238}U, Natural U, Eu)

  c. Nonradioactive objects externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of one square meter, does not exceed 0.0001 millicuries per square centimeter of Group I radionuclides or 0.001 millicuries per square centimeter of other radionuclides.

These wastes were received during 1971-1975.

- o Content code 950 (LSA metal and glass): LSA metal and glass waste contaminated as described for content code 900. Wastes received during 1971-1975.

- o Content code 960 (concrete and asphalt): Concrete and asphalt cleaned up in areas having suspected contamination. Waste received during 1971-1973.

- o Content code 970 (wood and Benelex): Waste consists of Benelex and wood removed from areas having suspected contamination.

- o Content code 976 (Building 776 process sludge): Waste consists of sludge removed from processing tanks located behind Building 776. The waste was received during 1976 and 1977. No other information concerning the sludge was available.

- o Content code 978 (laundry sludge): Waste consists of laundry sludge generated by the laundry facility. The waste was received in 1976 only.

- o Content code 980 (equipment): One drum containing discarded equipment was shipped during 1973. No other information was available.

- o Content code 990 (soil): Category consists of soil removed from the perimeter of Building 774.

- o Content code 995 (sludge): Category consists of sanitary sludge from the sanitary waste treatment facility, Building 995. The waste was shipped during 1972-1974 and 1976.

3.5.6 Nonradiological Hazards

3.5.6.1 Biological Waste. A project co-sponsored by RFP and the Atomic Energy Commission (AEC) was conducted at Colorado State University, Fort Collins, Colorado, from 1968 to 1977 [CSU Contract AT (11-1)-1787]. The project was titled "A Study of the Translocation of Plutonium and Americium from Puncture Wounds." The purpose of the project was to determine the body distribution, metabolism, and dynamics of plutonium and americium, and the effectiveness of chelating agents. The test animal for the experiment was the beagle.

Three 4 by 4 by 7 ft boxes of waste originating from this experiment were shipped in February of 1978. One box of waste consisted of numerous empty glass quart jars originally used to collect urine and tissue samples. The tissue samples were packaged in plastic bags and placed in second stage (content code 2) waste drums. The jars containing urine were emptied into the RFP solar evaporation ponds. The empty jars were repackaged in their original cartons and placed in a 4 by 4 by 7 ft waste box. The two remaining boxes contain cardboard boxes of tissue samples, dog paws, syringes, empty scintillation vials, and feces wrapped in plastic bags. No pathogenic or chemical carcinogenic work was conducted in conjunction with these experiments.

3.5.6.2 Gas Cylinders. A variety of pressurized gases have been used at RFP for calibration of laboratory and monitoring instrumentation and for use in production areas. After the 1969 fire, a large number of contaminated gas cylinders, including CO_2 fire extinguishers, were included in waste shipments to the INEL. It was believed most of the gas cylinders were depressurized prior to placement in waste containers. However, it was speculated that certain gases may have been hazardous to depressurize in the work environment and may have been placed directly into waste containers. Information concerning the type of gases, cylinder sizes, shipment dates, etc. was not available.

3.5.6.3 Asbestos. Large quantities (specifics unknown) of asbestos or asbestos containing materials such as filters, insulation, fire blankets, gloves, etc., have been included in waste shipments to the INEL. Examples of waste categories containing asbestos-type wastes include content codes 335, 338, 360, 376, and 490.

3.5.6.4 Polychlorinated Biphenyls. Transuranic contaminated oils containing polychlorinated biphenyls (PCB) have periodically been processed with other organic wastes (content code 3) until 1979.[12] The concentration of PCB in these oils is believed to be >500ppm. Records concerning processing of PCB oils are not complete. The following available information concerning known processing of PCB oils was provided by RFP personnel:

Processing Date	Drum Number	Gross Weight (lbs)
5-25-76	743-13393	457
8-31-76	1-litre bottle of PCB oil buried in the middle of one of the following drums: 743-13465 to 743-13472	
1-31-78	743-13948	624
	743-13949	524
	743-13950	615
	743-13951	644
	743-13952	615
	743-13953	641
	743-13954	639
	743-13955	537
2-14-78	743-13982	494
	743-13984	478

NOTE: 743-13983 should have residual PCB contamination.

The total number of PCB-contaminated content code 3 drums is unknown. The PCB contamination in a drum may be either localized or dispersed throughout the solidified organic waste matrix.

Other solidified organic wastes include chlorinated hydrocarbons (up to 50%), such as carbon tetrachloride and trichloroethane, and trace concentrations of miscellaneous organic laboratory wastes, such as organophosphates, nitrobenzene, etc.

3.5.6.5 Beryllium. Beryllium contamination exists in first and second stage sludges (content codes 1 and 2) and in solidified organic wastes (content code 3). The concentration of Be in first and second stage sludges is expected to be <1000ppm, see Appendix B. The source of Be in sludge waste is usually from plutonium recovery operations. Organic degreasing agents used by Be machining operations (Building 444) are processed with other RFP generated organic waste. The concentration of Be in content code 3 waste drums is unknown.

A significant source of stored beryllium (Be) wastes is from wastes retrieved during the INEL IDR and EWR project. In addition, small amounts of Be are generated by R&D efforts conducted in the plutonium areas. The specific quantity of Be or Be compounds in INEL stored wastes is unknown.

3.5.6.6 Nitrated Wastes. Large quantities of nitric acid are used in plutonium recovery operations, and smaller quantities are used by many other plutonium operations. Generally, no free nitric acid is present in solid waste packages. The acid was absorbed on paperwipes, rags, or other absorbent material. Nitrated cellulose materials may become highly flammable if allowed to dry. Combustible wastes, such as content codes 330 and 336, may contain nitrated cellulose wastes.

Ion-exchange resins are used by production plutonium recovery operations to purify plutonium-bearing solutions. The resin is an organic-based (styrene) polymer produced by the Dow Chemical Company. During recovery operations, the resins are exposed to various concentrations of nitric acid. Nitrated resins may become highly flammable and/or explosive if the resin is allowed to dry. Ion-exchange column resins are usually changed once or twice a year depending on the rate of production recovery operations. Information provided by RFP recovery personnel indicated that each change, depending on the number of columns involved, could generate between 600 to 1200 lbs. or more of resin waste. Disposal practices for resin wastes were changed several times during 1972, based on content code changes appearing in the INEL Transuranic Contaminated Waste Container Information System (TCWCIS) and information provided by recovery personnel. During and prior to 1972, resin wastes were not leached for recovery of remaining plutonium and were packaged in plastic bags before placement in a waste drum (content code 430). During 1972, the procedure was changed to leaching the resins with water (content code 431) to recover the plutonium before packaging in plastic bags. The final procedure change also occurred during 1972. Since 1972, resin wastes have been leached with water and then solidified with Portland cement in 1-gallon polyethylene bottles before placement in a waste drum. It is believed cemented resins should not represent a significant hazard. Any resin wastes packaged before the solidification process was established (including retrieved drums) may represent a flammability or explosion hazard if the resins have dried out while in storage. The number of drums containing resin wastes that may represent a hazard is unknown.

3.5.6.7 Batteries. Prior to 1973, mercury and lithium batteries were periodically placed in second stage sludge drums (content code 2). The number of batteries included in sludge drums is unknown. The batteries may represent a toxic and/or explosion hazard.

3.5.6.8 Other Chemical Wastes. Generally, all liquid chemical wastes generated by various RFP operations are processed by the AWTF (building 774) as first or second stage sludges, solidified organics, special set-ups, or evaporator salts (content codes 1, 2, 3, 4, and 5 respectively). Prior to 1973, second stage sludge drums were periodically used to dispose of bottles of liquid chemical wastes, small containers of elemental mercury, and batteries. The volume or type of chemicals placed in the sludge drums is unknown.

Sludge drums (content codes 1 and 2) also contain a variety of residual toxic heavy elements from processing various plant-generated liquid wastes. Appendix C contains RFP analyses of 7412-series sludge drums.

3.5.6.9 Hydrogen Generation. Recent waste characterization projects conducted by RFP for EG&G Idaho, Inc. indicate that hydrogen generation occurs in waste drums. During 1979 and 1980, seventy RFP-generated waste drums were retrieved from storage at the INEL and returned to RFP for characterization. Results of the chacterization project[9,10] revealed that four drums had elevated levels of hydrogen (6, 12, 13, and 19% by volume). The lower explosive limit for hydrogen in air is 4.1% by volume. Hydrogen generation may occur from alpha-radiolysis of water and organic or cellulosic materials.

3.5.6.10 Drum Pressurization. Pressurization of waste drums may occur from gases [illegible], oxygen, etc.) produced by radiolytic, bacterial, and chemical actions. During 1980, a first stage sludge drum, placed in storage at the INEL during 1978, was discovered to be pressurized. Analysis of the drum indicated the pressure to be 19.6 psig.[13] Other stored waste drums, such as first stage sludge drums, may also be pressurized.

3.5.6.11 Pyrophorics. Small amounts of unoxidized (metallic) plutonium and/or metastable plutonium suboxides may be found trapped in machining oil, such as in the vacuum pots that were connected to each plutonium machining station. The pots, which were removed during D&D operations after the 1969 fire, contained a mixture of highly contaminated machining oil, carbon tetrachloride, and sludge.

Depleted uranium wastes, primarily roaster oxide, placed in storage from INEL retrieval projects, may contain some pyrophoric metal. Generally, all pyrophoric metal such as machining chips, turnings, and fines were incinerated prior to disposal. However, information provided by machining personnel indicates that, on occasion, larger pieces of uranium such as a damaged parts, were placed in drums containing roaster oxide waste. Specific information is not available.

4. IDAHO NATIONAL ENGINEERING LABORATORY-GENERATED WASTES

Small volumes of transuranic contaminated wastes generated by INEL operations have periodically been placed in storage at the Transuranic Storage Area (TSA). Stored INEL wastes have been generated by the following facilities: Naval Reactor Facility (NRF), Test Area North (TAN), Test Reactor Area (TRA), Chemical Processing Plant (CPP), and Argonne National Laboratory-west (ANL-W).

The INEL Transuranic Contaminated Waste Container Information System (TCWCIS) records concerning storage of INEL-generated wastes are not complete. In 1975, available records were incorporated into the TCWCIS. The TCWCIS includes container information concerning wastes stored at TSA and the Intermediate Level Transuranic Storage Facility (ILTSF). Characterization of INEL wastes was conducted for TSA stored wastes only. The total volume of INEL wastes stored at TSA is estimated at 338.0 ft^3 (~30 drums--assumed to be 55-gallon size, one 4 by 4 by 8 ft box, and one special package). The following volumes (ft^3) of waste were placed on TSA:

	Year						
Generator	1975	1976	1977	1978	1979	1980	Total
ANL-W	15.8	--	--	14.8	3.0	29.6	63.2
TAN	14.8	--	--	--	7.4	--	22.2
TRA	149.0	--	--	--	14.8	--	163.8
CPP	44.4	--	--	--	--	7.4	51.8
NRF	--	--	--	37.0	--	--	37.0
Total	224.0	0	0	51.8	25.2	37.0	338.0

The following individuals provided information concerning INEL-generated wastes: R. Ponto (ANL-W), J. B. Leavitt (TAN), D. K. Wenzel (CPP), W. C. Olsen (CPP), T. D. Enyeart (NRF), G. F. Marriott (NRF), A. H. Clark (TRA), J. D. Baker (TRA), D. M. Anderson (TRA), and H. M. Batchelder, Jr. (WMO).

4.1 Test Area North (TAN)

Waste generated by TAN consisted of radioactive sources used for instrument calibrations. In 1975, two waste drums containing plutonium-beryllium neutron sources (content code 152) and in 1979, one waste drum containing americium sources (content code 200) were placed in storage. The sources were sealed in carbon steel pipes, and each pipe was centered in a waste drum. Cement was added, filling the annular space of the drum and encapsulating the pipe containing the sources. No other wastes were included in the waste drums.

4.2 Chemical Processing Plant (CPP)

The 1975 waste shipment from CPP consisted of six waste drums generated from decontamination and removal of equipment (content code 150) from a processing cell in Building 601. Wastes generated by this operation included rags, anti-contamination clothing, equipment, piping, and ducting. The wastes were not segregated into combustible and noncombustible fractions.

The 1980 shipment consisted of one 55-gallon waste drum. The drum contains one 1-gallon metal can of radioactive sources (content code 150--laboratory wastes) contained in aluminum or stainless steel capsules. The capsules contain oxides of plutonium and americium isotopes and ^{235}U. No other wastes were included in the waste drum.

4.3 Argonne National Laboratory-West (ANL-W)

Wastes generated by ANL-W originates primarily from Building 752 analytical laboratory operations. Laboratory operations include sample preparation and radiochemical analyses of pre- and post-irradiated fuel samples. Laboratory wastes (content code 150) may include combustible wastes such as empty polyethylene bottles, tubing (PVC, Tygon, etc.), O-rings, paper products, rags, wood, and plastics. Noncombustible wastes may include ferrous and nonferrous metals, glassware, ceramics, and small containers of absorbed liquid waste. The liquid waste is usually a mixture of HNO_3/HCL acids (aqua-regia) containing dissolved fuel samples. The liquid waste is absorbed on Oil-Dri, or in the past on vermiculite, contained in 2-gallon size metal cans. Some metal cans have been wrapped with lead sheeting to reduce radiation levels. Wastes are segregated into combustible and noncombustible fractions.

Other waste generated by ANL-W includes one drum containing a "leaky" plutonium-beryllium neutron source (content code 152). The source was wrapped in plastic and placed in a paraffin-lined 15-gallon drum. The drum was then placed inside a 55-gallon waste drum. Another waste drum identified as containing a neutron source, contains a plutonium standard, a plutonium foil, tools, and other noncombustible wastes.

4.4 Naval Reactor Facility (NRF)

Transuranic waste generated by the NRF Expended Core Facility was placed on TSA in 1978. The waste consisted of five waste drums containing neutron sources. Four drums (content code 152) contain one each ^{238}Pu-Be neutron source. The sources originated from the Bettis Atomic Power Laboratory. Each source was contained in a 6M 55-gallon drum. The fifth drum, identified as containing combustible laboratory waste (content code 153), contained a ^{239}Pu-Be neutron source. The source was generally used for calibration of reactor and monitoring instrumentation. The source was packaged in a type 2R container and placed inside a 30-gallon drum lined with paraffin. The drum was then placed inside a 55-gallon drum, and wood was added to provide shoring between the drums.

4.5 Test Reactor Area (TRA)

Transuranic waste generated in 1975 originated from decontamination and removal of equipment from the alpha-wing of Building 661. The waste consisted of one 4 by 4 by 8 ft FRP box and five 55-gallon drums containing TRU scrap (content code 155) and one 55-gallon drum containing sample fuel (content code 154). The box is believed to contain a plastic glovebox. Other equipment, such as a hydraulic pump (oil was not drained), vacuum pumps, centrifuges, tools, etc., was used to fill the remaining space of the waste box. Materials such as actinide sources, a radium needle, and small vials of sample fuel were packaged in the waste drum (content code 154). The drum was filled with cement for shielding purposes, with a cavity in the center for the TRU materials.

The 1979 waste shipment consisted of two waste drums (content code 155 and 154) containing experimental mixed oxide fuel capsules from the Bett-51 program. The capsules originated from the Advanced Reactivity Measurement Facility (ARMF), Building 660. The capsules were packaged in 1-gallon metal containers before placement in a waste drum. Lead shot was used for shielding around the containers, and diatomaceous earth was added for support. No other wastes were included in the drums.

4.6 Nonradiological Hazards

No nonradiological hazards, other than the small amounts of beryllium contained in neutron sources, were identified as existing in stored wastes generated by INEL operations.

5. SUMMARY

All site- and offsite-generated transuranic wastes stored at the INEL-TSA have been characterized. Information obtained during the characterization study indicates that nonradiological hazardous materials such as biological wastes, inorganic and organic chemicals, have been included in stored wastes. Generally, specific information (container identification, shipment date, quantity of material, etc.) concerning these hazardous materials is not available. Until April 1980, information identifying hazardous materials in waste containers was not required. Also, waste generators do not usually keep any records concerning disposal of hazardous materials in waste containers. Therefore, the information contained in this report was primarily obtained by interviewing personnel familiar with operations, processes, material usage, and waste management practices at each waste generating facility. Information concerning operations, process descriptions, etc. is contained in the text for each waste generating facility.

A summary discussion of hazardous materials included in wastes shipped to INEL by each waste generator is presented below. Specific information concerning hazardous materials is contained in the Nonradiological Hazards section for each waste generator. Table 1 provides a summary of this information.

Evaluation of future management alternatives for stored transuranic wastes should include the environmental and operational impacts of identified hazardous materials. Certain hazardous materials, such as nitrated ion exchange resins, may require special handling and processing procedures to ensure personnel and environmental protection.

TABLE 1. HAZARDOUS MATERIALS INCLUDED IN STORED TRU WASTES

	Waste Generators					
Hazardous Material	MND	BCL	BAPL	ANL-E	RFP	INEL
Mercury (elemental)	X				X	
Beryllium (compounds)	X			X	X	X
Asbestos	X				X	
Nitrated Wastes	X			X	X	
Organic Wastes (mixtures or unknown)				X	X	
Polychlorinated Biphenyl (PCB)		O		O	X	
Polyethylene Glycol			X			
Other Chemical Unknown					X	
Gas Generation/Pressurization in waste Containers	O				X	
Pressurized Vessels					O	
Batteries (lithium, mercury)					X	
Biological Wastes					X	
Pyrophorics					O	

MND = Mound Laboratory
BCL = Battelle Columbus Laboratory
BAPL = Bettis Atomic Power Laboratory
ANL-E = Argonne National Laboratory-East
RFP = Rocky Flats Plant
INEL = Idaho National Engineering Laboratory
X = Hazard identified as existing in stored waste
O = Hazard identified as potentially existing in stored waste

5.1 Mound Laboratory

5.1.1 Mercury

Sixty-one cartons of contaminated elemental mercury have been included in waste shipments. The cartons are contained in 28 55-gallon waste drums. The estimated total quantity of mercury included in the waste is 7.63 gallons or 864 lbs.

5.1.2 Beryllium

Approximately one to three 1-gallon cartons of beryllium-contaminated wastes are generated on a yearly basis by analytical operations. The weight of beryllium in each carton is estimated to be ≤0.05 grams.

5.1.3 Pressurized Drums

An estimated 20 drums of absorbed acidic wastes were shipped to INEL and may be pressurized due to reaction with calcium carbonate contained in the absorbent agent.

5.1.4 Gas Generation

Radiolytic production of hydrogen gas may occur in certain waste drums. Suspect drums would be in-line generated combustible wastes and <100 nCi/g combustible waste drums. Since 1975, all combustible waste drums have been required to contain <1 g ^{238}Pu.

Seventy-four 55-gallon drums, containing unsegregated combustible and noncombustible wastes that exceed the 1 g limit of ^{238}Pu, have been shipped to the INEL. The drums were packaged before the 1 g limit was establisned. The drums were packaged in 18 standard size boxes for shipment to the INEL.

5.1.5 Ion Exchange Resins

Twenty-eight cartons of spent ion exchange resins from recovery operations have been included in waste shipments. The cartons are contained in five waste drums and three waste boxes. The resins were exposed to various concentrations of nitric acid during recovery operations. Nitrated resins may represent a flammable and/or explosive hazard if the resin is allowed to dry. It is believed all resin wastes were washed with water before packaging. It is not known how completely the resins were denitrated.

5.1.6 Asbestos

As of February 1980, 1,108 cartons of asbestos filters and some asbestos gloves have been included in waste shipments.

5.2 Battelle Columbus Laboratories

5.2.1 Polychlorinated Biphenyls (PCB)

Waste oils removed from various equipment pieces (lathes, presses, etc.) during D&D operations were absorbed with Oil-Dri (trade name) contained in approximately 20 1-gallon metal cans. The absorbed oils may be contaminated with PCBs of unknown concentrations.

5.3 Bettis Atomic Power Laboratory

5.3.1 Carbo Wax 6000 (Polyethylene Glycol)

Carbo wax in the form of solid powder or flakes was packaged in metal cans before placement in waste drums. The volume of material included in waste shipments is unknown. Carbo wax may represent a slight fire hazard when exposed to heat or flame.

5.4 Argonne National Laboratory-East

5.4.1 Beryllium

Small amounts of beryllium in the form of crucibles, rods, etc. have been included in waste shipments. These wastes were removed from glovebox lines during D&D operations. The volume of beryllium included in the waste is unknown.

5.4.2 Organic Wastes

Organic wastes such as scintillation liquids, alcohols, and machining and pump oils, have been included in waste shipments. The wastes are absorbed on vermiculite contained in metal cans and polyethylene bottles.

Until January 1981, organic scintillation liquids were absorbed on vermiculite and allowed to dry. This practice ceased due to concern that peroxide formation could occur from decomposition of ether-based scintillation liquids. This could represent a potential explosion hazard. The number or volume of cans or bottles containing absorbed scintillation liquids included in waste shipments is unknown.

Chemical bottles containing low-carbon aliphatic (generally butyl) alcohols were filled with vermiculite by D&D personnel. Waste machining, lubricating, and pump oils generated during D&D operations were also absorbed on vermiculite contained in metal cans and polyethylene bottles. It is unknown if any of the oils contained polychlorinated biphenyls (PCB). The number or volume of cans or bottles containing absorbed alcohols or oil is unknown.

5.4.3 Ion Exchange Resins

Small plastic ion exchange columns, containing 5 to 15 mL of organic-based resin, are used by several ANL-E areas for isotope separation and recovery experiments. The resins are exposed to various concentrations of nitric acid. The resins are usually rinsed with either oxalic acid or a mixture of HCl/HF acids before disposal. Information provided by ANL-E personnel indicates that the resins rinsed with oxalic acid should not represent a hazard. Oxalic acid denitrates the resin and removes most of the fissile material. Resins rinsed with HCl/HF may be in the nitrate form. Nitrated organic resins, if dry, may represent a flammability and/or explosion hazard. The overall volume of ion exchange resins generated by ANL-E operations is believed to be small. Specific information is not available.

5.5 Rocky Flats Plant

5.5.1 Biological Wastes

Three standard size boxes containing biological wastes, generated by plutonium and americium translocation experiments, were shipped to the INEL in February 1978. One box of waste contains numerous empty glass quart jars originally used to collect urine and tissue samples. The two remaining boxes contain cardboard boxes of tissue samples, dog paws, syringes, empty scintillation vials, and feces wrapped in plastic bags. No pathogenic or chemical carcinogenic work was conducted in conjunction with these experiments.

5.5.2 Gas Cylinders

A variety of pressurized gases have been used at RFP for calibration of laboratory and monitoring instrumentation and for use in production areas. After the 1969 fire, a large number of contaminated gas cylinders, including CO_2 fire extinguishers, were included in waste shipments to the INEL. It was believed most of the gas cylinders were depressurized prior to placement in waste containers. However, it was speculated that certain gases may have been hazardous to depres rize in the work environment and would have been placed directly into waste containers. Information concerning the type of gases, cylinder sizes, shipment dates, etc. was not available.

5.5.3 Asbestos

Large quantities (specifics unknown) of asbestos or materials containing asbestos, such as filters, insulation, fire blankets, gloves, etc., have been included in waste shipments to the INEL.

5.5.4 Polychlorinated Biphenyls (PCB)

Transuranic-contaminated oils containing polychlorinated biphenyls were periodically processed with other organic wastes until 1979.[12] The concentration of PCB in these oils is believed to be >500 ppm. Records concerning processing of PCB oils are not complete. The total number of PCB-contaminated drums is unknown.

5.5.5 Beryllium

Beryllium (Be) contamination exists in first and second stage sludges and in solidified organic wastes. The concentration of Be in first and second stage sludges is expected to be <1000 ppm, see Appendix B. The concentration of Be in drums of solidified organic waste is unknown.

A significant source of stored Be wastes is from wastes retrieved during the INEL IDR and EWR projects. In addition, small amounts of Be are generated by various R&D efforts in plutonium processing areas. The specific quantity of Be or Be compounds in INEL stored wastes is unknown.

5.5.6 Nitrated wastes

Large quantities of nitric acid are used in plutonium recovery operations, and smaller quantities are used by many other plutonium operations. Generally, no free nitric acid is present in solid waste packages. The acid was absorbed on paperwipes, rags, or other absorbent material. Nitrated cellulose materials may become highly flammable if allowed to dry.

Ion-exchange resins are used by production plutonium recovery operations to purify plutonium-bearing solutions. During recovery operations, the resins are exposed to various concentrations of nitric acid. Nitrated resins may become highly flammable and/or explosive if the resin is allowed to dry. Ion-exchange column resins are usually changed once or twice a year depending on the rate of production recovery operations. Disposal practices for resin wastes were changed several times during 1972, based on content code changes appearing in the INEL Transuranic Contaminated Waste Container Information System (TCWCIS) and information provided by recovery personnel. Since 1972, resin wastes have been leached with water and then solidified with Portland cement in 1-gallon polyethylene bottles before placement in a waste drum. It is believed cemented resins should not represent a significant hazard. Any resin wastes packaged before the solidification process was established (including retrieved drums) may represent a flammability or explosion hazard if the resins have dried out while in storage. The number of drums containing resin wastes that may represent a hazard is unknown.

5.5.7 Batteries

Prior to 1973, mercury and lithium batteries were periodically placed in second stage sludge drums (content code 2). The number of batteries included in sludge drums is unknown. The batteries may represent a toxic and/or explosion hazard.

5.5.8 Other Chemical Wastes

Prior to 1973, second stage sludge drums were periodically used to dispose of bottles of liquid chemical wastes, small containers of elemental mercury, and batteries. The volume or type of chemicals placed in the sludge drums is unknown. First and second sludge drums also contain a variety of residual toxic heavy elements from processing various plant-generated liquid wastes. Appendix C contains RFP analyses of 7412-series sludge drums.

5.5.9 Hydrogen Generation

Recent waste characterization projects conducted by RFP for EG&G Idaho, Inc. indicate that hydrogen generation occurs in certain waste drums. During 1979 and 1980, 70 RFP-generated waste drums were retrieved from storage at the INEL and returned to RFP for characterization. Results of the characterization project[9,10] revealed that four drums had elevated levels of hydrogen (6, 12, 13, and 19% by volume). The lower explosive limit for hydrogen in air is 4.1% by volume. Hydrogen generation may occur from alpha-radiolysis of water and organic or cellulosic materials.

5.5.10 Drum Pressurization

Pressurization of waste drums may occur from gases (hydrogen, oxygen, etc.) produced by radiolytic, bacterial, and chemical actions. During 1980, a first stage sludge drum, placed in storage at the INEL during 1978, was discovered to be pressurized. Analysis of the drum indicated the pressure to be 19.6 psig.[13] Other stored waste drums, particularly first stage sludge drums, may also be pressurized.

5.5.11 Pyrophorics

Small amounts of unoxidized (metallic) plutonium and/or metastable plutonium suboxides may be present in vacuum pots that were connected to plutonium machining stations. The pots were included with other wastes generated by D&D operations conducted after the 1969 fire. Another potential source of pyrophorics includes any depleted uranium wastes retrieved and placed in storage during INEL retrieval projects.

5.6 Idaho National Engineering Laboratory

5.6.1 Beryllium

Small amounts of beryllium contained in neutron sources were identified as existing in stored wastes generated by INEL operations.

REFERENCES

1. R. K. Blauvelt, "TRU Waste Certification Analysis," Monsanto Research Corporation--Mound Facility, October 17, 1980.

2. U.S. Department of Energy, Final Environmental Impact Statement--Rocky Flats Plant Site, DOE/EIS-0064, April 1980.

3. C. E. Wickland letter to R. M. Schletter, 81-RF-0876 (Rocky Flats Plant), "Additional Information for Authorization of Non-standard Waste Shipments," May 11, 1981.

4. Telephone conversation with H. M. Batchelder, July 6, 1981.

5. Personal communication with J. R. Bishoff, July 6, 1981.

6. B. C. Anderson and R. M. Schletter, A History of the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory, WM-F1-81-003, March 1981.

7. Letter, H. M. Batchelder to T. G. Hedahl, "Large Boxes on TSA-1," HMB-02-81, July 9, 1981.

8. Letter, H. M. Batchelder to G. R. Darnell, "Stored Containers Not Included in the TCWCIS," HMB-01-81, June 12, 1981.

9. L. L. Luckett and P. T. Fraccini, Characterization and Categorization Study of TRU Waste for EG&G (Transmitted by J. R. Bishoff, JRB-16-80), Rockwell International Pilot Plant Development Group, Rocky Flats Plant, no date.

10. L. L. Luckett, Characterization and Categorization Study of TRU Waste for EG&G, CSE-81-0022, Rockwell International Rocky Flats Plant, April 10, 1981.

11. L. L. Luckett, et al., Rocky Flats Waste Stream History Report (Draft), TRU Waste Certification Analysis Program Report--FY-81, Rockwell International Rocky Flats Plant, January 13, 1981.

12. Letter, T. L. Clements, Jr. to K. B. McKinley, "PCB Contaminated Wastes at the RWMC," TLC-7-81, April 27, 1981.

13. T. H. Smith, "Minutes of Meeting on Gas Generation--Rocky Flats Plant," THS-28-80, July 17, 1980.

APPENDIX A

EXAMPLE: WASTE QUESTIONNAIRE FOR BETTIS ATOMIC POWER LABORATORY

APPENDIX A

STOREJ TRANSURANIC WASTE CHARACTERIZATION FOR
BETTIS ATOMIC POWER LABORATORY

I. The INEL Waste Management Information System (Form ID-135) and the Transuranic Contaminat[illegible] Waste Container Information System (Form ID-137 or equiv[illegible]) indicates the following waste information:

A. VOLUME OF STORED TRANSURANIC WASTE:

Year	Volume (m^3)	Volume (ft^3)	Drums	Boxes	Bins
1973	33.67	1,189.1	119	-	-
1974	92.86	3,279.3	446	-	-
1975	122.40	4,322.5	588	-	-
1976	113.1	3,994.1	543	-	-
1977	8.745	308.8	42	-	-
1978	8.121	286.8	39	-	-
1979	11.66	411.8	56	-	-
1980	31.65	1,117.7	89	-	-
TOTALS	422.15	14,910.1	1,922	-	-

B. STORED TRANSURANIC WASTE CONTENT CODES:

Content Code	Description	Drums	Boxes	Bins
10	Combustibles (rags, gloves, poly)	912	-	-
20	Noncompress, noncombustible	792	-	-
30	Solidified grinding sludge, etc.	45	-	-

40	Solid binary scrap powder, etc.	172	-	-

NOTE: Totals may not be consistent due to use of separate information systems.

II. Facility Information

A. What is the overall function or purpose of Bettis Atomis Power Laboratory?

B. What areas, facilities, sites, laboratories, etc., within Bettis Atomic Power Laboratory generate transuranic wastes that are shipped to INEL for storage?

C. For each facility, area, etc., that generates waste shipped to INEL:

1. What is the function of that facility?

2. What type of processes, operations, etc., are or have been conducted within each facility since waste shipments to INEL began?

3. What type of materials, chemical processes, etc., are associated with operation of this facility?

4. What type of wastes are generated?

5. What physical form is the waste in?

a. Solid

b. Liquid

c. Sludge

d. Other.

6. What is the major radionuclide contaminant?

7. What percentage of the waste shipped to INEL is generated by each facility?

III. Waste Information

A. How are the wastes generated from each facility handled?

B. How are the different types of waste packaged or prepared for shipment?

1. Wrapped in plastic

2. Use of special containers

3. Solidification of liquids

4. Waste treatment (evaporation, etc.)

5. Volume reduction

6. Other.

C. What type of plastic is used for packaging?

1. Polyethylene

2. Polyvinyl chloride (PVC)

3. Other, please specifiy.

D. If several types of plastic are used, what percentage of each is used?

E. How many layers of plastic are used?

F. Are any unsolidified liquids included in the waste (examples: scintillation vials, chemical bottles, etc.)?

G. Are any absorbents, such as Oil-Dri, vermiculite, etc., used in packaging the wastes?

H. Is the waste segregated as to content codes used for shipping information?

I. Is additional information available concerning the description of the content codes?

1. Physical description

2. Chemical characteristics, such as analysis of sludges, etc.

J. TWTF information requirements appear as Attachment 1.

IV. Nonradiological Hazards

This section concerns identification of potential nonradiological hazards that may exist in the stored transuranic waste. Nonradiological hazards may include inorganic and organic chemicals, biological agents, and mechanical hazards (gas cylinders, etc.). These wastes are not only radiologically contaminated, but may represent a nonradiological hazard due to associated chemical, biological, or mechanical properties.

A. Chemical Waste:

1. Were elemental chemicals or chemical compounds utilized in research experiments, production operations or processes, etc., in facilities generating waste shipped to INEL?

2. Were any chemicals included in waste shipments to INEL?

3. If chemicals or chemical wastes were included in waste shipments, what content code(s) were used?

4. What physical form is the chemical waste in?

   a. Gas (cylinders)

   b. Liquids

   c. Solid or particulate

   d. Sludge

   e. Other.

5. What chemical classification?

   a. Inorganic--please detail specifics, including pyrolhorics

   b. Organic--please detail specifics.

6. Is the volume of each disposed chemical waste known?

7. How was the waste packaged?

8. Was the chemical waste stabilized prior to shipment? If so, what stabilization method was used?

B. Biological Waste:

1. Were any biological wastes (animal carcasses, feces, microbes, etc.) in wastes shipped to INEL?

2. If so, what type of experiments, etc., were conducted?

   a. Radiological

   b. Military agent

   c. Carcinogenic or toxic

   d. Viral or bacteriological.

3. What type of wastes?

   a. Carcass

   b. Feces

   c. Microbes

   d. Other.

4. What type of animals or microbes were included in waste shipments?

5. How large is the volume of animal waste?

6. How was the waste prepared for shipping?

7. Are any residual hazards associated with this waste?

C. Mechanical Hazards and Other

1. Have any potential hazards, such as pressurized or partially pressurized gas cylinders, batteries, explosives or explosive mixtures, initiating devices or dispersing devices, enter any wastes shipped to INEL for storage? If so, please detail.

2. Have any of the facilities generating wastes shipped to INEL conducted experiments, research, testing, or production of chemical or biological agents for or under the direction of any military or defense agency? If so, please detail.

APPENDIX B

MOUND SLUDGE ANALYSES

V. RADIOACTIVE SOLUTIONS FROM DEVELOPMENT GROUPS IN THE WD BUILDING TO INFLUENT TANKS:

1. Trace amounts of U-233, Np-237, Am-241, and Pu-238
2. Trace amounts of radioactivity discarded directly to the liquid sludge in the past. Co-60, Cs-137, Sr-90
   Now it is added directly to cement.
3. Solutions added directly to the sludge without treatment in the WD Bldg. Sodium Carbonate, Sodium Chloride with trace amounts of Pu-238 from incinerator (development). Estimated 200 gallons over a 3-month period.

4. Other sludge from WD production type incinerator WD Building. 15% fly ash in NaCL Solid.
   Years 1974 through 1976: None due to cold testing.

	GALLONS	TYPE	TREATMENT
1977	350	sludge	none
1978	425	"	"
1979	162	"	"
1980 Jan-June	81	"	"

5. Incinerator scrubber solution to WD influent tank.
   Contents: Water nearly saturated with NaCl and other salts, plus various amounts of suspended solids.

	VOLUME IN GALLONS
1974	None
1975	150
1976	300
1977	1600
1978	1900
1979	500
1980 Jan - June	None at that time
1980 Oct 1	Incinerator to start daily operations

After each effluent tank is filled, the treated waste water is sampled for pH and alpha in the WD and a sample is sent to the Analytical Department for specific plutonium-238, u-234, and H-3.

When a specific plutonium-238 count of 1.0 d/m/ml or less and all other discharge standards are met, the waste water is discharged. Effluent waste water that does not meet discharge standards is reprocessed through the waste disposal system.

Sludge Sampling and Specifications

A sample of sludge is taken from the sludge storage tank and submitted for % solids and Pu-238 mci/kg. In past years, the percentage of solids was 17-20% when a large amount of iron was used in treatment, but now with less iron in the process the solids are in the 25-30% range. An analysis of a recent sludge batch is as follows:

Moisture	-	58.3 wt%
Volatiles	-	14.3 "
Carbon	-	7.2 "
Ash	-	20.2 "

pH range = 10.5 to 11.5

Emission spec. analysis in % of a dried sample are:

Si,P,AL,Fe	=	.6
Mg,Ca,Sr	=	.6
Co,B,Zr	=	.01
Na	=	0.6
Cr	=	0.08
Ni	=	0.08
Cu	=	0.09
V	=	0.05
Ti	=	0.05
Mn	=	0.03
Pb	=	0.01
Sn	=	0.01
Density	=	1.1gms/cc

THESE ELEMENTS FOUND TO BE IN THE SLUDGE DUE TO PRECIPITATION OR ADSORPTION.

The following Table 4 list the amount of influent, chemicals used, drums of sludge produced, and the mciPu-238 since 1974.

TABLE 4

INFLUENT GALLONS X1000		CHEMICAL USED/LBS.	DRUMS OF SLUDGE	Pu-238mci/Drum RANDOM BATCHES
1974	18,000	C = 915	400	estimated 250mci
		Ca = 5775		
		Fe = 2900		
		3 month period		
1975	3,264	C = 9020	1588	Batch - 19 = 250 mci
		Ca = 26400		" 39 = 180 "
		Fe = 17200		" 73 = 110 "
1976	2,260	C = 4000	427	Batch - 89 = 38 mci
		Ca = 48700		" 92 = 82 "
		Fe = 9500		
1977	2552	C = 7000	200	Batch - 94 = 120 mci
		Ca = 59300		" 99 = 50 "
		Fe = 11200		
1978	2614	C = 12300	455	Batch -101 = 71 mci
		Ca = 63400		
		Fe = 8020		
1979	2544	C = 8[illegible]00	373	estimated ave. = 30 mci
		Ca = 71900		
		Fe = 2400		
1980	952	C = 3325	51	estimated ave. = 40 mci
Jan - June		Ca = 30900		
		Fe = 1500		

APPENDIX C

ROCKY FLATS 7412-SLUDGE ANALYSES

774 Sludge

SAMPLE-ID	00-008395	DJC NUMBER	97038000
ENTRY DATE	11-01-79	ACCOUNT CHARGED	8037
COMPLETION DATE	01-25-80	BUILDING	559
		CLASS	SS91
CUSTOMER	P. T. GODESAIBOIS		

** ATOMIC ABSORPTION SPECTROMETRY RESULTS

CA	86612.	PPM(W)	FE	61597.	PPM(W)
K	6162.	PPM(W)	NA	65501.	PPM(W)
SI	3659.	PPM(W)			

** PLUTONIUM CHEMISTRY LABORATORY RESULTS

CL(-)		0.16	%(W)	CO3*		0.36	%(W)
F(-)		57.	PPM(W)	H2O		61.0	%(W)
NO3		4.2	%(W)	PO4	<	0.0025	%(W)
SO4		0.085	%(W)				

** SEMI-QUANTATIVE EMISSION SPEC RESULTS

AG		50.	PPM(W)	AL		20000.	PPM(W)
AS	<	50.	PPM(W)	B		100.	PPM(W)
BA		100.	PPM(W)	BE		50.	PPM(W)
BI	<	50.	PPM(W)	CA	>	200000.	PPM(W)
CD	<	1000.	PPM(W)	CE	<	500.	PPM(W)
CO	<	50.	PPM(W)	CR		500.	PPM(W)
CS	<	1000.	PPM(W)	CU		4000.	PPM(W)
FE		50000.	PPM(W)	GE	<	10.	PPM(W)
HG	<	10.	PPM(W)	K		40000.	PPM(W)
LI	<	1000.	PPM(W)	MG		10000.	PPM(W)
MN		500.	PPM(W)	MO		500.	PPM(W)
NA		50000.	PPM(W)	NB	<	50.	PPM(W)
NI		2000.	PPM(W)	P	<	1000.	PPM(W)
PB	<	50.	PPM(W)	RB	<	500.	PPM(W)
SB	<	50.	PPM(W)	SI		100000.	PPM(W)
SN	<	10.	PPM(W)	SR		10000.	PPM(W)
TA	<	50.	PPM(W)	TE	<	100.	PPM(W)
TH	<	500.	PPM(W)	TI		500.	PPM(W)
TL	<	500.	PPM(W)	U	<	500.	PPM(W)
V	<	5.	PPM(W)	W	<	1000.	PPM(W)
ZN	<	500.	PPM(W)	ZR	<	50.	PPM(W)

** RADIOCHEMISTRY LABORATORY RESULTS

AM	0.0000317	G/G

SAMPLE-ID 00-008395

** RADIOCHEMISTRY LABORATORY RESULTS (CONTINUED)

PU	0.0000223	G/G	U	0.0017	G/G

AUTHORIZED SIGNATURE

Hewell

SAMPLE-ID	00-008396	DJO NUMBER	97038000
ENTRY DATE	11-01-79	ACCOUNT CHARGED	8037
COMPLETION DATE	01-25-80	BUILDING	559
		CLASS	SSP1
CUSTOMER	P. T. DODESAIBOIS		

** ATOMIC ABSORPTION SPECTROMETRY RESULTS

CA		194587.	PPM(W)	FE		47915.	PPM(W)
MG		9581.	PPM(W)	NA		105060.	PPM(W)
SI		158.	PPM(W)				

** PLUTONIUM CHEMISTRY LABORATORY RESULTS

CL(-)		0.15	%(W)	CO3*		0.74	%(W)
F(-)		101.	PPM(W)	H2O		55.0	%(W)
NO3		9.0	%(W)	PO4	<	0.0025	%(W)
SO4		0.096	%(W)				

** SEMI-QUANTATIVE EMISSION SPEC RESULTS

AG		10.	PPM(W)	AL		10000.	PPM(W)
AS	<	50.	PPM(W)	B		100.	PPM(W)
BA		500.	PPM(W)	BE		1000.	PPM(W)
BI	<	50.	PPM(W)	CA	>	200000.	PPM(W)
CD	<	1000.	PPM(W)	CE	<	500.	PPM(W)
CO	<	50.	PPM(W)	CR		500.	PPM(W)
CS	<	1000.	PPM(W)	CU		500.	PPM(W)
FE		50000.	PPM(W)	GE	<	10.	PPM(W)
HG	<	10.	PPM(W)	K		40000.	PPM(W)
LI	<	1000.	PPM(W)	MG		50000.	PPM(W)
MN		500.	PPM(W)	MO		200.	PPM(W)
NA		50000.	PPM(W)	NB	<	50.	PPM(W)
NI		1000.	PPM(W)	P	<	1000.	PPM(W)
PB		50.	PPM(W)	PU	<	100.	PPM(W)
RB	<	500.	PPM(W)	SB	<	50.	PPM(W)
SI		100000.	PPM(W)	SN	<	10.	PPM(W)
SR		10000.	PPM(W)	TA	<	50.	PPM(W)
TE	<	100.	PPM(W)	TH	<	500.	PPM(W)
TI		500.	PPM(W)	TL	<	500.	PPM(W)
U	<	500.	PPM(W)	V	<	5.	PPM(W)
W	<	1000.	PPM(W)	ZN	<	500.	PPM(W)
ZR	<	50.	PPM(W)				

SAMPLE-ID 00-008396

** RADIOCHEMISTRY LABORATORY RESULTS

AM	0.00000546 G/G		
PU	0.0000389 G/G	U	0.000198 G/G

AUTHORIZED SIGNATURE

Havel

717 Sludge

D61478-01

LABORATORY SAMPLE RESULTS

DATE 01/25/80
PAGE 1

SAMPLE-ID	00-008397	DJC NUMBER	97038000
ENTRY DATE	11-01-79	ACCOUNT CHARGED	8037
COMPLETION DATE	01-25-80	BUILDING	559
		CLASS	SSP1
CUSTOMER	P. T. GODESAIBOIS		

** ATOMIC ABSORPTION SPECTROMETRY RESULTS

CA		121661.	PPM(W)	FE		49286.	PPM(W)
MG		18377.	PPM(W)	NA		100179.	PPM(W)
SI		217.	PPM(W)				

** PLUTONIUM CHEMISTRY LABORATORY RESULTS

CL(-)		1.5	%(W)	CO3*		0.59	%(W)
F(-)		143.	PPM(W)	H2O		60.2	%(W)
NO3		3.1	%(W)	PO4	<	0.0025	%(W)
SO4		0.14	%(W)				

** SEMI-QUANTATATIVE EMISSION SPEC RESULTS

AG		40000.	PPM(W)	AL		10000.	PPM(W)
AS	<	50.	PPM(W)	B		100.	PPM(W)
BA		50.	PPM(W)	BE		1000.	PPM(W)
BI	<	50.	PPM(W)	CA		200000.	PPM(W)
CD	<	1000.	PPM(W)	CE	<	500.	PPM(W)
CO	<	50.	PPM(W)	CR		500.	PPM(W)
CS	<	1000.	PPM(W)	CU		1000.	PPM(W)
FE		50000.	PPM(W)	GE	<	10.	PPM(W)
HG	<	10.	PPM(W)	K		40000.	PPM(W)
LI	<	1000.	PPM(W)	MG		100000.	PPM(W)
MN		100.	PPM(W)	MO		200.	PPM(W)
NA		60000.	PPM(W)	NB	<	50.	PPM(W)
NI		500.	PPM(W)	P	<	1000.	PPM(W)
PB		50.	PPM(W)	PU	<	100.	PPM(W)
RB	<	500.	PPM(W)	SB	<	50.	PPM(W)
SI		100000.	PPM(W)	SN	<	10.	PPM(W)
SR		10000.	PPM(W)	TA	<	50.	PPM(W)
TE	<	100.	PPM(W)	TH	<	500.	PPM(W)
TI		300.	PPM(W)	TL	<	500.	PPM(W)
U	<	500.	PPM(W)	V	<	5.	PPM(W)
W	<	1000.	PPM(W)	ZN	<	500.	PPM(W)
ZR	<	50.	PPM(W)				

D61472-01 LABORATORY SAMPLE RESULTS DATE 01/25/80 PAGE 2

SAMPLE-ID 00-008397

** RADIOCHEMISTRY LABORATORY RESULTS

AM	0.000628 MG/G		
PU	0.00000481 G/G	U	0.000561 G/G

AUTHORIZED SIGNATURE

Hukel

SAMPLE-ID	01-008398	DJO NUMBER	97038000
ENTRY DATE	02-20-80	ACCOUNT CHARGED	8037
COMPLETION DATE	09-12-80	BUILDING	559
		CLASS	SSP1
CUSTOMER	R. . GOOESIABOIS		

** ATOMIC ABSORPTION SPECTROMETRY RESULTS

CA	77000.	PPM(W)	FE	52000.	PPM(W)
GA	99.	PPM(W)	K	65000.	PPM(W)
NA	90000.	PPM(W)	SI	900.	PPM(W)

** PLUTONIUM CHEMISTRY LABORATORY RESULTS

C	5.2	%(W)	CL(-)	0.74	%(W)
CO3*	1.9	%(W)	F(-)	0.042	%(W)
H	1.2	%(W)	H2O	49.9	%(W)
N	2.0	%(W)	NO3	9.1	%(W)
PO4	3.2	%(W)	SO4	0.15	%(W)
U	443.	PPM(W)			

** SEMI-QUANTATATIVE EMISSION SPEC RESULTS

AG		7.	PPM(W)	AL		5000.	PPM(W)
AS	<	50.	PPM(W)	B	<	1.	PPM(W)
BA		100.	PPM(W)	BE		500.	PPM(W)
BI	<	50.	PPM(W)	CA		150000.	PPM(W)
CD	<	1000.	PPM(W)	CE	<	500.	PPM(W)
CO	<	50.	PPM(W)	CR		200.	PPM(W)
CS	<	1000.	PPM(W)	CU		1000.	PPM(W)
FE		40000.	PPM(W)	GA	<	1000.	PPM(W)
GE	<	10.	PPM(W)	HG	<	10.	PPM(W)
K		100000.	PPM(W)	LI	<	1000.	PPM(W)
MG		100000.	PPM(W)	MN	<	1.	PPM(W)
MO		100.	PPM(W)	NA		50000.	PPM(W)
NB	<	50.	PPM(W)	NI		700.	PPM(W)
P	<	1000.	PPM(W)	PB		5000.	PPM(W)
PU	<	100.	PPM(W)	RB	<	500.	PPM(W)
SB	<	50.	PPM(W)	SI		50000.	PPM(W)
SN		50.	PPM(W)	SR		5000.	PPM(W)
TA	<	50.	PPM(W)	TE	<	100.	PPM(W)
TH	<	500.	PPM(W)	TI	<	10.	PPM(W)
TL	<	500.	PPM(W)	U	<	500.	PPM(W)
V	<	5.	PPM(W)	W	<	1000.	PPM(W)
ZN		500.	PPM(W)	ZR	<	50.	PPM(W)

SAMPLE-ID 00-008398

** RADIOCHEMISTRY LABORATORY RESULTS

AM	0.000465	MG/G
PU	0.0000226	G/G

AUTHORIZED SIGNATURE
O. Fidlin

SAMPLE-ID	00-008399	DJO NUMBER	97038000
ENTRY DATE	02-20-80	ACCOUNT CHARGED	8037
COMPLETION DATE	09-12-80	BUILDING	559
		CLASS	SSP1
CUSTOMER	P. . CODESIABCIS		

** ATOMIC ABSORPTION SPECTROMETRY RESULTS

CA	78000.	PPM(W)	FE	47000.	PPM(W)
GA	150.	PPM(W)	K	12000.	PPM(W)
NA	100000.	PPM(W)	SI	290.	PPM(W)

** PLUTONIUM CHEMISTRY LABORATORY RESULTS

C	11.1	%(W)	CL(-)	0.28	%(W)
CO3=	1.4	%(W)	F(-)	0.032	%(W)
H	2.5	%(W)	H2O	57.5	%(W)
N	3.4	%(W)	NO3	6.3	%(W)
PO4	6.9	%(W)	SO4	0.36	%(W)
U	345.	PPM(W)			

** SEMI-QUANTATIVE EMISSION SPEC RESULTS

AG		8.	PPM(W)	AL		5000.	PPM(W)
AS	<	50.	PPM(W)	B	<	1.	PPM(W)
BA		100.	PPM(W)	BE		100.	PPM(W)
BI	<	50.	PPM(W)	CA		150000.	PPM(W)
CD	<	1000.	PPM(W)	CE	<	500.	PPM(W)
CO	<	50.	PPM(W)	CR		200.	PPM(W)
CS	<	1000.	PPM(W)	CU		1000.	PPM(W)
FE		50000.	PPM(W)	GA	<	1000.	PPM(W)
GE	<	10.	PPM(W)	HG	<	10.	PPM(W)
K		50000.	PPM(W)	LI	<	1000.	PPM(W)
MG	<	100000.	PPM(W)	MN	<	1.	PPM(W)
MO		100.	PPM(W)	NA		50000.	PPM(W)
NB	<	50.	PPM(W)	NI		700.	PPM(W)
P	<	1000.	PPM(W)	PB		100.	PPM(W)
PU	<	100.	PPM(W)	RB	<	500.	PPM(W)
SB	>	50.	PPM(W)	SI		50000.	PPM(W)
SN		20.	PPM(W)	SR		5000.	PPM(W)
TA	<	50.	PPM(W)	TE	<	100.	PPM(W)
TH	<	500.	PPM(W)	TI	<	10.	PPM(W)
TL	<	500.	PPM(W)	U	<	500.	PPM(W)
V	<	5.	PPM(W)	W	<	1000.	PPM(W)
ZN	<	500.	PPM(W)	ZR	<	50.	PPM(W)

D61472-01 LABORATORY SAMPLE RESULTS DATE 09/12/8
PAGE

SAMPLE-ID 00-008399

** RADIOCHEMISTRY LABORATORY RESULTS

AM	0.000619	MG/G
PU	0.00000363	G/G

AUTHORIZED SIGNATURE

A. Ficklin