Idaho National Engineering Laboratory

Managed by the U.S. Department of Energy

EGG-WM-10079
Revision 0
January 1992

NONRADIONUCLIDE INVENTORY IN PIT 9 AT THE RWMC

K. J. Liekhus

EG&G Idaho

Work performed under DOE Contract No. DE-AC07-76ID01570

EGG-WM-10079
Revision 0

NONRADIONUCLIDE INVENTORY IN PIT 9 AT THE RWMC

K. J. Liekhus

Published January 1992

Idaho National Engineering Laboratory
EG&G Idaho, Inc.
Idaho Falls, ID 83415

Prepared for the
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
Under DOE Idaho Field Office
Contract No. DE-AC07-76ID01570

NONRADIONUCLIDE INVENTORY IN PIT 9 AT THE RWMC
EGG-WM-10079

January 1992

Approved by:

W. H. Sullivan, Unit Manager
Waste Area Group 7

1/28/92
Date

U. W. Watson for J. P. S

J. P. Shea, Chair
ERP Independent Review Committee

1/31/92
Date

Prepared by:

K. J. Liekhus

1/27/92
Date

ABSTRACT

The purpose of this report is to document the references, calculations, and assumptions used to estimate the quantity and types of materials buried in Pit 9 of the Radioactive Waste Management Complex (RWMC). Available shipping records and the Radioactive Waste Management Information System (RWMIS) data base were the primary sources of information for Pit 9 contents, although the RWMIS was developed from information in the shipping records. Past investigators estimated some Pit 9 contents based on available data and assumptions. These calculations and assumptions are also reexamined.

CONTENTS

TABLES

NONRADIONUCLIDE INVENTORY IN PIT 9 AT THE RWMC

INTRODUCTION

The Radioactive Waste Management Complex (RWMC) located at the Idaho National Energy Laboratory (INEL) has served as a disposal area for low-level radioactive waste generated at the INEL since 1952. The RWMC includes the Subsurface Disposal Area (SDA), which contains buried transuranic (TRU) waste generated at the Rocky Flats Plant from 1954 to 1970. The TRU waste currently remains buried at the RWMC.

From current shipping records, the waste in Pit 9 is primarily TRU waste generated at the Rocky Flats Plant, with additional wastes (primarily low-level waste) from generators located at the INEL. Approximately 150,000 ft^3 of waste was buried in Pit 9, of which approximately 110,000 ft^3 was generated at the Rocky Flats Plant. Waste from Rocky Flats consisted primarily of drums of 74-series sludge, drums of assorted solid waste, and cardboard boxes containing empty contaminated drums.

WASTE CONTENT IN PIT 9

74-Series Sludge Inventory

Five 74-series sludge types (741, 742, 743, 744, and 745) were generated at Rocky Flats during the period waste was buried in Pit 9. The composition of each sludge type has been described (Clements 1982). Shipping records indicate that there were 2,106 55-gal sludge drums buried in Pit 9, but the records do not identify the type of 74-series sludge in each drum.

According to shipping records, radioactive waste was buried in Pit 9 from November 1967 to June 1969, and containers of TRU waste from the Rocky Flats Plant (RFP) were buried in Pit 9 from February to September 1968. It was assumed that 74-series sludge generated in 1967 or 1968 may have been sent to Pit 9, depending on the holding time of the sludge drums at the RFP. Therefore, it is assumed that the relative fraction of each sludge type in Pit 9 was equal to the relative fraction of each sludge type generated and packaged in 55-gal drums at Rocky Flats in 1967 and 1968. The number of drums of sludge generated at Rocky Flats in 1967 and 1968 has been reported (Vigil 1989).

Specific information of drum preparation during 1967 and 1968 is not available. From information of drum preparation from 1970 to 1981 (Clements 1982), it was assumed that 745 sludge occupied 90 percent of container volume and that the other sludge types occupied 80 percent of the container volume. The calculation of the estimated container and content volumes of each sludge type is given in the Appendix. The estimated volumes (to the nearest 100 gal) are summarized in Table 1.

Organic Content of 74-Series Sludges

The content and composition of each 74-series sludge have been described (Clements 1982). The 743 and 744 sludges contain significant amounts of hazardous organics that are radioactively contaminated.

In 743 sludge, approximately 30 gal of organic liquid is mixed with 100 lb of calcium silicate and 10-20 lb Oil-Dri absorbent. It is assumed that this recipe was used to fill each drum. The organic liquid was described as 47% lathe coolant (60% Texaco Regal oil, 40% carbon tetrachloride), 10% degreasing agents (trichloroethane), and 43% miscellaneous organics consisting of unspecified amounts of carbon tetrachloride, chloroethylenes, and hydraulic, gear box, and spindle oils. The organic liquid also included Freon, Varsol, and trace amounts of laboratory wastes (organophosphates and nitrobenzene). In addition, an unknown amount of oil contaminated with polychlorinated biphenyls was processed with the other organic wastes in 743 sludge.

In 744 sludge, about 26.4 gal (100 l) is mixed with 190 lb Portland cement and 50 lb of pipe insulation cement, such as magnesia cement. Approximately 10 to 15 lb of additional Portland cement was placed on top of the cement mixture before sealing in a plastic bag. It is assumed that this recipe was used to fill each drum.

The calculations used to estimate the organic content of each sludge type is shown in the Appendix. Estimates of organic content of sludges buried in Pit 9 are summarized in Table 2.

Inorganic Content of 74-Series Sludges

The inorganic content of the sludges was estimated from available data (Clements 1982) and is summarized in Table 3. Specific information of drum preparation during 1967 and 1968 is unavailable. A brief description of drum preparation methods between 1971 and 1981 is available (Clements 1982). It is assumed that this data and information of sludge drum preparation are

Table 1. Estimate of sludge volume buried in Pit 9.

Sludge	Estimated container volume (gal)	Estimated sludge volume (gal)
Series 741	12,700	10,200
Series 742	18,500	14,800
Series 743	53,300	42,600
Series 744	4,600	3,700
Series 745	26,600	23,900

Table 2. Estimate of organic content of sludge drums buried in Pit 9.

Waste stream	Volume (gal)
Total organics in 743 Sludge	29,100
Texaco regal oil	8,200
Carbon tetrachloride	5,500
Trichloroethane	2,900
Miscellaneous organics	12,500
Carbon tetrachloride	—
Trichloroethylene	—
Tetrachloroethylene	—
Hydraulic oil	—
Gearbox oil	—
Spindle oil	—
Freon	—
Varsol	—
Polychlorinated biphenyls	Trace amounts
Organic phosphates	Trace amounts
Nitrobenzene	Trace amounts
Total organics in 744 Sludge	2,200
Alcohols	—
Organic acids	—
Versenes (EDTA)	—

Table 3. Estimate of inorganic compounds in sludge buried in Pit 9.

Material	Mass (kg)	Volume (gal)
Total inorganics in 741 sludge	—	10,200
Hydrated iron oxides	—	—
Hydrated magnesium oxides	—	—
Hydrated aluminum oxides	—	—
Hydrated silicon oxides	—	—
Hydrated plutonium oxides	—	—
Hydrated americium oxides	—	—
Beryllium (500 ppm)	20	—
Portland cement	4,700	—
Total inorganics in 742 sludge	—	14,800
Hydrated iron oxides	—	—
Hydrated magnesium oxides	—	—
Hydrated aluminum oxides	—	—
Hydrated silicon oxides	—	—
Hydrated plutonium oxides	—	—
Hydrated americium oxides	—	—
Mercury (containerized)	100	—
Lithium (batteries)	10	—
Portland cement	6,900	—
Total inorganics in 743 sludge	—	—
Calcium silicate	44,000	—
Oil absorbent	6,600	—
Beryllium (ppm)	—	—
Total inorganics in 744 sludge	—	—
Portland cement	7,600	—
Magnesia cement	1,900	—
Total inorganics in 745 sludge	—	—
Sodium nitrate	—	14,400
Potassium nitrate	—	7,200

applicable to 1967 and 1968 sludge drums. The drums were assumed to have a mass of 50 lb (23 kg). In 741 sludge drums, about 40 to 50 lb of Portland cement were added to each drum to absorb free liquid. Some drums of 741 sludge contained low concentrations of beryllium, on the order of 1,000 ppm. The amount of 741 sludge in Pit 9 was determined from estimates of the total average drum weight (Clements 1982), the total number of drums in Pit 9, and the mass of drum and contents.

The 742 sludge drums were prepared in a similar manner to the 741 sludge drums. The 742-series sludge packaged prior to 1973 may contain other waste items, such as electric motors or liquid chemical waste containers. Liquid chemical wastes contained in polyethylene or glass bottles were periodically included in the 742-series drums. Prior to 1969, at least two 25-lb packs of sodium or potassium cyanide pellets were distributed in 742-series waste drums. Prior to 1973, small amounts of contaminated mercury in 0.5-liter bottles were periodically placed in drums every 1 or 2 years. Since 1954, mercury and lithium batteries were periodically included in the waste drums.[a] In 743 sludge, approximately 30 gal of organic liquid are mixed with 100 lb of calcium silicate and 10-20 lb Oil-Dri absorbent in each drum. The 743 sludge consists primarily of organic constituents; however, the degreasing agents contained unknown amounts of beryllium (Clements 1982). In 744 sludge, approximately 200 lb of Portland cement and 50 lb of pipe insulation cement, such as magnesia cement, were placed in each drum. The contents of 745 sludge are described as 60% sodium nitrate, 30% potassium nitrate, and 10% miscellaneous mass meant to describe the limited amount of odds and ends (gloves, rags, paper) dumped in these sludge drums (Clements 1982).

Content Estimate of Metals and Other Materials

The metal content in Pit 9 has been estimated using information available from RWMIS.[b] It was assumed that all drums were made of carbon steel and estimated the composition in each container identified as holding metal or metal components. In addition, the weight percent metal for each waste defined by content code was assumed. The total mass of each waste form was determined from the shipping records, taking into account the estimated mass of the container and other wastes. Metal drums were assumed to weigh 50 lb (23 kg) and cardboard boxes were assumed to have negligible mass. The mass of a wooden box depended on the box size.

Some entries to the RWMIS list a single mass for a shipment consisting of several waste forms. Most mixed shipments consisted partly of drums of 74-series sludge and cardboard boxes of empty 55-gal drums. The mass of cardboard boxes containing empty 55-gal drums was assumed to be the number of boxes (each containing one empty drum) multiplied by 23 kg. By subtracting the approximate mass of the sludge and empty drums, the mass of the remaining waste in the shipment could be estimated. In the absence of specific information, an average mass of a sludge drum content was calculated.

The contents of drums and boxes are identified by RWMIS content codes. The content codes are summarized in Table 4. The nature of the content codes and the brief description associated with each code can result in packaged waste forms that are not fully described by the assigned content code. In particular, content codes identifying containers that held several different types of waste (metal, wood, glass) do not indicate the waste composition in the container. Also, contaminated waste containing innocuous material may have been assigned a content code that only identifies the contaminant. Waste content codes 035 and 043 indicate the possible presence of asbestos in the container. The worst case was assumed that all contents not described as metal were asbestos.

---

a. Unpublished research results of waste characterization of Rocky Flats waste shipped to the INEL—G. R. Darnell, T. L. Clements, Jr., and R. R. Wright, EG&G Idaho, Inc. (March 1980).

b. Unpublished research results of metal content in the SDA—E. C. Garcia and J. L. Knight, EG&G Idaho, Inc. (January 1989).

Table 4. Content code descriptions.

Content code	Description
002[a]	74 series sludge
003[b]	Paper, metal, wood, plastic, glass, rubber, misc.
004[a]	Graphite, paper, wood, metal, glass, plastic
006[c]	Concrete, masonry
010[c]	Metal scrap, ductwork, concrete
024[c]	Pipe
027[c]	Metal components
030[c]	Scrap stainless steel, aluminum
031[c]	Dirt
032[c]	Lead
035[c]	CWS-type filters
040[c]	Zirconium
043[a]	Filters
053[c]	Oil (in drums)
066[a]	Paper, plastic, rubber, scrap metal, wood, glass, concrete, equipment
088[c]	Equipment and scrap metal
089[c]	Sand
093[a]	Empty 55-gallon Rocky Flats drums

a. Generated at Rocky Flats Plant only.

b. Generated at Rocky Flats Plant and the INEL.

c. Generated at the INEL only.

Combustible waste from the Naval Reactor Facility (NRF) listed in the RWMIS did not have an assigned mass.

From shipping records in the early 1970s, the approximate mass for 18 12-ft^3 cardboard boxes labeled by Content Code 008 (blotting paper, floor sweepings, rags, mops, routine hot waste, bottles) was approximately 900 lb.[c]

All lead in Pit 9 was assumed to be defined by Content Code 032. In the preparation of 741-series sludge drums, less than an estimated 100 drums were lead-lined to reduce the radiation levels below 200 mR/hr.[d] Since less than an estimated 100 drums were lead-lined out of the more than 10,000 741-series sludge drums shipped from Rocky Flats (Vigil 1989), no lead was assumed in the sludge drums.

There are a number of items identified as atypical waste. The presence of a stainless-steel vault in Pit 9 has been reported (McKinley and McKinney 1978). A large PM-2A carbon steel reactor weighing approximately 100,000 kg and sized into 12 sections, with a total container volume of 11,881 ft^3, is listed under Content Code 027. In addition, a pickup bed listed under Content Code 027 was identified in the pit from shipping records. This specific information led to the assumption that all items described by Content Code 027 were 100% carbon steel. This assumption of metal composition differs from an earlier assumption.[e] Shipping records indicate that shipments listed under Content Code 031 (dirt) are actually containers filled with metal parts and dirt. The exact mass of metal parts in the containers is unknown.

An estimate of the total combustible mass in Pit 9 was determined in a similar manner as that done for the total metal content in Pit 9. Content codes are identified in which containers used are wooden boxes or contain combustible material. The weight percent estimate of the combustible material for each content code is assumed. Additional content codes of wastes in Pit 9 are identified as follows:

Content Code	Description
007	Radioactive waste (not otherwise specified)
008	Blotting paper, floor sweepings, rags, mops, routine hot waste, bottles
026	Wood scrap
064	Asphalt, gravel

The total mass of wooden boxes was calculated using an estimate of the total surface area of the boxes, the wall thickness, and assumed wood density. The wall thickness of the wooden boxes was assumed to be 1 in., and wood density was assumed to be 30 lb/ft^3. The wall thickness assumed is greater than the actual wall thickness of the boxes but was used to account for additional wood used for reinforcement and shorings.

After reviewing the shipping records of waste defined by Content Code 007, it was assumed that this waste consisted of 100% combustible material. The bottles in waste defined by

---

c. Unpublished communication concerning typical mass of specific INEL-generated waste—D. L. Rhodes, EG&G Idaho, Inc. (October 1991).

d. Unpublished research results of waste characterization of Rocky Flats waste shipped to the INEL—G. R. Darnell, T. L. Clements, Jr., and R. R. Wright, EG&G Idaho, Inc. (March 1980).

e. Unpublished research results of metal content in the SDA—E. C. Garcia and J. L. Knight, EG&G Idaho, Inc. (January 1989).

Content Code 008 were assumed to be plastic bottles. Because of the relatively small masses of each of these waste streams, these assumptions have little effect on the estimated total mass of combustibles and noncombustibles.

In waste streams containing metals and combustibles, the weight percent combustible was calculated by subtracting the assumed weight percent metal from 100 percent. In the case of Content Code 066, glass and concrete were assumed to account for 15% of the total mass; the remaining 20% was assumed to be combustibles.

The number of containers or the container volume of each waste type is tabulated in Table 5. The calculations to estimate the mass or volume of metal and other materials buried in Pit 9 are shown in the Appendix. Estimates of the mass of metal and combustibles associated with each waste stream are listed for each content code in Table 6 and Table 7, respectively. The total content estimates of metal and other bulky items in Pit 9 are summarized in Table 8.

Comparison with Earlier Estimates of Pit 9 Contents

Several entry errors were identified in the RWMIS. These errors were detected by comparing entries on the RWMIS to actual shipping records. All containers described by content codes 019 (empty) and 092 (lead, asbestos) should have been listed by Content Code 093. Also, 54 cardboard boxes labeled by Content Code 002 (74-series sludge) should be changed to Content Code 093. As a result, the total number of cardboard boxes containing empty 55-gal drums is now believed to be 1,471. Current efforts are under way to correct these errors in the RWMIS.

Many earlier estimates of Pit 9 contents were based on the amount of waste sent to the SDA instead of information specifically pertaining to Pit 9. The assumptions of the 74-series sludge were meant to more closely estimate the sludge contents in Pit 9. Other investigators[f] estimated the amount of 743 sludge in Pit 9 from knowledge of the total volume of 743 sludge sent to the SDA from 1953 to 1969 and from comparing volume fraction of Pit 9 to total burial volume in the SDA. Also, they assumed that the relative fraction of the other sludge types in the remaining volume was the same as the relative fraction of each type sent to the SDA between 1967-1969.

Earlier estimates of the organic content of Pit 9 assumed that the quantities of Texaco Regal oil, carbon tetrachloride, and other organics in 743 sludge in Pit 9 were proportional to the amounts of these materials reportedly shipped to the entire SDA[f]. In addition, it was assumed that the miscellaneous organics consisted of 20 percent trichloroethane and that the rest consisted of used oils. It was also assumed that 10 percent of the oil was contaminated with 500 ppm of PCBs. There is no reference to support this assumption of the miscellaneous organics composition.

A previous assumption of one percent mercury and one percent lithium in each drum[g] appears to be an overestimation of the regularity of this practice. There is little information to determine the amount of mercury and lithium in the 742 sludge, and any estimate must be based on assumptions; but the evidence available suggests the assumptions made in this report to estimate mercury and lithium content in the 742 sludge more closely represent the actual situation than do earlier assumptions. In addition, the content code of boxes or drums specifically containing mercury waste are not listed in the shipping records and RWMIS for Pit 9.

---

f. Unpublished research results of metal content in the SDA—E. C. Garcia and J. L. Knight, EG&G Idaho, Inc. (January 1989).

g. Unpublished research results of hazardous organic content in the SDA—E. C. Garcia and J. L. Knight, EG&G Idaho, Inc. (January 1989).

Table 5. Estimated number of containers or container volume of waste buried in Pit 9.

Code description	Generator							
	RFPDOW	TAN	TRA	NRF	CPP	CFA	PER	ANL
002 74 series sludge	2106 BLM	—	—	—	—	—	—	—
003 Paper, metal, wood	1512 BLM	—	13 BXC	17 BXC	11 BXC	—	8 BXC	68 BXC
004 Graphite, paper	303 BLM	—	—	—	—	—	—	—
006 Concrete, masonry	—	—	—	137 ft^3	25 BXC	—	—	—
007 RAD waste NOS	—	—	405 ft^3	33 BXC	—	—	—	—
008 Combustibles	—	—	36 BXC	85 BXC	17 BXC	3 BXC	—	—
010 Metal scrap	—	—	120 ft^3	25 BXC 1278 ft^3	11 BXC 450 ft^3	—	—	—
024 Pipe	—	—	1328 ft^3	—	—	—	—	—
026 Wood scrap	96 BXW	—	—	550 ft^3	—	—	—	—
027 Metal comp	—	11881 ft^3	43 BXC 128 ft^3	1338 ft^3	—	90 ft^3	—	—
028 Unirradiated fuel	—	—	—	—	—	—	3 BXC	—
030 S.S. Al	—	—	—	840 ft^3	—	—	—	—
031 Dirt	—	—	—	164 ft^3	576 ft^3	—	—	—
032 Lead	—	—	20 ft^3	—	—	30 ft^3	—	—

Table 5. (continued).

Code description	Generator							
	RFPDOW	TAN	TRA	NRF	CPP	CFA	PER	ANL
035 CWS filters	66 BXC	—	—	—	—	—	—	—
040 Zirconium	—	—	—	—	415 ft^3	—	—	—
043 Filters	1 BXW	—	—	—	—	—	—	—
053 Oil	—	—	—	9 BLM	—	—	—	—
064 Asphalt, gravel	—	—	102 ft^3	—	—	—	—	—
066 Paper, equipment	423 BXW	—	—	—	—	—	—	—
088 Equipment, Scrapmetal	3 BXW	133 ft^3	500 ft^3	—	—	—	—	—
089 Sand	—	480 ft^3	—	—	—	—	—	—
093 RFO empty	1471 BLM/BXC[1]	—	—	—	—	—	—	—

RFPDOW - Rocky Flats Plant
TAN - Test Area North (INEL)
TRA - Test Reactor Area (INEL)
NRF - Naval Reactors Facility (INEL)
BLM - Barrel, metal
BXW - Box, wooden
CPP - Chemical Processing Plant (INEL)
CFA - Central Facilities Area (INEL)
PER - Power Excursion Reactor (INEL)
ANL - Argonne National Laboratory - West (INEL)
BXC - Box, cardboard

a. Code 092, Code 019 and 54 drums of code 002 have been added to the Code 093 total based on corrections to be made to the RWMIS from comparisons with shipping records.

Table 6. Estimated metal content of waste buried in Pit 9.

Content code	Wt% metal[a]	Total mass[b] (kg)	Estimated metal mass (kg)	Estimated metal composition[c]
002	Drums	2,106[d]	48,400	CS (100)
003	Drums	1,512[d]	34,800	CS (100)
—	65	95,000	61,750	SS (50), CS (50)
004	Drums	303[d]	7,000	CS (100)
—	65	27,200	17,700	SS (100)
010	Drums	7[d]	160	CS (100)
—	75	23,900[e]	17,900	SS (75), CS (15), AL (10)
024	100	18,600	18,600	SS (75), CS (25)
027	100	126,600[e]	126,600	CS (100)[f]
030	100	3,600	3,600	SS (85), AL (15)
032	100	3,000[e]	3,000	PB (100)
035	5	100	5	SS (100)
040	100	15,000	15,000	ZR (100)
043	5	300	15	SS (100)
053	Drums	9[d]	200	CS (100)
066	65	420,000	273,000	SS (50), CS (50)
088	100	2,700	2,700	SS (50), CS (50)
093	Drums	1,471[d]	32,000	CS (100)

a. Drums denotes metal drum containers, number is weight percent estimate of all metal inside containers.

b. Estimated container contents determined from shipping records and RWMIS.

c. Composition and weight percent estimates from unpublished research results of metal content in the SDA - E. C. Garcia and J. L. Knight, EG&G Idaho, Inc. (January 1989). CS-carbon steel, SS-stainless steel, AL-aluminum, PB-lead, ZR-zirconium, FE-iron.

d. Total number of drums.

e. Incomplete RWMIS records of shipment weights, mass estimate used from Garcia and Knight.

f. Different assumption than made by Garcia and Knight.

Table 7. Estimated combustibles content of waste buried in Pit 9.

Content code	Wt% Comb.	Total Mass (kg)	Mass of Comb. (kg)
003	35	95,000	33,250
004	35	27,200	9,500
007	100	3,000	3,000
008	100	2,500	2,500
010	Boxes	160	160
026	100	64,200	64,200
—	Boxes	24,000	24,000
027	Boxes	2,200	2,200
043	Boxes	200	200
053	100	1,500	1,500
064	50	3,200	1,600
066	20	420,000	84,000
—	Boxes	85,500	85,500
088	Boxes	1,600	1,600

Table 8. Content estimate of metal and other materials buried in Pit 9.

Metals	Mass (kg)	Volume (ft^3)[a]
Material		
Carbon steel[b]	427,000	—
Stainless steel	217,000	—
Aluminum	2,300	—
Lead	3,000	50
Zirconium and Zr alloy[c]	15,000	415
Noncombustibles	—	—
Asbestos	400[d]	—
Sand	7,700	500
Concrete, masonry	—	450
Total combustibles	315,000	—
Wooden boxes	115,000	—
Paper[d]	—	—
Wood scraps	—	20,000
Rags[d]	—	—
Rubber[d]	—	—
Plastics[d]	—	—
Graphite[d]	—	—
Asphalt	—	100
Oil	—	75
Atypical waste	—	—
Stainless steel vault	—	216
Pickup bed	—	90
PM-2A reactor (sized)	100,000[e]	11,881[f]
Shipping cask	—	324
Stainless storage rack	—	840
Degasifier and piping	—	417[g]
Dirt and metal scrap	11,000	750

a. Total volume of all containers.

b. Metal drums are assumed to be carbon steel. The weight of the drums are included in the total weight estimate.

c. Miscellaneous shapes, sizes (large bars, narrow plates and long strips).

d. Buried in containers with other materials, exact composition of material in containers unknown.

e. Already included in total mass of carbon steel.

f. Twelve separate shipments.

g. Two separate shipments.

Earlier calculations estimating the content composition of the drums and boxes containing different types of materials such as wood, metal, and concrete[h] used data presented elsewhere (Low 1985). The data used were a breakdown of TRU waste composition stored in drums and boxes sent to the INEL and were created from Rocky Flats data based on TRU waste code content shipped to the INEL between 1971 and 1973. These data do not describe the specific contents in the drums and boxes.

An earlier estimate of asbestos[h] calculated the total mass of asbestos in Pit 9 to be 87,500 kg by adding the total mass of wastes identified by seven different content codes (003, 004, 035, 043, 066, 092, and 093). A later reevaluation of these results led to an estimate of 30,500 kg.[i] Content codes 004 and 093 were eliminated from the earlier list, but content codes 006 and 024 were added. The single entry listed in the RWMIS as Content Code 092 was a data entry error.

A reexamination of the content descriptions for content codes 003, 006, 024, and 066 does not indicate the presence of asbestos or asbestos-containing materials. In absence of information to suggest otherwise, it is assumed that concrete and masonry do not contain asbestos. The estimate of 400 kg in this report represents an order-of-magnitude value believed to better represent the actual amount in Pit 9.

The friability of the asbestos is unknown.

Items Not Believed to be in Pit 9

The presence of other items possibly in Pit 9 was investigated. Many of these materials were considered because of information stating these items had been shipped to the SDA. The following items were considered.

Ether - Listed under Content Code 152 (ether, organics, diphenyls). There is no record of any container with Content Code 152 buried in Pit 9.

Gasoline - Listed under Content Code 055 (gasoline tank with gasoline). There is no record of any container with Content Code 055 buried in Pit 9.

Ethylene Glycol - Listed under Content Code 136 (ethylene glycol). There is no record of any container with Content Code 136 buried in Pit 9.

Caustic Compounds (NaOH) - Listed under Content Code 124 (caustic wash solution, with enriched uranium). There is no record of any container with Content Code 124 buried in Pit 9.

Acids (HF, HCl) - Listed under content codes 045 (solidified acids), 073 (U, Zr, HNO_3, HCl, HF - solidified in plaster of paris), 074 (uranium hastelloy N in nitric, hydrochloric, hydrofluoric acid [solidified in calcium sulfate]), 095 (HCl), 135 (empty drum with HNO_3 residue), 148 (lead batteries with acid). There is no record of any container with these content codes buried in Pit 9.

Sodium and Sodium Compounds (excluding $NaNO_3$, NaCl) - Listed under content codes 054 (sodium), 067 (plaster of paris containing Zr, Al, Na, NaCl, NaF, $NaNO_3$), 068 (NaK pipe),

---

h. Unpublished research results of hazardous organic content in the SDA—E. C. Garcia and J. L. Knight, EG&G Idaho, Inc. (January 1989).

i. Unpublished study results of asbestos material in Pit 9—M. J. Vigil, EG&G Idaho, Inc. (August 1989).

147 (irradiated fuel with NaK), and 161 (NaK). There is no record of any container with these content codes buried in Pit 9.

Thallium Oxide - Listed under Content Code 156 (thallium oxide). There is no record of any container with Content Code 156 buried in Pit 9.

TRU-Contaminated Fire Wastes - Listed Content Code 051 (fire waste). There is no record of any container with Content Code 051 being buried in Pit 9. Although Rocky Flats may have been sent fire waste beginning in 1969, no Rocky Flats waste was received and buried in Pit 9 after 1968.

Finally, the possibility of large vehicles being buried in Pit 9 was examined. A review of available records and interviews of present and former employees of the RWMC performed by Mike Vigil and Sandy Jenkins between March and July of 1989 revealed no evidence that entire large vehicles were buried in Pit 9.

REFERENCES

Clements, T. L., 1982, *Content Code Assessments for INEL Contact-Handled Stored Transuranic Wastes*, WM-F1-82-021.

Low, J. O., 1985, *Annual Technology Assessment and Progress Report for the Buried Transuranic Waste Program at the Idaho National Engineering Laboratory*, EGG-2429.

McKinley, K. B., and J. D. McKinney, 1978, *Initial Drum Retrieval Final Report*, TREE-1286.

Vigil, M. J., 1989, *Subsurface Disposal Area (SDA) Waste Identification (1952-1970) Emphasis*, EGG-WM-8727.

Appendix

Calculations

Appendix

Calculations

Containerized Volume Estimates of 74-Series Sludge in Pit 9

Number of 55-gal drums of 74-series sludge in Pit 9 (RWMIS): 2,106

Container volume of sludge drums: 2,106 x 55 gal ≈ 115,800 gal

74-series sludges (55-gal drums only) shipped from Rocky Flats in 1967 and 1968 (Vigil 1989)

	Number of Drums			
Type	1967	1968	Total	Percent of Total
741	1092	802	1894	11
742	1209	1521	2730	16
743	5518	2391	7909	46
744	375	371	746	4
745	1214	2802	4016	23

Total = 17,295 drums

Estimated number of drums of 741 sludge: 0.11 x 2,106 ≈ 232
Estimated number of drums of 742 sludge: 0.16 x 2,106 ≈ 337
Estimated number of drums of 743 sludge: 0.46 x 2,106 ≈ 969
Estimated number of drums of 744 sludge: 0.04 x 2,106 ≈ 84
Estimated number of drums of 745 sludge: 0.23 x 2,106 ≈ 484

Estimated container volume of 741 sludge: 0.11 x 115,800 gal ≈ 12,700 gal
Estimated container volume of 742 sludge: 0.16 x 115,800 gal ≈ 18,500 gal
Estimated container volume of 743 sludge: 0.46 x 115,800 gal ≈ 53,300 gal
Estimated container volume of 744 sludge: 0.04 x 115,800 gal ≈ 4,600 gal
Estimated container volume of 745 sludge: 0.23 x 115,800 gal ≈ 26,600 gal

Estimated 741 sludge volume: 0.8 x 12,700 gal ≈ 10,200 gal
Estimated 742 sludge volume: 0.8 x 18,500 gal ≈ 14,800 gal
Estimated 743 sludge volume: 0.8 x 53,300 gal ≈ 42,600 gal
Estimated 744 sludge volume: 0.8 x 4,600 gal ≈ 3,700 gal
Estimated 745 sludge volume: 0.9 x 26,600 gal ≈ 23,900 gal

Estimate of Organic Content in Sludges in Pit 9

Total organics in 743 sludge: 30 gal organics/drum x 969 drums ≈ 29,100 gal

Organic component fractions:

Texaco Regal oil: 0.47 x 0.6 x 29,100 ≈ 8,200 gal

Carbon tetrachloride: 0.47 x 0.4 x 29,100 ≈ 5,500 gal
Trichloroethane: 0.10 x 29,100 ≈ 2,900 gal
Other miscellaneous organics: 0.43 x 29,100 ≈ 12,500 gal

Total organics in 744 sludge: 26.4 gal/drum x 84 drums ≈ 2,200 gal

Estimate of Inorganic Compounds in Sludges Buried in Pit 9

Estimated mass of Portland cement in 741 drums: 45 lb/drum x 232 drums

≈ 10,400 lb = 4,700 kg

Average 741 drum mass (Clements 1982) = 490 lb ≈ 222 kg
Estimated total 741 drum mass: 222 kg/drum x 232 drums ≈ 51,500 kg
Estimated total mass of empty drums: 23 kg/drum x 232 drums ≈ 5,300 kg
Approximate mass of 741 sludge: 51,500 - 5,300 - 4,700 ≈ 41,500 kg

Some 741 sludge was reported to contain beryllium, up to 1,000 ppm (Clements 1982). This is a maximum value not an average value. It is assumed that the average beryllium concentration in all 741 sludge is 500 ppm.

Estimate of beryllium mass in 741 sludge:

(0.0005 kg Be/kg waste) x 41,500 kg waste ≈ 20 kg

Estimated mass of containerized mercury in 742 sludge (order-of-magnitude):

The placing of batteries and pint bottles of mercury in drums of 742 sludge is suggested as a possible but irregular practice. It is assumed that pint bottles of mercury account for most of the mercury waste. A scenario of 16 pint bottles (2 gal) of mercury placed in the 742 sludge drums is used.

2 gal mercury x (3.785 l/gal) x (13.60 kg/l) ≈ 100 kg mercury

Estimated mass of lithium in batteries in 742 sludge (order-of-magnitude):

It is assumed that nearly pure mercury disposed of in containers represents the significant portion of mercury in any waste stream. The mass of mercury and lithium in batteries represents only a small fraction of the total weight of these wastes. The mass of lithium is assumed to be an order of magnitude less than mercury ≈ 10 kg.

Estimated mass of Portland cement in 742 drums: 45 lb/drum x 337 drums

≈ 15,200 lb = 6,900 kg

Estimated mass of calcium silicate in 743 drums: 100 lb/drum x 969 drums

= 96,900 lb ≈ 44,000 kg

Estimated mass of oil absorbent in 743 drums: 15 lb/drum x 969 drums

≈ 14,500 lb ≈ 6,600 kg

Estimated mass of Portland cement in 744 drums: 200 lb/drum x 84 drums

$$\approx 16{,}800 \text{ lb} \approx 7{,}600 \text{ kg}$$

Estimated mass of magnesia cement in 744 drums: 50 lb/drum x 84 drums

$$= 4{,}200 \text{ lb} \approx 1{,}900 \text{ kg}$$

Estimated mass of sodium nitrate in 745 drums: 0.6 x 23,900 gal ≈ 14,400 gal

Estimated mass of potassium nitrate in 745 drums: 0.3 x 23,900 gal ≈ 7,200 gal

Content Estimate of Metal and Other Materials Buried in Pit 9

The average mass of 74-series drums, AVE, is defined as

$$\text{AVE} = \Sigma f_i M_i$$

where f_i is the fraction of drums containing sludge type i with an average mass of M_i.

Average mass of 74-series sludge (Clements 1982)

741 sludge: 490 lb ≈ 222 kg
742 sludge: 528 lb ≈ 240 kg
743 sludge: 509 lb ≈ 231 kg
744 sludge: 585 lb ≈ 266 kg
745 sludge: 364 lb ≈ 165 kg

AVE = 0.11 (222 kg) + 0.16 (240 kg) + 0.46 (231 kg) + 0.04 (266 kg) + 0.23 (165 kg)
≈ 220 kg

Sample calculation using the average mass of 74-series sludge drum:

A shipment containing 24 drums of paper, wood, etc. (Content Code 003), 52 drums of 74-series sludge (Content Code 002), and 54 cardboard boxes of empty 55-gal drums (Content Code 093). The total shipment weight is listed as 14,410 kg.

Estimated total weight of 74-series drums: 220 kg/drum x 52 drums = 11,440 kg

Estimated total weight of cardboard boxes:

23 kg/drum x 1 drum/box x 54 boxes ≈ 1,240 kg

Estimated total mass of Content Code 003 drums: 14,410 - 11,400 - 1,240 = 1,770 kg

Estimated total mass of contents in 003 drums: 1,770 - 24(23) ≈ 1,220 kg