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Solid Waste Management History of the Hanford Site

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EXECUTIVE SUMMARY

The Hanford Site, a 1,450 km^2 (560 mi^2) tract of land located in semiarid southeastern Washington State, began operations in 1944 as a major site for production of plutonium and other nuclear materials for World War II. Since the initiation of the defense materials production mission, a total of more than 600,000 m^3 (21.2 million ft^3) of solid radioactive wastes have been stored or disposed at Hanford. This includes 595,000 m^3 (21.0 million ft^3) of low-level waste (LLW) and 15,500 m^3 (500,000 ft^3) of transuranic (TRU) waste.

PURPOSE AND APPROACH

The purpose of this report is to summarize and document the management of solid radioactive waste from 1944 to the present. This report includes the following topics:

- The scope of solid waste management practices and the changes in these practices with time
- Waste categorization
- The history of waste management requirements, including waste management laws, policies, and orders
- Waste acceptance criteria
- How different waste types were handled and packaged
- The types of containers used for waste packaging
- Disposal practices, including detailed descriptions of burial and storage facilities
- The various forms of documentation required for solid waste storage or disposal.

Whenever possible, the information in this report has been presented in chronological order to illustrate how management practices have changed through time.

BACKGROUND

The Hanford Site is divided into several distinct "areas." The three primary areas of interest in this study include the 100 Area, where the nuclear reactors are situated; the 200 Areas (200 East and 200 West), where the fuel reprocessing, plutonium recovery, and waste management facilities are located; and the 300 Area, where fuel fabrication took place, but which now houses mostly research and development facilities and administrative offices.

Many contractors have managed the Hanford Site since the Manhattan Engineer District of the Army Corps of Engineers first arrived in the Columbia Basin in 1943. E. I. duPont de Nemours and Company (duPont) was the original contractor selected for the design and operation of all the Hanford nuclear facilities. This role was assumed by General Electric (GE) in 1946 when duPont stepped down from operating the plant. Operations and maintenance of the reactor and fuel manufacturing facilities, waste management and fuel reprocessing facilities, and laboratories and research reactors were managed by GE until 1965. At this time, the company withdrew as the sole operator of the Hanford atomic energy complex in order to permit the diversification of the Tri-City area. Pacific Northwest Laboratory (PNL) took over the laboratories and research reactors division, while Isochem and Douglas United Nuclear managed the remainder of the site. In 1967, the Atlantic Richfield Hanford Company (ARHCO) took over the waste management and fuel reprocessing facilities from Isochem for the next 10 years, until Rockwell Hanford Operations (RHO) took over these operations in 1977. Westinghouse Hanford Company (WHC) was awarded a new contract, which involved the design, construction, and management of the Fast Flux Test Facility (FFTF) in 1970. In 1987, several operating contracts were consolidated into one and WHC assumed the management of the reactors, reprocessing plants, and the FFTF. Concurrently, PNL expanded its management of research and development activities.

CONTENT

Waste management regulations have changed considerably since waste generation began at Hanford. Until 1970, the burial of Hanford solid waste was subject to relatively few restrictions, and both TRU and LLW were disposed in shallow land trenches. In 1970, the Atomic Energy Commission (AEC) issued Immediate Action Directive (IAD) 0511-21 directing AEC sites to segregate "waste with known or detectable contamination of transuranium nuclides" from other waste types (AEC 1970). The AEC further directed that TRU wastes be packaged and stored as contamination-free packages for at least 20 years. Hazardous components of radioactive wastes have been regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA) by the U.S. Environmental Protection Agency (EPA) at U.S. Department of Energy (DOE) sites since 1987. In May of 1989, the Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement (TPA) was signed by the DOE, Richland Operations Office, the EPA, and Washington State Department of Ecology (Ecology et al. 1994). The primary focus of the TPA is to set milestones for achieving a timely cleanup of the Hanford Site in full regulatory compliance.

Over the years, as federal, state, and local regulators passed more stringent regulations for disposal of radioactive and hazardous materials to the environs, the DOE and site management contractors developed an increasing number of specifications and standards for the acceptance of waste for storage and disposal. The procedures for handling, packaging, and disposing radioactive solid wastes were based on these acceptance criteria.

Before the first waste acceptance criteria were released in the late 1960's, early waste management procedures were simple and primarily based on operator safety. Early Hanford procedures define solid radioactive waste as "radioactive waste which is essentially dry, or whose fluids are of small volume and are contained or absorbed to the extent that they are essentially immobile during storage." Since documentation that refers to solid waste is scanty during the early years of Hanford operation, it is assumed that this definition, or one similar, was observed in the 1940's and 1950's. In the mid-1950's, radioactive wastes were classified as either "dry" or "industrial" waste. Dry waste were described as wastes containing little contamination, including absorbent tissues, rubber gloves, wood, metal parts, broken glassware, small tools, and other small miscellaneous items. Industrial wastes consisted of large items or failed equipment.

Waste packaging practices during the 1940's, 1950's, and early 1960's depended primarily on the size and type of waste being packaged, with special consideration given to dangerous or hazardous wastes. Small materials consisting mainly of dry waste were placed in quart-size cardboard containers, which were than placed in larger cardboard cartons for burial. Equipment was buried in wooden boxes when available, and, if a wooden box could not be provided, the equipment was buried without a protective covering. If it was determined that the equipment was too hazardous to bury without confinement, the equipment was wrapped in plastic prior to disposal.

Radioactive solid waste has been disposed by shallow land burial or stored in underground vaults and caissons since 1943. The burial grounds in the 100 Areas began operation in 1944; the burial grounds in the 200 Areas began operation in 1945, and the burial grounds in the 300 Area began operation in 1943. Prior to 1968, all waste buried in the 200 Areas was generated as a result of the fuel reprocessing operations. After 1968, the waste generated by the 300 Area operations was sent to the 200 Areas for burial. Wastes from the reactor operations in the 100 Area have been sent to the 200 Area for burial since 1973.

Since early Hanford operations, waste management personnel have been interested in reducing the volume of solid waste that was generated. As early as the 1940's, studies were conducted to evaluated the feasibility of waste incineration and compaction at Hanford. The first incineration of contaminated solid waste took place during the late 1940's in two burning grounds (trenches) located in the 300 Area. Since that time, combustible wastes were burned in the 100, 200, and 300 Areas, usually within an incinerator, rather than by open-burning. These incinerators were phased out in approximately 1971, when stricter federal air regulations were imposed.

In the late 1960's, the first waste acceptance criteria documents were written for the 200 and 300 Areas. These documents provided specifications and standards for industrial wastes as well as for chemical hazards control with respect to the burial grounds. Waste generators were required to segregate their waste with respect to compatibility and content. During this time, small materials were packaged in fiber drums, liquid wastes were acceptable only if absorbed by an inert absorbent material, and organic matter had to be sealed in plastic and packaged in wooden or metal containers.

The most common method of depositing wastes in trenches during the 1960's was to dump boxes of solid waste directly into the burial trenches. Wood or concrete boxes that contained bulky or highly contaminated materials were dragged from railroad cars into the trench by bulldozers using long cables. Before 1970, the primary concern during burial operations was to assure confinement of contaminated materials during transport, minimization of exposure to operating personnel, confinement of radioactive or chemical materials to prevent releases to the environment, and protection of public health. The packaging of waste materials was designed to maintain safety until the material was securely buried; once buried, the containers were considered permanently disposed. Because of the favorable hydrological conditions, concern was not given to whether the containers remained intact after burial. Until the mid-1970's, there were no requirements for venting burial containers to allow for the release of built up pressure. If waste materials were known to generate gases, they were placed within containers constructed of a material known to collapse under the weight of backfilling. Once the integrity of the container was no longer intact, it was considered vented.

In 1970, a new specifications and standards document, *Specifications and Standards for the Burial of ARHCO Solid Wastes*, ARH-1842 (Hanson and Oberg 1970), was released shortly after the AEC directed the segregation of TRU wastes. This document stated that generators and operators must segregate and package waste materials containing or suspected of containing, plutonium or other TRU radionuclides for containment and retrievability. Beginning in 1970, in addition to fiber drums and metal containers that were used to bury failed equipment, iron drums were used for packaging small materials. Also, separate storage facilities and burial trenches were designed for TRU waste storage.

Solid TRU waste was packaged, stacked, and stored in trenches with gravel, concrete, plywood, or an asphalt pad bottom. The TRU wastes that were unsuitable for drum storage because of size, chemical composition, security requirements, or surface radiation were packaged in reinforced wood, concrete, or metal boxes.

The *Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Waste*, ARH-3032 (Anderson 1974), which was released in 1974, superseded the ARH-1842 document for the 200 and 300 Areas. This document classified wastes into four different segregation groups: nonradioactive, nonhazardous, combustible wastes; low-level, non-TRU (LLW) wastes; TRU wastes; and high-level wastes (HLW). Packages that contained less than 200 counts per minute beta/gama and less than 500 disintegrations per minute alpha contamination were classified as nonradioactive and disposed in the Central Landfill Facility. Solid wastes containing less than 10 nCi/g (3.7×10^5 Bq/g) of plutonium and/or other TRU radionuclides were considered LLW and were further divided into combustible and noncombustible wastes, which were packaged separately.

Solid wastes containing or suspected of containing greater than 10 nCi/g (3.7×10^5 Bq/g) plutonium and/or other TRU radionuclides were considered to be TRU waste. Failed equipment and large items contaminated with TRU radionuclides were also included in this category. For safe storage, TRU wastes were segregated into combustible and noncombustible. Small TRU items were also segregated from larger TRU items or equipment pieces. Small items were stored on asphalt pads, in underground trenches, or in caissons, whereas larger items were stored primarily in trenches. High-level (high-activity) solid wastes were defined as wastes that emitted high levels of beta and gamma radiation. This waste did not contain TRU radionuclides and typically included failed equipment from B Plant, tank farm operations, etc. The operation of high-level (high-activity) waste during this time period is different from the current definition of HLW, which refers to waste resulting from nuclear fuel processing. Small HLW items were transported to the caissons or burial trenches, while large items or failed equipment were buried in the industrial waste trenches.

The five revisions of RHO-MA-222, *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, spanned from 1980 to 1988, and established new definitions for waste classes, placed restrictions on waste contents, provided new specifications for container designs, and included other key elements that directly impacted the waste classification system and segregation requirements. This was the first document that referred specifically to waste classifications, including radioactive solid wastes and TRU solid wastes. Additional requirements mandated segregation of combustible and noncombustible TRU waste. Combustible material was defined as "any material which can be ignited to produce fire through friction, absorption of moisture, spontaneous chemical changes, or application of an external flame." This manual also included the requirement that waste containers be designed to provide the option of a vent or test connection capable of being fitted with or adapted to accept an air or vacuum hose, or gaseous diffusion vent. As of 1980, wood, steel, and/or concrete boxes were used for the burial of process equipment. It was also around 1980 that the U.S. Department of Transportation 17-C 55-gal galvanized drums were declared to be the required packaging for TRU waste. The 17-C and 17-H nongalvanized drums were used for non-TRU waste shipments.

One important change during the early 1980's was the revised AEC definition of TRU waste released in 1982. TRU waste was redefined as waste, without regard to source or form, that was contaminated with alpha-emitting radionuclides of atomic number greater than 92 and half-lives greater than 20 years in concentrations greater than 100 nCi/g (3.7×10^6 Bq/g) at the end of institutional control periods.

The *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, WHC-EP-0063 (Stickney 1988), was released in 1988 and superseded RHO-MA-222. This document required generators to:

- Segregate, to the maximum extent feasible, TRU waste, LLW, mixed radioactive and hazardous waste (MW), chemically incompatible waste, and uncontaminated waste to facilitate cost effective treatment, storage, and disposal.

- Segregate radioactive solid waste recognizing waste minimization practices.
- Segregate TRU, LLW, MW, hazardous, and noncontaminated waste into separate containers.
- Treat mixed TRU waste to destroy or remove and segregate any hazardous waste components, where permitted, feasible, and practical.
- Segregate certified TRU from noncertified TRU waste.
- Segregate low-level mixed waste from TRU mixed waste.

Since 1970, retrievable storage requirements for TRU waste have mandated interim and long-term storage facilities. Beginning in the mid to late 1980's, changes in the management of dangerous or hazardous waste have mandated storage facilities for these wastes as well. Since 1985, nonradioactive hazardous waste was not accepted for burial in the central landfill. This waste was temporarily stored awaiting shipment offsite for treatment and final disposal. Starting in 1987, LLW containing hazardous constituents was segregated and temporarily stored awaiting future treatment before final onsite disposal.

Subsequent revisions of WHC-EP-0063 further developed LLW classifications; expanded the storage and disposal requirements for MW; and added new sections for handling, storing, and disposing nonradioactive hazardous waste and a waste minimization section. They have also provided updated container design specifications, and included other key elements that directly impacted the waste classification system and segregation requirements. The newest revision of WHC-EP-0063 (Willis 1993), released in 1993, defines the current waste acceptance criteria for the Hanford Site. This version contains requirements similar to the previous revisions, as well as a new section defining the waste acceptance criteria for disposal of solid sanitary waste at the central landfill.

CONCLUSION

In conclusion, this report describes the scope of solid waste management practices and the changes in these practices over the past five decades. Ultimately, changes in waste handling, packaging, storage, and disposal influence the manner in which wastes will be retrieved. It is hoped that the information presented in this report will provide the historical background needed for planning the environmental restoration and solid waste remediation activities at Hanford.

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AEA	*Atomic Energy Act of 1954*
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ARHCO	Atlantic Richfield Hanford Company
BCC	Burial Compliance Checksheet
BNW	Battelle Northwest
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
CH	contact-handled
cpm	counts per minute
CWC	Central Waste Complex
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
dpm	disintegrations per minute
DUN	Douglas-United Nuclear Corporation
duPont	E. I. duPont de Nemours and Company
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
FFTF	Fast Flux Test Facility
FRP	fiberglass reinforced polyester
GE	General Electric
HEDL	Hanford Engineering Development Laboratory
HEPA	high-efficiency particulate air (filter)
HEW	Hanford Engineer Works
HLW	high-level waste
HSWA	*Hazardous and Solid Waste Amendments of 1984*
HW	Hanford Works
IAD	Immediate Action Directive
LLBG	low-level burial ground
LLW	low-level waste
MED	Manhattan Engineers District
MW	mixed waste
NDA	nondestructive assay
NMC	Nuclear Material Container
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
PFP	Plutonium Finishing Plant
PIN	package identification number
PNL	Pacific Northwest Laboratory
PUREX	Plutonium-Uranium Extraction (Plant)
PVC	polyvinyl chloride
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (Plant)

LIST OF TERMS (cont.)

RH	remote-handled
RHO	Rockwell Hanford Operations
RL	DOE, Richland Operations Office
RLID	Richland Operations Office Implementing Document
R-SWIMS	Richland - Solid Waste Information Management System
SARA	*Superfund Amendments and Reauthorization Act of 1986*
SARP	safety analysis report for packaging
SDAR	storage/disposal approval record
SWBR	Solid Waste Burial Record
SWDR	Solid Waste Disposal Record
SWITS	Solid Waste Information and Tracking System
SWSDR	Solid Waste Storage/Disposal Record
TPA	*Hanford Federal Facility Agreement and Consent Order of 1989 (Tri-Party Agreement)*
TRU	transuranic
TRUSAF	Transuranic Storage and Assay Facility
TSD	Treatment, Storage, and Disposal (Facility)
UNC	United Nuclear Corporation
UNH	uranyl nitrate hexahydrate
UNI	UNC Nuclear Industries
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WMSCA	Waste Management Safety Committee A
WRAP	Waste Receiving and Packaging Facility

RADIOACTIVE SOLID WASTE MANAGEMENT HISTORY OF THE HANFORD SITE

1.0 INTRODUCTION

1.1 BACKGROUND

The generation of solid waste began coincident with the defense materials production mission which was initiated at the Hanford Site in 1944. Since then, the Hanford Site has been managed and operated by several onsite government contractors. Throughout the years, these contractors developed standards and specifications in the form of Waste Acceptance Criteria for the handling, packaging, storing, and disposing of solid wastes. As federal regulations and requirements evolved, so did the Waste Acceptance Criteria. Ultimately, changes in waste handling, packaging, storage, and disposal influence the manner that waste will be retrieved from the burial grounds.

Between 1944 and 1970, approximately 388,000 m^3 (13,700,000 ft^3) of unsegregated solid wastes were buried at the Hanford Site. Since 1970, over 15,500 m^3 (500,000 ft^3) of transuranic (TRU) wastes have been placed in retrievable storage. To date, a total of over 600,000 m^3 (21 million ft^3) of solid radioactive wastes have been buried or stored at Hanford (Carlson et al., 1994). Table 1-1 provides the volume and status of each type of waste stored or disposed onsite at end of calendar year 1992. This report presents a chronological description of how these wastes have been managed over the past five decades.

1.2 PURPOSE

The purpose of this report is to summarize and document the history of solid waste management at the Hanford Site from 1944 to the present. This report describes the scope of solid waste management practices and the changes in these practices with time, a detailed review of how different waste types were handled and packaged, and the types of containers used for waste packaging and disposal practices. The historical procedures for handling, packaging, and disposing of solid waste were based on the Hanford Site Waste Acceptance Criteria and various facility-specific waste handling procedures. The federal and state regulations upon which the site-wide and facility-specific criteria were based are also discussed. It is hoped that the information presented here will provide the historical background needed for planning the environmental restoration and remediation activities that deal with solid wastes.

1.3 APPROACH

This history of solid waste management at the Hanford Site spans the time period from 1944 to the present. In some instances the date when a given practice was actually implemented is unknown; in such instances the time period identified is taken from the publication date of the source document.

Table 1-1. Volume of Waste Disposed or Stored Onsite at the End of Calendar Year 1992 (Carlson et al. 1994).

Waste class	Total volume (m^3)	Status
LLW	595,000	Disposed in burial grounds.
LLMW	3,400	Temporarily stored in aboveground buildings.
TRU		
CH	15,500	Retrievably stored in trenches and aboveground buildings.
RH	200	Retrievably stored in two trenches and five caissons.
TRU MW	190*	Stored in the Central Waste Complex and retrievably stored in trenches. (All TRU MW storage facilities are RCRA facilities.)
Nonradioactive hazardous	N/A	Accumulated at the source of generation until shipped offsite for treatment and disposal.

*This volume is already in the total volume of TRU waste (CH and RH).
CH = contact-handled.
LLW = low-level waste.
LLMW = low-level mixed waste.
MW = mixed waste.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RH = remote-handled.
TRU = transuranic.

When possible, the information in this report appears in chronological order to illustrate how waste management practices have changed through time. In addition, the waste handling, packaging, and burial practices are presented, whenever possible, by waste class or waste types.

1.4 LIMITATIONS

The following limitations are found in this report:

- The information presented in this report relies on the accuracy and detail of available historical documents.

- The material presented should not be considered totally inclusive. Considerably more documentation is available on the handling, packaging, and disposal of solid waste after 1970 than is available for the period before 1970. There are several fundamental reasons for this. First, most of the work done at Hanford prior to 1970 involved the chemical reprocessing of spent fuel for the production of plutonium, and the crucial disposal issues were focused on liquid, rather than solid, waste. Second, the increased awareness of environmental impacts that began in 1970's led to a greater concern for the documentation of solid waste disposal. Finally, many of the reports from the early plutonium production period are still classified. With the current declassification process, more solid waste information is expected to be made available in the near future.

1.5 SCOPE

The organization of this document follows:

- Section 2.0 provides a brief overview of the generation of the waste stored or disposed of at the Hanford Site, including site management by government oversight agencies and site management contractors; onsite waste generators; and offsite waste generators.
- Section 3.0 summarizes the categorization of solid waste at the Hanford Site.
- Section 4.0 provides a brief history of the waste management requirements that affected the Hanford Site, including state and federal laws and policies, and U.S. Department of Energy (DOE) orders. This section also covers the Hanford Waste Acceptance Criteria that arose from these requirements and the significant changes in the waste acceptance criteria.
- Section 5.0 describes waste handling and packaging procedures including general packaging requirements, special packaging procedures, and waste minimization practices and facilities.
- A description of the waste containers used at the Hanford Site is provided in Section 6.0. Subsections describe container design specifications, labeling requirements, and container types.
- Section 7.0 provides a description of burial ground opening and planning procedures; solid waste storage; disposal, and waste management facilities; and burial site deactivation procedures.
- Section 8.0 discusses solid waste databases, solid waste burial records, and the solid waste forecast.
- Section 9.0 lists the references used in writing this report.
- Appendix A is a list of drawing numbers and titles for approved packaging, transportation, and burial/storage containers at the Hanford Site.
- Appendix B provides the specifications for approved burial containers.
- Appendix C lists the drawing numbers for storage and burial facilities.

1.6 FOLLOW-ON ACTIVITIES

This document provides an overview of solid waste generation, storage, handling, and disposal at the Hanford Site. Based on available historical documents and personal interviews, it is intended to be used as a tool to facilitate future retrieval and closure activities by the Solid Waste Program at Hanford.

It is expected that this document will be a living document. Updates will include major modifications of current practices as well as relevant information obtained from the many classified and declassified historical documents that are scheduled to be reviewed for changes in classification status.

2.0 HANFORD SITE HISTORICAL OVERVIEW

2.1 SITE LOCATION

The DOE's Hanford Site occupies a 1,450 km^2 (560 mi^2) tract of arid steppe in the southeastern part of Washington State, approximately 72.4 km (45 mi) north of the Oregon border (Figure 2-1). The site is bounded on the north and east by the Columbia River and on the south edge by the Yakima River (Figure 2-2).

2.2 SITE MANAGEMENT

The history of the Hanford Site is complicated by the large number of contractors that have operated the site. Table 2-1 provides a list of the major contractors and the time period during which each contractor operated. This list includes only the contractors who managed the operations of Hanford nuclear facilities and does not include construction or service contractors. The table is divided into three columns that represent the three traditional operations: reactors, reprocessing, and laboratories. For the purpose of reading this table, reactor facility operation includes fuel manufacturing, and fuel reprocessing includes waste management.

In 1943, the Manhattan Engineer District (MED) of the Army Corps of Engineers arrived in the Columbia Basin to begin building the Hanford plutonium production complex (Gerber 1992a). E. I. duPont de Nemours and Company (duPont) was the original contractor for the design and operation of all the Hanford nuclear facilities. In 1946, General Electric (GE) assumed responsibility for operating the plant when duPont left (PNL 1977). On January 1, 1947, the U.S. Atomic Energy Commission (AEC) took over the government oversight responsibilities from the MED. The AEC simplified the name Hanford Engineer Works (HEW) to the Hanford Works (HW) (Gerber 1992a).

In February of 1964, GE announced its intention to withdraw in 1965 as the sole operator of the Hanford atomic energy complex in order to permit the diversification of the Tri-City area, which was greatly dependent on a government payroll. By splitting the Hanford plant into segments and requiring each of the several new contractors to provide a significant investment in the area, the AEC was able to stimulate the investment of capital by private industry in the Tri-City area (Godfrey 1966). GE was replaced in 1965 by a number of contractors responsible for different aspects of plant operation.

Isochem, Incorporated was formed to operate the chemical processing facilities in the expectation that a commercial market for radioisotopes would develop (DOE 1991). Specifically, Isochem was responsible for the separation and purification of the uranium and plutonium discharged by the Hanford reactors, as well as the management of the resulting waste (Godfrey 1966). When the expectation of a commercial market for radioisotopes did not materialize, Isochem withdrew and Atlantic Richfield Hanford Company (ARHCO) assumed management of the chemical operations (DOE 1991).

Figure 2-1. Location of the Hanford Site in Washington State.

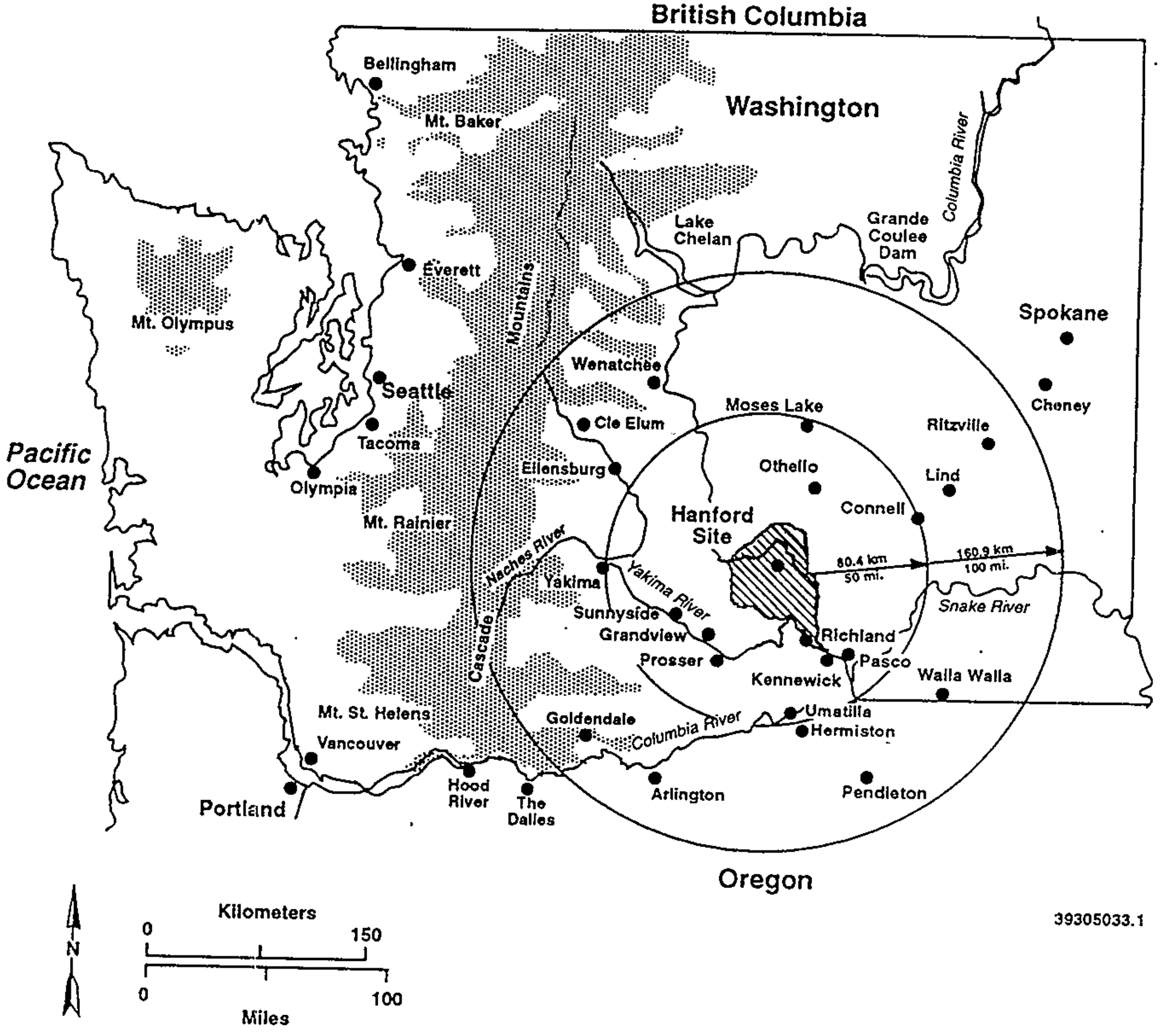

Figure 2-2. Map of the Hanford Site.

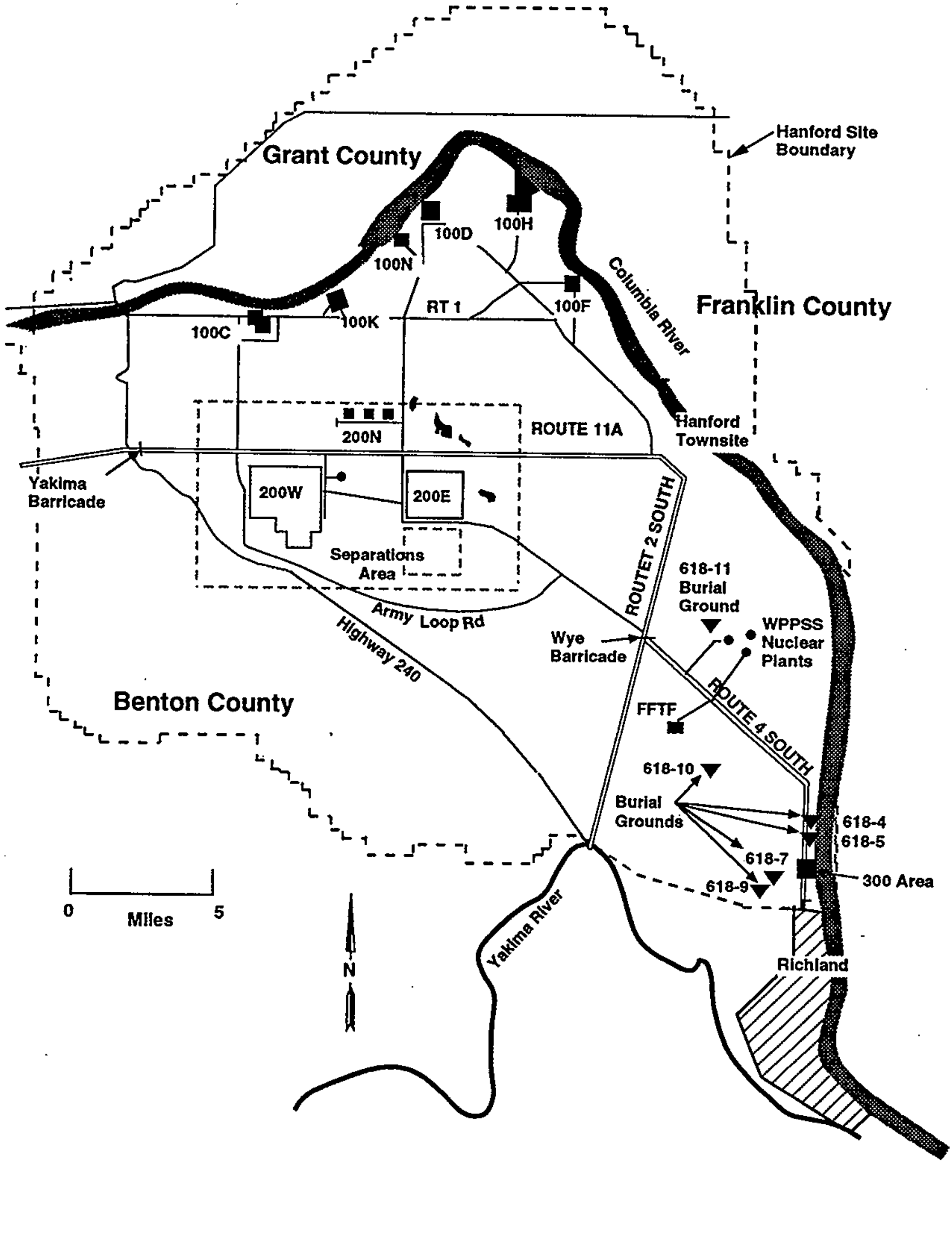

Table 2-1. Hanford Facility Operating Contractors (DOE 1991).

Contractor	Reactors	Waste Management/ reprocessing	Laboratories/ research reactors	Operating period
duPont	x	x	x	01/43 - 09/46
General Electric	x	x	x	09/46 - 11/65
Pacific Northwest Laboratory	--	--	x	01/65 - present
Isochem	--	x	--	12/65 - 09/67
Douglas United Nuclear	x	--	--	11/65 - 04/73
Atlantic Richfield Hanford Company	--	x	--	09/67 - 06/77
UNC Nuclear Industries[a]	x	--	--	09/73 - 06/87
Westinghouse Hanford Company-HEDL[b]	--	--	x	07/70 - 06/87
Rockwell Hanford Company	--	x	--	06/77 - 06/87
Westinghouse Hanford Company	x	x	x	08/87 - present

[a]United Nuclear Corporation (UNC).
[b]Hanford Engineering Development Laboratory (HEDL).

Douglas-United Nuclear Corporation (DUN) was also formed in 1965 as a joint venture between Douglas Aircraft Corporation and United Nuclear Corporation (UNC) to take over management of the production reactor operations. This transfer was accomplished in two phases, with GE retaining control over the operation of N Reactor until its power generation capability became operational in 1967. At that time, GE terminated its 21 years of Hanford operation. UNC acquired Douglas' interest in DUN in 1973, changing the name of the entity to UNC Nuclear Industries (UNI) (DOE 1991).

In January 1965, Battelle Memorial Institute assumed responsibility for management of the Hanford Laboratories, a research and development facility involved in a wide variety of physical and biological sciences programs, which had been operated by GE. Battelle Northwest (BNW) Laboratories were later renamed Pacific Northwest Laboratory (PNL) (DOE 1991).

ARHCO, a wholly owned subsidiary of the Atlantic Richfield Company, took over the management of the Nuclear Fuels Reprocessing Division at the AEC's Hanford Plant from Isochem in September 1967. In obtaining this contract, Atlantic Richfield promised to attempt to improve the industrial base of the area by investing in nonnuclear industry (ARHCO 1973). ARHCO was the prime contractor responsible for fuel reprocessing, plutonium production, radioactive waste management, and site supportive services. Beginning in July 1977, Rockwell Hanford Operations (RHO) took over these operations (PNL 1977).

A new activity was added in 1970, with the award of a contract to Westinghouse Electric to design and manage the Fast Flux Test Facility (FFTF) operations and its associated research and development laboratories, the Hanford Engineering Development Laboratory (HEDL) (PNL 1977).

In 1976, the Carter administration expanded the focus of the AEC to include the research and development of additional energy sources. This resulted in the AEC being rolled into the Energy Research and Development Administration (ERDA). The ERDA was brought up to cabinet level when the Reagan administration took over in 1980; at that time ERDA was renamed the U.S. Department of Energy (DOE).

Several operating contracts at Hanford were consolidated in 1987, and Westinghouse Hanford Company (WHC) assumed management of the reactors, reprocessing plants, and the FFTF. Concurrently, Battelle expanded its management of research and development activities (DOE 1991). These contractors are currently responsible for the management and operation of the Hanford Site for DOE.

A timeline of the above mentioned Hanford Site Management Contractors and Government Oversight Agencies is provided in Table 2-2.

2.3 ONSITE WASTE GENERATORS

Most of the solid waste generated at Hanford resulted from the production of defense related materials. This section describes the predominant waste generating facilities onsite, including the time periods during which the plants operated and the missions that they supported (PNL 1977).

Actual construction of the reactor facilities at Hanford began in March 1943. The first reactor began operating within 18 months and plutonium was available four months after startup. Reactors 100-B, 100-D, and 100-F were completed by the end of 1944. The addition of six more reactors (H, C, DR, KE, KW, and N) between 1948 and 1963 greatly expanded production capacities. In 1964, a Presidential decision was made to begin closing down the older reactors. Between 1964 and 1971, the eight single pass reactors were shut down. That left only the N Reactor operating until it was placed in "cold standby" in March 1987 and subsequently shut down.

Construction of the original three fuel separation plants (T Plant, B Plant, and U Plant) also began in 1943. All three plants were designed to use a bismuth-phosphate method to process irradiated fuels, although U Plant never used this process. In the bismuth-phosphate process, irradiated fuel was dissolved in sodium hydroxide to remove the cladding. Decladded uranium slugs were then dissolved in a solution of nitric acid and sodium nitrate. Upon the addition of bismuth nitrate and phosphoric acid, plutonium was removed from the solution by co-precipitation with the solid bismuth phosphate.

Table 2-2. A Timeline of Hanford Site Management Contractors and Government Oversight Agencies.

Government oversight agencies	Date	Site management contractors
MED of the Army Corps of Engineers was formed	1942	--
MED arrived in Columbia Basin	1943	--
	1943-1946	E. I. duPont de Nemours and Company (duPont), prime industrial contractor for the Hanford Project.
	1946-1965	General Electric (GE) relieved duPont as the prime contractor.
U.S. Atomic Energy Commission took over from MED	1947	--
	1965-present	Battelle Memorial Institute, later renamed Pacific Northwest Laboratory assumed responsibility for management of the Hanford Laboratories.
	1965	Various contractors replace GE.
	1965-1967	Isochem, Inc. operated the chemical facilities to separate and purify uranium and plutonium and manage the resulting waste.
	1965-1973	Douglas United Nuclear.
	1967-1977	Atlantic Richfield Hanford Company.
	1970-1987	Westinghouse Hanford Company (WHC) operated the Hanford Engineering Development Laboratory and the Fast Flux Test Facility.
	1973-1987	UNC Industries responsible for N Reactor and associated nuclear fuel fabrication facilities.
Energy Research and Development Administration	1976	--
	1977-1987	Rockwell Hanford Operations responsible for fuel reprocessing, plutonium production, radioactive waste management and site supportive services.
U.S. Department of Energy	1980	--
	1987-present	WHC assumed additional management of operations.

Completed in 1944, T Plant operated using the bismuth phosphate process until it was decommissioned in 1956. The T Plant is unique among most of the DOE facilities; it is currently used for decontamination and repair of major equipment from other Hanford facilities. T Plant is a key facility in the decontamination and decommissioning (D&D) activities that are part of the overall cleanup of the Hanford Site.

Completed in 1945, B Plant operated until 1952 using the bismuth phosphate process. In 1968, it was converted to a waste fractionization plant. This campaign lasted from 1968 to 1985 and involved the recovery of ^{137}Cs and ^{90}Sr from high-level liquid wastes for encapsulation and storage. The strontium and cesium were converted to solid strontium fluoride and cesium chloride which were then doubly encapsulated in metal cylinders and placed in retrievable water-cooled storage (PNL 1977). A subsequent and final campaign involved 38,000 L of neutralized current acid waste from double-shelled tank 101-AZ. Waste from this campaign still remains in the tanks in B Plant, but will be removed prior to D&D. Currently, B Plant stores chemicals used to treat low-level waste (LLW) generated at the B Plant and the Waste Encapsulation and Storage Facility. It is used for the generation of demineralized water and for the conditioning of water used in heating, ventilation, and air conditioning units (Gehrke 1992).

U Plant was also designed to use the bismuth phosphate process, but was never used for that purpose. After startup of the Reduction-Oxidation (REDOX) Plant, U Plant was converted to recover uranium from stored radioactive wastes. From 1952 until 1958, wastes were mined from storage tanks for uranium recovery at U Plant. The adjacent uranium oxide plant made powdered uranium oxide by calcining uranyl nitrate hexahydrate (UNH) solutions from the Plutonium-Uranium Extraction (PUREX) Plant for offsite shipment (PNL 1977). Since the shutdown of U Plant, the plant has been used to store deactivated equipment.

The REDOX Plant (202-S Building and supporting facilities) was completed in 1951. It was a second generation processing plant designed around a solvent-extraction fuel separation process. REDOX operated from 1952 to 1967. The REDOX process for fuel separation succeeded the bismuth phosphate process and preceded the PUREX process (PNL 1977). The building still contains all of the original process equipment that was used for dissolution, separation, and decontamination of uranium, plutonium, and neptunium, as well as equipment used for support processes. Currently, the facility is considered to be retired (Baxter 1990).

The PUREX Plant, completed in 1955, eventually took over the fuel separation operations from the REDOX Plant. When operating, the plant processed irradiated uranium fuels from N Reactor to recover plutonium, neptunium, and uranium. The plutonium nitrate production solution was transferred to Z Plant for further treatment. The uranium product, UNH, was transferred to U Plant for conversion to uranium oxide (PNL 1977). In February 1991, PUREX Plant operations were terminated by the DOE, and an official deactivation notice was issued in December 1992.

The Plutonium Finishing Plant (PFP) or Z Plant, as it is commonly known, was completed in 1949. When Z Plant operations began in 1951, its historic mission was to process plutonium-based chemical solutions and convert them into metal and oxide, which were shipped offsite to be used in the nation's weapons program. The plutonium nitrate product from scrap processing and from PUREX was converted to either plutonium oxide or metal buttons. The recovered americium was sold for commercial purposes (PNL 1977). In 1989, the PFP production processes were placed on standby.

In addition to the facilities described above, there have been over 244 additional onsite waste generating facilities at Hanford. Table 2-3 lists these generators by the contractors that was or is now responsible for the facility (Genoni 1991).

2.4 OFFSITE WASTE GENERATORS

In addition to the onsite waste generators discussed in the previous section, Hanford has received wastes for disposal/storage from numerous offsite generators.

Guidance for the packaging and shipping of waste was provided to offsite generators with the release of *Packaging and Shipping Requirements of Radioactive Waste Materials of Rockwell Hanford Operations for Offsite Customers*, RHO-LD-64, in 1978 (Anderson 1978). Prior to the delivery of any offsite waste, an agreement had to be executed between the DOE, Richland Operations Office (RL) and the shipper. This agreement identified the acceptable containers and the requirements for packaging, labeling, documentation, material accountability, and transportation.

The three largest offsite TRU solid waste generators, in terms of volume of waste, are:

- Babcock and Wilcox, Leechburg, Pennsylvania
- G.E. Vallecitos Nuclear Center, Pleasanton, California
- Westinghouse Advanced Reactors and Nuclear Fuels Divisions, Cheswick, Pennsylvania.

The wastes generated by these facilities have been characterized in great detail in the following reports:

- *Radioactive Waste Shipments to Hanford Retrievable Storage from Babcock and Wilcox, Leechburg, Pennsylvania*, WHC-EP-0719 (Duncan 1994).
- *Radioactive Waste Shipments to Hanford Retrievable Storage from the G.E. Vallecitos Nuclear Center, Pleasanton, California*, WHC-EP-0672 (Vejvoda et al. 1993).
- *Radioactive Waste Shipments to Hanford Retrievable Storage from Westinghouse Advanced Reactors and Nuclear Fuels Divisions, Cheswick, Pennsylvania*, WHC-EP-0718 (Duncan et al. 1994b).

Table 2-3. Onsite Waste Generators.

Generator	Facility
Hanford Environmental Health Foundation	EDF, 747
J.A. Jones	200E, 200R, 200W
Kaiser Engineering Hanford	100, 200E, 200W, 300
Pacific Northwest Laboratory	EDC, EDF, ISV, LSLII, OSB, RTL, 100D, 108F, 116B, 1171, 1234, 141F, 144F, 1705F, 1706K, 1717K, 189D, 189F, 190D, 209E, 221T, 221T, 222U, 231Z, 242B, 271CR, 271U, 2718E, 292T, 300A, 300N, 3000, 303C, 305, 305B, 306, 306W, 308, 309, 314, 318, 320, 323, 324, 325, 325A, 325B, 326, 327, 327C, 329, 331, 340, 3706, 3708, 3720, 3730, 3745, 3746, 377, 6652, 6652H, 6652I, 6652J, 748
Westinghouse Hanford Company	200E, 200W, BG002, BG005, BG02A, BG03A, BG04A, BG12B, BG3AE, CRBBC, CRB57, Central Waste Complex, ENRES, ENSUR, MASF, PRTR, U216E, U216W, WADCO, 100B, 100C, 100D, 100F, 100H, 100K, 100KE, 100N, 105B , 105C, 105D, 105DR, 105F, 105H, 105KE, 105KW, 105N, 108B, 108F, 109H, 1100, 111B, 1120N, 115D, 1166, 1167B, 117D, 1171, 1310P, 1314N, 1322A, 141C, 141F, 153ER, 1608D, 1608F, 1608H, 163N , 163PA, 1703D, 1720K, 183H , 183KE, 189D, 189F, 190C, 190D, 2EBG, 2ETF, 2WBG, 2WTF, 200W, 201C, 202A, 202AL, 202S, 204AR, 204T, 207A, 207U, 2101M, 211S, 211U, 212R, 213W, 216A, 216B, 216C, 216S, 216Z9, 221B, 221T, 221TS, 221U, 222S, 222SP, 222T, 222U, 224T, 224U, 225B, 231Z, 233S, 2345Z, 241A, 241AN, 241AP, 241AW, 241AX, 241AY, 241AZ, 241B, 241BX, 241BY, 241C, 241S, 241SX, 241TX, 242A, 242S, 244A, 244AR, 244BX, 2703E, 2704W, 2704Z, 2706T, 2709W, 271B, 271C, 271CR, 271T, 271U, 2711E, 2713W, 272AW, 272W, 272WA, 2723W, 2724W, 2727S, 2727W, 274W, 275W, 276S, 277W, 284E, 284W, 291S, 292U, 300, 305, 308, 309, 313, 324, 325, 325B, 327C, 333, 340, 3707B, 3708, 377, 405, 437, 4710, 501A, 600, 702A

The Solid Waste Information Tracking System (SWITS) database indicates that 47 generators have sent waste to the Hanford Site since 1970. Table 2-4 provides a list of the generators, their locations, the years they shipped waste, and the total number of containers that were sent. Nine of the 48 generators shipped over 75% of the containers; the generators are:

- Battelle Columbus
- Babcock and Wilcox
- Dow Chemical-Rocky Flats
- Fermi National Accelerator Laboratories
- University of California, Lawrence Berkeley Laboratories
- Rocketdyne (RKD)
- Shippingport, Pennsylvania
- Westinghouse Advanced Reactors Division
- Woodriver.

Table 2-4. Offsite Waste Generators. (3 sheets)

Generator	Location	Years	Total containers
Atomic International	Canoga Park, CA	1978	293
AI Research	Torrence, CA	1986-1987	57
Bechtel National	Albany, OR	1987-1988	692
Ames Laboratory	Ames, IA	1980-1988	630
Argonne National Laboratory	Argonne, IL	1974-1987	391
Bettis Atomic Power Laboratory	West Mifflin, PA	1987-1988	61
Bartlesville Energy Technology Center	Bartlesville, OK	1981	69
Battelle Columbus	W. Jefferson, OH	1976-1988	2,559
Bettis Naval	West Mifflin, PA	1978-1986	177
Brookhaven National Laboratory	Upton, NY	1983-1988	629
Bonneville Power	Portland, OR	1988	1
FUSRAP	Beverly, MA	1988	106
Babcock and Wilcox	Apollo, PA	1981-1983	1,173
Ceer University Labs	Mayaguez, Puerto Rico	1987	156
Chicago National Guard	Chicago, IL	1987	32
Chem Nuclear Systems	Richland, WA	1981	1
Ventron Bechtel Facility	Colony, NY	1988	1
Dow Chemical (Rocky Flats)	Golden, CO	1968-1974	1,005

Table 2-4. Offsite Waste Generators. (3 sheets)

Generator	Location	Years	Total containers
Exxon Nuclear System	Richland, WA	1980-1982	203
Fermi National Accelerator Labs	Batavia, IL	1980-1988	3,062
General Electric	Vallecitos, CA	1974-1983	256
General Electric	San Jose, CA	1975	16
International Atomic Energy Agency	Seibersdorf, Austria	1986	1
Idaho National Engineering Laboratory	Idaho Falls, ID	1978	15
General Electric Knolls Atomic Power Laboratory	Schenectady, NY	1986	175
Kaiser Engineers	Richland, WA	1987-1988	105
Kerr McGee	Crescent, OK	1983-1987	122
Kaman Sciences Corporation	Colorado Springs, CO	1977	17
University of California Lawrence Berkeley Labs	Berkeley, CA	1974-1988	1,472
Lawrence Livermore Labs	Livermore, CA	1968-1978	374
Morgantown Energy Technology	Morgantown, WV	1981	3
Puget Sound Naval Shipyard	Bremerton, WA	1984-1988	5
Mare Island Navy	Vallejo, CA	1987-1988	10
Naval Aviation Center	Indianapolis, IN	1980	1
Naval Energy/Environment	Port Hueneme, CA	1983	1
Pearl Harbor Naval Shipyards	Pearl Harbor, HA	1985-1988	6
Princeton Laboratory	Princeton, NJ	1988	4
Quadrex HPS	Oakridge, TN	1987	13
Rocketdyne	Canoga Park, CA	1980-1988	3,264
Rocky Flats Facility	Golden, CO	1976-1984	785
Special Air Force	N/A	1968	38
Shippingport	Shippingport, PA	1986-1988	2,742
Three Mile Island	Middletown, PA	1983-1985	16
TRW Incorporated	Redmond Beach, CA	1984-1988	295

Table 2-4. Offsite Waste Generators. (3 sheets)

Generator	Location	Years	Total containers
University of Utah	Salt Lake, UT	1983-1986	18
University of Washington	Seattle, WA	1984	1
Westinghouse Advanced Reactor Division	Cheswick, PA	1980-1984	1,245
Woodriver	Charleston, RI	1987-1988	3,247
Total			22,281

3.0 CATEGORIZATION OF SOLID WASTE

The production processes and operations at Hanford as well as other offsite locations generated a variety of solid wastes. Currently, solid waste is defined by the Westinghouse Solid Waste Program as:

> "*any discarded solid, semi-solid, or solidified liquid material such as garbage, refuse, sludge, or discarded commodity resulting from industrial, commercial, mining, agricultural, or community operations or activities that is not a primary product of such operations or activities*" (Carlson et al. 1994).

This definition includes solid materials, containerized liquid or semi-solid materials, and containerized gaseous materials in drums, boxes, or other containers.

Hanford wastes fit into five basic categories: sanitary waste, dangerous or hazardous waste, radioactive waste, mixed radioactive and hazardous waste (MW), and classified waste. A general description of each category is presented below.

3.1 SANITARY WASTE (GARBAGE)

Sanitary waste is comprised of discarded material that is not radioactive, or regulated by Washington Administrative Code (WAC) 173-303. This waste is outside the scope of the Solid Waste Program; however, it is addressed in this document, as appropriate, for clarification.

Sanitary waste was routinely buried in the central landfill located on the Hanford Site. The wastes generated by facilities located within the Richland City limits are transported to the Richland City Landfill. Former Hanford personnel indicated that early practices could have included burning this type of waste and burying the ash separately from radioactive solid waste.

3.2 DANGEROUS OR HAZARDOUS WASTE

Dangerous or hazardous waste is defined as nonradioactive waste that is contaminated with dangerous constituents as defined in WAC 173-303. The State of Washington is authorized by the U.S. Environmental Protection Agency (EPA) to administer the dangerous waste program and regulate dangerous and hazardous waste at the Hanford Site.

Since 1985, all dangerous or hazardous waste has been shipped offsite for treatment and final disposal. Before that time, it was buried in the central landfill or in area waste burial grounds.

3.3 RADIOACTIVE SOLID WASTE

Radioactive waste is defined as solid, liquid, or gaseous material that contains regulated radionuclides and is of negligible economic value considering the cost of recovery (Willis 1993). It includes LLW, TRU waste, and high-level waste (HLW).

All packages of LLW and TRU solid waste are further divided according to the surface dose rate of beta, gamma, and neutron radiation. These categories are contact-handled (CH) and remote-handled (RH) (Carlson et al. 1994). CH waste packages have a surface dose rate of 200 mrem/hour (2 mSv/hour) or less at any point on the surface. Waste packages above this surface dose rate are considered RH (Willis 1993).

3.3.1 Low-Level Waste

Low-level solid waste has small amounts of radioactivity [<100 nCi/g (<3.7×10^{6} Bq/g)] from TRU elements and is not HLW, spent nuclear fuel, or by-product material. At Hanford, LLW is further classified according to the concentration of specific radionuclides into Category 1, Category 3, and Greater Than Category 3. This system is similar to the U.S. Nuclear Regulatory Commission (NRC) waste classification system found in Title 10 of the Code of Federal Regulations (CFR), Part 61. The Hanford LLW categorization has been adapted to fit isotopic and volume characteristics of Hanford waste. Higher category numbers reflect higher concentrations of radionuclides with greater activities and longer half-lives in the waste. Disposal requirements are more stringent for higher LLW categories. It should be noted that Hanford does not designate any waste as Category 2. Small volumes of Category 2 waste at the Hanford Site led to an extension of the activity limits for Category 3 to envelope Category 2 waste (Carlson et al. 1994). Category 1 and 3 activity limits for disposal are shown in Table 3-1.

Historically, LLW disposal did not depend on radionuclide concentration. Waste that was not classified as TRU waste or HLW was considered dry or industrial radioactive waste, and handling and disposal depended primarily on size and/or surface contamination and dose rate.

3.3.2 Transuranic Waste

Transuranic waste is defined as "waste which, without regard to source or form, is contaminated with alpha-emitting transuranium radionuclides having atomic number greater than 92 with half-lives greater than 20 years, or ^{226}Ra or ^{233}U in concentrations greater than 100 nCi/g (3.7×10^{6} Bq/g) of waste matrix in any single waste package" (Willis 1993).

The definition of TRU waste has evolved since it originated in 1970. The first TRU waste designations were based on process knowledge rather than concentration limits. In 1973, TRU waste was defined as material contaminated with certain alpha-emitting radionuclides with half-lives greater than 20 years, and activity greater than 10 nCi/g (3.7×10^{5} Bq/g). The concentration limits were raised to 100 nCi/g (3.7×10^{6} Bq/g) in 1982.

Table 3-1. Category 1 and 3 Activity Limits for Disposal.
(3 sheets)

Nuclide	Activity Limits (Ci/m^{3})	
	Category 1	Category 3[a]
^{3}H	5.0 E+06	--
^{10}Be	1.0 E+00	2.2 E+02
^{14}C	4.0 E-02	9.1 E+00
^{14}C[b]	4.0 E-01	9.1 E+01
^{36}Cl	4.0 E-04	8.3 E-02
^{40}K	1.7 E-03	3.4 E-01
^{60}Co	7.7 E+01	--
^{59}Ni	4.0 E+00	8.3 E+02
^{59}Ni[b]	4.0 E+01	8.3 E+03
^{63}Ni	4.8 E+00	1.7 E+04
^{63}Ni[b]	4.8 E+01	1.7 E+05
^{79}Se	3.8 E+01	8.3 E+01
^{90}Sr	4.3 E-03	1.5 E+04
^{93}Zr	2.7 E+00	5.9 E+02
^{94}Nb	2.6 E-04	5.6 E-02
^{94}Nb[b]	2.6 E-03	5.6 E-01
^{93}Mo	3.0 E-01	7.1 E+01
^{98}Tc	5.6 E-03	1.2 E+00
^{99}Tc	5.6 E-03	1.2 E+00
^{107}Pd	4.8 E+00	1.0 E+03
^{113m}Cd	2.0 E-01	--
^{121m}Sn	6.3 E+00	2.0 E+05
^{126}Sn	1.8 E-04	--
^{129}I	2.9 E-03	5.9 E-01
^{133}B	7.7 E-01	--
^{135}Cs	1.9 E-01	4.2 E+01
^{137}Cs	6.3 E-03	1.3 E+04
^{147}Sm	1.6 E-02	3.4 E+00

Table 3-1. Category 1 and 3 Activity Limits for Disposal. (3 sheets)

Nuclide	Activity Limits (Ci/m^3)	
	Category 1	Category 3[a]
^{151}Sm	3.8 E+01	1.8 E+05
^{150}Eu	1.6 E-03	7.7 E+02
^{152}Eu	8.3 E-01	--
^{152}Gd	6.3 E-03	1.3 E+00
^{187}Re	5.3 E+00	1.1 E+03
^{209}Po	2.9 E-02	7.7 E+01
^{210}Pb	1.0 E-02	5.6 E+05
^{226}Ra	1.4 E-04	3.6 E-02
^{228}Ra	1.9 E+01	--
^{227}Ac	4.5 E-03	3.2 E+05
^{229}Th	4.8 E-04	1.1 E-01
^{230}Th	2.1 E-03	1.3 E-01
^{232}Th	1.2 E-04	2.2 E-02
^{231}Pa	1.6 E-04	3.3 E-02
^{232}U	5.3 E-04	4.0 E+00
^{232}U[c]	7.7 E-03	1.1 E+00
^{234}U	9.1 E-03	2.1 E+00
^{235}U	3.2 E-03	5.9 E-01
^{236}U	1.0 E-02	2.2 E+00
^{238}U	6.3 E-03	1.4 E+00
^{237}Np[c]	1.9 E-04	4.0 E-02
^{238}Pu[c]	9.1 E-03	4.5 E+01
^{239}Pu[c]	3.6 E-03	7.7 E-01
^{240}Pu[c]	3.6 E-03	7.7 E-01
^{241}Pu[c]	7.7 E-02	3.1 E+01
^{242}Pu[b]	3.8 E-03	8.3 E-01
^{244}Pu[c]	8.3 E-04	1.7 E-01
^{241}Am[c]	2.6 E-03	1.1 E+00

Table 3-1. Category 1 and 3 Activity Limits for Disposal.
(3 sheets)

Nuclide	Activity Limits (Ci/m^3)	
	Category 1	Category 3[a]
^{242m}Am[c]	2.6 E-03	2.4 E+00
^{243}Am[c]	1.3 E-03	2.8 E-01
^{243}Cm[c]	2.5 E-02	6.3 E+02
^{244}Cm[c]	2.3 E-01	2.9 E+02
^{245}Cm[c]	2.1 E-03	3.3 E-01
^{246}Cm[c]	3.3 E-03	7.7 E-01
^{247}Cm[c]	7.1 E-04	1.5 E-01
^{248}Cm[c]	9.1 E-04	2.0 E-01

[a]A dash (--) indicates no value was provided.
[b]Limit for isotope in activated metal.
[c]Category 3 limit is the lower of this value or 100 nCi/g.
Ci = 3.7×10^{10} Bq

3.3.3 High-Level Waste

HLW is "highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of TRU waste and fission products in concentrations requiring permanent isolation" (RL 1994). This waste is currently outside the scope of the Solid Waste Program unless the waste is currently stored in the low-level burial grounds (LLBGs). Historically, the term HLW referred to high-activity solid waste regardless of the waste source.

3.4 MIXED WASTE

Mixed waste (MW) is "waste containing both radioactive and hazardous components as defined by the *Atomic Energy Act of 1954* (AEA) and the *Resource Conservation and Recovery Act of 1976* (RCRA), respectively" (Willis 1993). The radioactive content of MW may be either LLW or TRU.

In 1987, MW was segregated and stored separately from other wastes as a result of the mixed by-product ruling implemented by DOE (Pauly 1987). Previous to this decision, MW was disposed or retrievably stored as radioactive waste.

3.5 CLASSIFIED RADIOACTIVE WASTE

Classified radioactive waste is waste bearing a security classification (e.g., restricted, confidential, or secret) such that special security precautions are required during transport, handling, and disposal. There are approximately 1,200 containers of classified radioactive solid waste that are known to have been either stored or disposed in the 200 Area Burial Grounds since 1970. Shipments of radioactive classified wastes were also buried at Hanford prior to 1970; however, available information about this waste is scanty. Combustible nonradioactive classified solid waste was burned. The information in this document focuses on radioactive classified waste buried since 1970.

4.0 HISTORY OF WASTE MANAGEMENT REQUIREMENTS

4.1 WASTE MANAGEMENT LAWS, POLICIES, AND ORDERS

The production of defense related materials at the Hanford Site has generated radioactive wastes including source, special nuclear, and by-product materials that are regulated under the AEA. Subclasses of radioactive waste containing AEA materials are currently defined to include TRU waste, HLW, spent nuclear fuel, LLW, and mill tailings waste. The NRC is primarily responsible for exercising authority over commercial facilities while the DOE is primarily responsible for exercising authority over government-owned and -operated facilities. Because of the framework of dual regulation created by Congress, the EPA and NRC/DOE jointly regulate the same waste. Much of the waste that is now regulated as MW was previously regulated as radioactive waste under the AEA and is subject to the RCRA regulatory program.

Between 1944 and 1970, Hanford solid waste was disposed in shallow land trenches with little segregation of the materials by their chemical or radioactive natures. In 1970, the AEC directed that AEC sites segregate "waste with known or detectable contamination of transuranic nuclides" from other waste types (Immediate Action Directive [IAD] 0511-21) (AEC 1970). TRU radionuclides are those with an atomic number greater than that of uranium (92). The AEC further directed that these wastes be packaged and stored as contamination-free packages for at least 20 years. The 20-year interim storage period was to allow time to study permanent disposal options for TRU contaminated wastes.

The IAD did not provide a detailed definition for TRU waste in 1970. AEC contractors implemented the IAD to the best of their ability with the instrumentation then available. In 1973, the *Atomic Energy Commission Manual* (AEC 1973) further defined TRU waste as material contaminated with certain alpha-emitting radionuclides with half-lives greater than 20 years and activity greater than 10 nCi/g (3.7 x 10^2 Bq/g). The radionuclides included were ^{233}U and its daughter products, as well as plutonium and transplutonium nuclides with the exception of ^{238}Pu and ^{241}Pu. In 1982, the TRU waste segregation limits were raised to 100 nCi/g (3.7 x 10^3 Bq/g) by the DOE Order 5820.1, *Management of Transuranic Material* (DOE 1982).

In 1976, Congress passed the RCRA to amend the *Solid Waste Disposal Act of 1964*. RCRA mandated provisions for managing, handling, shipping, and disposing solid waste. In addition, it closed most open dumps, redefined which wastes were hazardous, and set standards for treatment, storage, and disposal facilities. The RCRA was amended by the *Hazardous and Solid Waste Amendments of 1984* (HSWA). Major provisions of the HSWA amendments called for banning land disposal of untreated hazardous waste. The *Comprehensive Environmental Response Compensation and Liability Act of 1980* (CERCLA) was passed to assure financial responsibility for the long-term maintenance of hazardous waste disposal facilities, and provides for the containment and cleanup of abandoned hazardous waste disposal sites that are leaking or endangering public health. It was amended and expanded in 1986 by the *Superfund Amendments and Reauthorization Act of 1986* (SARA).

During the time when much of the MW currently stored at the Hanford Site was generated, the storage, disposal, and documentation of MW was not regulated. In 1987, the DOE issued a mixed by-product ruling stating that the hazardous components of MW are regulated by RCRA (10 CFR 962). In November of that year, the EPA authorized the Washington State Department of Ecology (Ecology) to regulate the hazardous constituents of MW at Hanford. As a result, the Hanford Site stopped disposing of MW in unlined trenches and began to store these wastes in aboveground facilities. In January 1988, an agreement with the state stipulated that MW with a dose rate less than 200 mrem/hour (2 mSv/hour) would be retrievably stored and placed in a building that met all of the Washington State storage requirements. MW with greater than 200 mrem/hour (2 mSv/hour) (RH) would be disposed of below ground to satisfy as low as reasonably achievable (ALARA) radiation safety requirements, assuming successful waiver applications (Carlson et al. 1994).

As part of the Washington State dangerous waste regulations, the Hanford Site was also required to submit permits for operation of those burial grounds which would remain active. All other burial grounds were considered inactive and were to be remediated under CERCLA as part of the Environmental Restoration Program mission (Carlson et al. 1994).

On May 15, 1989, the *Hanford Federal Facility Agreement and Consent Order of 1989* (also known as the Tri-Party Agreement [TPA]) was signed by RL, EPA, and Ecology. The TPA is primarily focused on setting milestones to achieve a timely cleanup of the Hanford Site in full compliance with RCRA and CERCLA.

DOE Order 5820.2A, *Radioactive Waste Management*, which replaced DOE Order 5820.2 in September of 1988, established policies, guidelines, and minimum requirements by which the DOE manages its radioactive and MW and contaminated facilities. Richland Operations Office Implementing Document (RLID) 5820.2A, dated August 1990, provides the guidelines, policies, and minimum requirements by which RL manages radioactive wastes, MW, and contaminated facilities (RL 1990). These orders define the performance objectives for DOE disposal sites and dictate the certification requirements associated with wastes destined for disposal. Implementation of DOE orders was accomplished by including the requirements as part of the *Hanford Site Solid Waste Acceptance Criteria* (Willis 1993) and Plant Standard Operating Procedures.

4.2 HANFORD WASTE ACCEPTANCE CRITERIA

Site contractors have provided waste generators with written criteria for the acceptance of solid waste in the Hanford burial grounds and storage facilities since 1967. BNW and ARHCO published *Specifications and Standards for the Disposal of Solid Wastes* in 1967 and 1968, respectively. These specifications and standards specified the controls required to minimize the hazards associated with the disposal of solid radioactive wastes, thus assuring that all ARHCO and BNW generated solid wastes were packaged and disposed in accordance with ARHCO Waste Management Program Objectives. Through the years, as new contractors took over the site and as state and federal laws imposed increasing regulations on the disposal and storage of solid wastes to the ground, the Waste Acceptance Criteria evolved as well.

Current disposal of solid waste is guided by the *Hanford Site Radioactive Solid Waste Acceptance Criteria*, WHC-EP-0063-4 (Willis 1993). An overview of the Waste Acceptance Criteria documents, the waste management laws, policies, and orders that resulted in changes in these documents, and the definition of TRU waste throughout this time period is given in Table 4-1.

4.3 SIGNIFICANT CHANGES IN WASTE ACCEPTANCE CRITERIA

4.3.1 Waste Classifications and Segregation

In the early production years, waste management procedures were primarily based on operator and public safety. Over the years, waste management and handling procedures and practices have increased in size and complexity. Major changes in waste segregation practices have been driven by evolving federal, state, and local regulations, DOE orders, Hanford Waste Acceptance Criteria, and TPA milestones. The most significant modifications to impact waste segregation practices resulted from the implementation of the AEC's IAD 0511-21 in 1970 and the DOE Mixed By-Product Ruling in 1987.

Early Hanford procedures define solid radioactive waste as "radioactive waste which is essentially dry, or whose fluids are of small volume and are contained or absorbed to the extent that they are essentially immobile during storage" (Backman et al. 1963). Because documentation of solid waste practices is scanty during Hanford's early period, it is assumed that this definition, or a similar definition, was observed throughout the 1940's and 1950's.

Existing documents from the 1950's divided solid radioactive wastes into either "dry" wastes or "industrial" wastes (HAPO 1955). "Dry" wastes were described as wastes containing relatively little contamination and included such items as absorbent tissues, rubber gloves, wood, metal parts, broken glassware, small tools, and other small miscellaneous items. "Industrial wastes" consisted of large items or failed equipment (HAPO 1955). For equipment that was either too large or too contaminated to transport to the solid waste burial grounds, a railroad storage tunnel was constructed under the PUREX Facility to allow safer storage (Backman et al. 1963). The PUREX tunnel is described more completely in Section 7.3.3.

Segregation practices to separate wastes based on radiation intensity or content became more common in the mid-1960's. Small size, high activity, solid waste, which primarily consisted of laboratory wastes was segregated for disposal into the caissons (Beard and Godfrey 1967). Larger wastes considered to contain high levels of plutonium were segregated and incinerated to recover approximately 98% of the plutonium (Hill et al. 1970). Slightly contaminated solid waste was segregated and buried in cardboard boxes.

In the late 1960's, some of the first available specifications and standards documents for managing radioactive wastes were introduced. These documents were the predecessors of the current Hanford Site Solid Waste Acceptance Criteria document, WHC-EP-0063-4 (Willis 1993).

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Table 4-1. Summary of Waste Acceptance Criteria Documents, Regulations, and TRU Definition. (3 sheets)

DOCUMENT NUMBER AND DATE OF PUBLICATION							
ARH-183 12/67	ARH-919 12/68	ARH-1842 12/70	ARH-1516 1/71	ARH-3032 4/74	ARH-1128 1/77	ARH-3032 Rev.1 4/77	ARH-3032 Rev 1 Sup 1 8/78
DOCUMENT TITLE							
Specifications and Standards for the Disposal of Battelle Northwest Solid Wastes (Smith 1967)	*Specifications and Standards for the Disposal of ARHCO Solid Wastes (Smith 1968)*	*Specifications and Standards for the Burial of ARHCO Solid Wastes (Hanson and Oberg 1970)*	*Environmental Specifications, Objectives and Standards for PUREX Plant Effluents (Henry and Ritter 1971)*	*Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Waste (Anderson 1974)*	*Supplemental Criticality Prevention Specifications-The PUREX Plant in Shutdown Status (Anderson 1977a)*	*Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Waste (Anderson 1977b)*	*Supplemental Requirements for Disposal of 400 Area Solid Waste (Teal and Moose 1978)*
SUPERSEDES							
N/A	N/A	ARH-919	N/A	ARH-183 and ARH-1842	N/A	ARH-3032 Rev 0	N/A
WASTE MANAGEMENT LAWS, POLICIES, AND ORDERS AFFECTING WASTE ACCEPTANCE CRITERIA							
	The *National Environmental Policy Act of 1969* established the requirement for conducting environmental reviews of Federal actions that have the potential for significant impact on the human environment.	In 1970, the Atomic Energy Commission (AEC) issued the *Immediate Action Directive (IAD) 0511-21* requiring the segregation of wastes with known or detectable contamination of transuranic (TRU) nuclides from other waste types (AEC 1970).	In 1973, the AEC further defined TRU waste as material contaminated with certain alpha-emitting radionuclides with half-lives greater than 100 years, and activities greater than 10 nCi/g (3.7 x 10^5 Bq/g) (AEC 1973).	In 1976, the *Resource Conservation and Recovery Act* (RCRA) was passed mandating provisions for managing, handling, shipping, and disposing solid waste.	The *Toxic Substances Control Act* (TSCA) was enacted in 1976 to protect human health and the environment from unreasonable risk due to exposure to, manufacture, distribution, use, or disposal of substances containing toxic chemicals.		
DEFINITION OF TRANSURANIC WASTE							
		Solid wastes containing or suspected of containing plutonium or other transuranium radionuclides.		Solid wastes containing greater than an average 10 nCi/g (3.7 x 10^5 Bq/g) of total plutonium, ^{233}U, and transuranium nuclides.		Solid wastes containing greater than an average 10 nCi/g (3.7 x 10^5 Bq/g) of total plutonium, ^{233}U, and transuranium nuclides.	

Table 4-1. Summary of Waste Acceptance Criteria Documents, Regulations, and TRU Definition. (3 sheets)

DOCUMENT NUMBER AND DATE OF PUBLICATION							
RHO-LD-64 9/78	RHO-CD-568 10/78	ARH-3032 Rev 1 Sup 2 12/78	RHO-CD-711 6/79	RHO-MA-222 Rev 0 5/80	RHO-MA-222 Revised 6/82	RHO-MA-222 Rev 1 12/83	RHO-MA-222 Rev 2 7/84
DOCUMENT TITLE							
Packaging and Shipping Requirements for Radioactive Waste Material for Rockwell Hanford Operations for Offsite Customers (Anderson 1978)	*Commercial Waste Packaging Program Radioactive Waste Package Acceptance Criteria (Moore and Calmus 1978)*	*Supplemental Requirements for Disposal of Gas Generating Solid TRU Waste (Panwala 1978)*	*Commercial Waste and Spent Fuel Packaging Program (RHO 1979b)*	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (McCall 1980)*	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Masa 1982)*	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Masa 1983a)*	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Belgrair 1984)*
SUPERSEDES							
N/A	N/A	N/A	N/A	ARH-3032 Rev 1 and RHO-LD-64	RHO-MA-222 Rev 0	RHO-MA-222 1982 Revision	RHO-MA-222 Rev 1
WASTE MANAGEMENT LAWS, POLICIES, AND ORDERS AFFECTING WASTE ACCEPTANCE CRITERIA							
				In 1980, the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) was passed. CERCLA provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites.	The *Atomic Energy Act of 1954* was amended in 1982 authorizing and directing the AEC to produce special nuclear material in its own facilities, to produce atomic weapons or atomic weapons parts, and to research and develop military applications of atomic energy.	In 1982, DOE Order 5820.1, *Management of Transuranic Material*, raised the TRU waste segregation limits to 100 nCi/g (3.7 x 10^{6} Bq/g) (DOE 1982).	In 1984, The *Hazardous and Solid Waste Amendments* (HSWA) amended RCRA, calling for a ban on the land disposal of untreated hazardous waste. Also in 1984, DOE Order 5820.2, *Radioactive Waste Management*, was implemented.
DEFINITION OF TRANSURANIC WASTE							
Solid wastes containing greater than an average 10 nCi/g (3.7 x 10^{5} Bq/g) of total plutonium, ^{233}U, and transuranium nuclides.	Waste containing or suspected of containing plutonium or other long-lived alpha emitters in concentrations greater than 10 nCi/g (3.7 x 10^{5} Bq/g).	Solid wastes containing greater than an average 10 nCi/g (3.7 x 10^{5} Bq/g) of total plutonium, ^{233}U, and transuranium nuclides.	Waste contaminated with alpha-emitting radionuclides or ^{233}U of long half-life and activity in excess of 10 nCi/g (3.7 x 10^{5} Bq/g) of waste matrix.	Waste containing or suspected of containing transuranium alpha-emitting radionuclides with half-lives greater than 100 years or ^{233}U in concentrations greater than 10 nCi/g (3.7 x 10^{5} Bq/g) of waste matrix.		Wastes which, without regard to source or form, are contaminated with alpha-emitting transuranium radionuclides with atomic numbers greater than 92 and half-lives greater than 20 years or ^{226}Ra or ^{233}U in concentrations greater than 100 nCi/g (3.7 x 10^{6} Bq/g).	Radioactive waste contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years or ^{226}Ra or ^{233}U in concentrations greater than 100 nCi/g (3.7 x 10^{6} Bq/g) of waste matrix in any single waste package.

Table 4-1. Summary of Waste Acceptance Criteria Documents, Regulations, and TRU Definition. (3 sheets)

DOCUMENT NUMBER AND DATE OF PUBLICATION							
RHO-MA-222 Rev 3 8/85	RHO-MA-222 Rev 3A 1/87	RHO-MA-222 Rev 4 6/87	WHC-EP-0063 9/88	WHC-EP-0063 Rev 1 9/89	WHC-EP-0063 Rev 2 9/90	WHC-EP-0063 Rev 3 9/91	WHC-EP-0063 Rev 4 11/93
DOCUMENT TITLE							
Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Pauly 1985)	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Pauly 1987)*	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Amir et al. 1987)*	*Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements (Stickney 1988)*	*Hanford Site Radioactive Solid Waste Acceptance Criteria (Stickney 1989a)*	*Hanford Site Radioactive Solid Waste Acceptance Criteria (Willis 1990)*	*Hanford Site Radioactive Solid Waste Acceptance Criteria (Willis and Triner 1991)*	*Hanford Site Solid Waste Acceptance Criteria (Willis 1993)*
SUPERSEDES							
RHO-MA-222 Rev 2	Amends RHO-MA-222 Rev 3	RHO-MA-222 Rev 3A	RHO-MA-222 Rev 4	WHC-EP-0063 Rev 0	WHC-EP-0063 Rev 1	WHC-EP-0063 Rev 2	WHC-EP-0063 Rev 3
WASTE MANAGEMENT LAWS, POLICIES, AND ORDERS AFFECTING WASTE ACCEPTANCE CRITERIA							
In 1986, the *Superfund Amendments and Reauthorization Act* (SARA) amended CERCLA. It expedited Superfund response and liability, included emergency planning and notification requirements, and expanded publicly available information.	In 1987, the DOE issued a mixed-by-product ruling stating that hazardous components of mixed wastes are regulated by RCRA (10 CFR 962).	In 1987, the EPA authorized Ecology to regulate the hazardous constituents of mixed wastes at Hanford.	In 1988, DOE Order 5820.2A, *Radioactive Waste Management*, established policies, guidelines, and minimum requirements by which DOE manages its radioactive and mixed waste and contaminated facilities.	In 1989, the *Hanford Federal Facility Agreement and Consent Order, or Tri-Party Agreement* (TPA) established milestones for cleanup of the Hanford Site in compliance with RCRA and CERCLA.			
DEFINITION OF TRANSURANIC WASTE							
Radioactive waste contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years or ^{226}Ra or ^{233}U in concentrations greater than 100 nCi/g (3.7 x 10^6 Bq/g) of waste matrix in any single waste package.		Radioactive waste contaminated with alpha-emitting transuranium radionuclides of atomic number greater than 92 with half-lives greater than 20 years or ^{226}Ra or ^{233}U in concentrations greater than 100 nCi/g (3.7 x 10^6 Bq/g) of waste matrix in any single waste package.	Waste which, without regard to source or form, is contaminated with alpha-emitting transuranium radionuclides having atomic number greater than 92 with half-lives greater than 20 years, or ^{226}Ra or ^{233}U in concentrations greater than 100 nCi/g (3.7 x 10^6 Bq/g) of waste matrix in any single waste package.				

Specifications and Standards for the Disposal of Battelle Northwest Solid Wastes, ARH-183 (Smith 1967), and *Specifications and Standards for the Disposal of ARHCO Solid Wastes*, ARH-919 (Smith 1968), were released in 1967 and 1968, respectively. They were developed in accordance to the ARHCO Waste Management Program Objectives and the *Radiation Protection Standards*, HW-25457, which are both currently unavailable. The ARHCO specifications and standards document defined specifications as requirements developed to protect the environs, operating facilities, and personnel and defined standards as requirements developed to prudently operate the waste disposal sites (Smith 1968).

The *Specifications and Standards for the Disposal of ARHCO Solid Wastes* provided specifications and standards for the disposal of industrial and dry wastes, as well as for chemical hazards control for the burial grounds. Generators were required to provide segregation according to waste compatibility or content (Smith 1968). Specific requirements and packaging procedures are detailed in Section 5.0.

In 1970, a new specifications and standards document replaced ARH-919. This new document was similarly titled *Specifications and Standards for the Burial of ARHCO Solid Wastes* (Hanson et al. 1970). With the implementation of the AEC IAD 0511-21, *Policy Statement Regarding Solid Waste Burial*, segregation of wastes containing TRU radionuclides was required, and this document specifically stated that generators and operators must segregate and package waste materials containing or suspected of containing plutonium or other TRU radionuclides for containment and retrievability (Hanson and Oberg 1970). With the exception of TRU waste segregation, this document basically maintained the previous specifications and standards of ARH-919 (Smith 1968).

Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Wastes, ARH-3032 (Anderson 1974), superseded ARH-183 (Smith 1967) and ARH-1842 (Hanson and Oberg 1970). Solid waste was defined in this document as "solid material or solidified residue that had a negative value relative to recovery and disposal costs and was to be discarded." This document classified solid waste into the following four groups, which were to be segregated:

- Nonradioactive, nonhazardous, combustible wastes
- Low-level, non-TRU wastes
- TRU wastes
- HLW.

Although it was not always the case, it was common during this time period to assume that all material removed from a radiation zone was radioactively contaminated. Packages of waste that were considered to be nonradioactive wastes included those wastes that contained less than 200 counts per minute (cpm) beta/gamma and less than 500 disintegrations per minute (dpm) alpha contamination (Anderson 1974). Nonradioactive wastes eventually were transported by compactor vehicles and disposed in the Central Landfill Facility (Anderson 1974).

Low-level, non-TRU wastes were considered to be those solid wastes containing less than 10 nCi/g (3.7×10^5 Bq/g) of plutonium and/or other TRU radionuclides. This waste type was further divided into wastes that were combustible and wastes that were noncombustible. In this instance, noncombustible wastes were defined as those wastes that were not safe to burn. Wastes containing toxic chemicals or oxidizing agents, such as nitric acid or permanganates, were packaged in specified noncombustible containers (Anderson 1974).

Solid wastes containing, or suspected of containing, greater than 10 nCi/g (3.7×10^5 Bq/g) plutonium and/or other transuranium radionuclides were considered to be TRU wastes. The concentration limit for TRU waste was established as a result of the AEC definition released in 1973. Failed equipment and large items contaminated with TRU radionuclides were also included in this category. For safe storage, TRU wastes were segregated into combustible waste and noncombustible waste as described above for LLW. At Hanford, TRU waste usually consisted of rags, paper, rubber gloves, tools, filters, hoods, and equipment from the processing of plutonium (Anderson 1974). Small TRU items were also segregated from larger TRU items or equipment, since small items were stored on asphalt pads, in underground trenches, or in caissons (200 Areas), whereas larger items were stored primarily in burial trenches.

High-level (high activity) solid wastes were defined in this document as those wastes that emitted high levels of beta and gamma radiation. Note this definition referred to the activity level of solid waste and was different from the currently defined term HLW, which refers to waste generated from specific nuclear processes. High-level (high activity) solid waste did not include TRU waste and typically included failed equipment from B Plant, tank farm operations, etc. (Anderson 1974). Small items were transported to the caissons or burial trenches, while large items and failed equipment were buried in the industrial waste trenches.

Revision 1 of *Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Waste*, ARH-3032 (Anderson 1977b), was issued in April of 1977. This revision was supplemented in August of 1978 with the *Requirements for Disposal of 400 Area Solid Waste* (Teal and Moose 1978) and in December of 1978 with the *Requirements for Disposal of Gas Generating Solid TRU Waste* (Panwala 1978). The December 1978 supplement contained a listing of nonacceptable waste categories including specified liquid organics, oxidizers, metals, and explosives (Anderson 1977b). These restricted wastes are discussed further in Section 4.3.5.

The next major site specifications and standards document was in effect for approximately seven years and included a series of revisions. *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, RHO-MA-222 (McCall 1980), was released in May of 1980 and superseded ARH-3032 Rev. 1 (Anderson 1977b) and *Packaging and Shipping Requirements for Radioactive Waste Material of Rockwell Hanford Operations for Offsite Customers*, RHO-LD-64 (Anderson 1978). This was the first specifications document that referred specifically to waste classifications; however, only two classes, radioactive solid wastes and TRU solid wastes, were defined. Additional requirements mandated segregation of combustible and noncombustible TRU waste. Combustible material was defined "as any material which can be ignited to produce fire through friction, absorption of moisture, spontaneous chemical changes, or application of an external flame" (McCall 1980). Since the incinerator used for plutonium recovery was shut down in 1973, it is assumed that segregation was performed for safety reasons.

Revision 1 of RHO-MA-222 (Masa 1983a) included changes in the concentration limits and the half-life requirements for TRU radionuclides. The revised AEC definition was released in 1982 and defined TRU waste as waste, without regard to source or form, contaminated with alpha-emitting radionuclides of atomic numbers greater than 92 and half-lives greater than 20 years in concentrations greater than 100 nCi/g (3.7×10^6 Bq/g) at the end of institutional control periods.

Revision 2 of RHO-MA-222 was released in 1984 and classified waste as TRU waste, non-TRU waste, or special case waste (Belgrair 1984). Special case waste was defined as "radioactive wastes with additional properties which increase potential hazards during handling, storage, burial, or required special processing" (Belgrair 1984). This category included animal waste; radioactive liquid waste requiring absorbent; tritiated waste; iodine, carbon, and krypton; radioactive and hazardous MW; asbestos; ion exchange resins; gas generating waste; alkali metals; heat generating waste; fissile waste; compactible wastes; and prohibited waste. Other special case wastes were evaluated on a case-by-case basis. In later revisions, requirements for special case wastes were included as waste form requirements or unacceptable waste types.

Revision 3 of RHO-MA-222 was released in 1985 (Pauly 1985). The waste classifications defined in this revision included TRU waste, LLW, and prohibited materials. The term non-TRU was replaced globally with LLW; however, the basic waste definition remained the same. Prohibited wastes included free liquids, unreacted alkali metals, chemically incompatible materials, explosives, untreated pyrophorics, and gas cylinders. This waste class replaced the special case wastes from the previous revision and placed the associated requirements in the LLW and TRU waste form requirements sections. The waste form requirements section also included MW requirements. Low-level MW and TRU MW had to be segregated from each other and from other waste types.

Revision 3A of RHO-MA-222 included some key elements that directly impacted the waste classification system and the segregation requirements (Pauly 1987). This revision was released in response to the DOE mixed by-product ruling which stated that DOE would fully comply with RCRA hazardous waste labeling, packaging, handling, and storage requirements. This revision amended the MW section of revision 3 by adding an appendix that contained the incorporated changes mandated by Washington State Regulations (WAC 173-303). Ecology was authorized by the EPA to regulate the hazardous waste program within Washington State.

As a result of Revision 3A, segregation requirements were expanded, and segregation was required for nonradioactive hazardous waste, LLW, and MW. The MW that contained constituents banned from land disposal was treated or stored on a case-by-case basis. This revision also encouraged waste minimization in order to reduce the amount of nonradioactive waste and MW being generated.

The last revision of RHO-MA-222 was released by WHC and became effective January 4, 1988 (Amir et al. 1987). The classes of waste were expanded to include MW and still included TRU waste, LLW, and prohibited materials. Segregation of MW, LLW, and nonradioactive hazardous waste was still required.

Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements, WHC-EP-0063 (Stickney 1988), was released in 1988 and superseded RHO-MA-222 (Amir et al. 1987). This document was the first in a series of four revisions and was very similar to the fourth revision of RHO-MA-222. The main difference between the two was the depth of discussion offered. This document contained a greater level of detail and identified specific segregation requirements for the generator. Generators were required to:

- Segregate, to the maximum extent feasible, TRU waste, LLW, MW, chemically incompatible waste, and uncontaminated waste in order to facilitate cost-effective treatment, storage, and disposal.

- Segregate radioactive solid waste according to waste minimization practices.

- Segregate TRU, LLW, MW, hazardous, and noncontaminated waste into separate containers.

- Treat mixed TRU waste to destroy or to remove and segregate any hazardous waste components (when permitted, feasible, and practical).

- Segregate certified TRU from noncertified TRU waste (certified TRU waste is waste meeting the Waste Isolation Pilot Plant [WIPP] Waste Acceptance Criteria).

- Segregate low-level MW from TRU MW.

Revision 1 of WHC-EP-0063 was released in 1989 and contained almost identical requirements to the original document with the exception of the emergence of LLW categories (Stickney 1989a). Categories of LLW were developed to comply with DOE Order 5820.A. These categories, based on radionuclide concentrations, were designed to indicate the radioactive intensity of LLW, and the information was used to determine the appropriate method of disposal. The categories included "low" (low activity), "intermediate" (moderate activity), "high" (moderate to high activity), and "greater than classification high" (radioactive concentration greater than high). The greater than classification high category was generally not acceptable for near-surface disposal.

Revision 2 of WHC-EP-0063 (Willis 1990), released in 1990, expanded MW requirements to include storage and disposal criteria and altered the LLW categories. The new categories were renamed to Class I, Class II, Class III, and Greater Than Class III. These classes were defined as:

- **Class I** — Low activity waste with very low concentrations of long-lived radionuclides.

- **Class II** — No limits at this time.

- **Class III** — Moderate and high activity waste with low to moderate concentrations of long-lived radionuclides in a stabilized waste form that minimizes subsidence for a period of 1,000 years.

- **Greater Than Class III** — Waste that has radionuclide concentrations greater than Class III and which is not generally acceptable for near-surface disposal. Greater Than Class III category was adopted to meet the intent of DOE Orders 5820.2A (DOE 1988) and 5400.3 (DOE 1989). Additional engineered features must be incorporated into the design of systems for disposal of this waste.

Revision 3 of WHC-EP-0063 (Willis and Triner 1991) was released in 1991 and added a nonradioactive hazardous waste handling and storage section, a nonradioactive hazardous wastes disposal requirements section, and a waste minimization section. In addition, this revision renamed the LLW categories. The new terminology included Category 1 (previously Class I), Category 3 (combination of previous Class II and Class III), and Greater Than Category 3 (previously greater than Class III). Actual determinations for LLW categories were calculated using a given concentration table (see Table 3-1). Waste segregation for each LLW category was required in addition to the previous segregation requirements for TRU, low-level MW, TRU MW, and nonradioactive hazardous waste.

Revision 4 of WHC-EP-0063 (Willis 1993), defines the current waste acceptance criteria for the Hanford Site. This version contains requirements similar to the past revision as well as a new section defining the waste acceptance criteria for disposal of solid sanitary waste at the central landfill.

4.3.2 Contamination/Dose Limits

For the purpose of personnel protection, contamination and radiation dose limits have been established for waste containers. In this section, the term "contamination" applies to radioactive materials present on the outside of a burial container, and the term "limit" applies to the maximum allowable amount of contamination. The focus of the following subsections is to summarize how surface dose rates, smearable contamination limits, and contamination limits on various containers have changed throughout the years.

4.3.2.1 Surface Dose Rates. The surface dose rate is the effective dose received by a receptor at a given distance from a package. Quantities of removable radioactive contamination on package surfaces were to be controlled such that radiation doses to operating personnel remained ALARA. The surface dose rates were used to distinguish between containers that were contact handled and remote handled.

The *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements,* RHO-MA-222, released in 1980, was the first document to provide surface dose rate limits for non-TRU and TRU CH waste (McCall 1980). Prior to 1980, the only restriction on surface dose rates stated that containers being placed in "dry waste" trenches were limited to 100 mR/hour (1 mGy/hour) (Hanson and Oberg 1970; Anderson 1974; Anderson 1977a). A summary of the changes in surface dose rate limits for CH waste since 1980 is provided in Table 4-2.

Table 4-2. Surface Dose Rates for Contact-Handled Waste. (2 sheets)

Year	Waste acceptance criteria document	Contact-handled waste	
		Non-TRU	TRU
1980	RHO-MA-222, Rev. 0 (McCall 1980)	Packages were evaluated on an individual basis and limits were dependent on container integrity and method of handling.	$\leq$200 mrem/hour (2 mSv/hour) at any point.
1982	RHO-MA-222, revised 6/82 (Masa 1982)		
1983	RHO-MA-222, Rev. 1 (Masa 1983a)	$\leq$500 mrem/hour ($\leq$5 mSv/hour).	
1984	RHO-MA-222, Rev. 2 (Belgrair 1984)		
1985	RHO-MA-222, Rev. 3 (Pauly 1985)	$\leq$500 mrem/hour ($\leq$5 mSv/hour) at any point for 55-gal drums or smaller waste packages.	
1987	RHO-MA-222, Rev. 3A (Pauly 1987)	$\leq$200 mrem/hour ($\leq$2 mSv/hour) for packages larger than 55-gal drums (.6 m x .6 m x .9 m [2 ft x 2 ft x 2.9 ft]). Marked points up to 1,000 mrem/hour (10 mSv/hour) on bottom or one side may be permitted with prior approval.	
1987	RHO-MA-222, Rev. 4 (Amir et al. 1987)	$\leq$500 mrem/hour ($\leq$5 mSv/hour) at any point for 55-gal drums or smaller waste packages. $\leq$500 mrem/hour ($\leq$5 mSv/hour) at any point for cardboard boxes <0.2m^3 volume and/or 27 kg (60 lb) weight. $\leq$200 mrem/hour ($\leq$2 mSv/hour) for packages larger than 55-gal drums (.6 m x .6 m x .9 m [2 ft x 2 ft x 2.9 ft]). Marked points up to 1,000 mrem/hour (10 mSv/hour) on bottom or one side may be permitted with prior approval.	
1988	WHC-EP-0063, Rev. 0 (Stickney 1988)	$\leq$200 mrem/hour ($\leq$2 mSv/hour) at any point for 55-gal drums or smaller packages.	
1989	WHC-EP-0063, Rev. 1 (Stickney 1989a)	$\leq$200 mrem/hour ($\leq$2 mSv/hour) at any point for packages larger than 55-gal drums. Marked points up to 1,000 mrem/hour (10 mSv/hour) on bottom or one side may be permitted with prior approval.	

Table 4-2. Surface Dose Rates for Contact-Handled Waste. (2 sheets)

Year	Waste acceptance criteria document	Contact-handled waste	
		Non-TRU	TRU
1990	WHC-EP-0063, Rev. 2 (Willis 1990)	$\leq$200 mrem/hour ($\leq$2 mSv/hour) at any point for 55-gal drums or smaller packages.	$\leq$200 mrem/hour (2 mSv/hour) at any point.
1991	WHC-ED-0063, Rev. 3 (Willis and Triner 1991)	$\leq$200 mrem/hour ($\leq$2 mSv/hour) at any point for packages larger than 55-gal drums. Marked pints up to 1,000 mrem/hour (10 mSv/hour) on bottom or one side may be permitted with prior approval.	$\leq$100 mrem/hour (1 mSv/hour) for waste intended for storage at the Transuranic Storage and Assay Facility. $\leq$200 mrem/hour (2 mSv/hour) for all other waste.
1993	WHC-EP-0063, Rev. 4 (Willis 1993)		

TRU = transuranic.

The *Commercial Waste and Spent Fuel Packaging Program Package Acceptance Criteria* indicated that the surface dose rates for RH packages could, depending on the contents and the container, range as high as 10^6 R/hour (10^4 Gy/hour) for offsite commercial waste (RHO 1979b). This was not a specific limit but an observed surface dose rate on containers in 1979. RH packages were assumed to be containers that had surface dose rate limits greater than the limit for CH waste. Since 1980, specifications for the surface dose rate limits of non-TRU RH waste at specified distances from transportation vehicles have remained the same; 5 rem/hour (0.05 Sv/hour) at 1 m from a transportation rail car and 3 rem/hour (0.03 Sv/hour) at 1 m from a transportation truck (McCall 1980; Masa 1982; Masa 1983a; Belgrair 1984; Pauly 1985; Pauly 1987; Amir et al. 1987, Stickney 1988; Stickney 1989a; Willis 1990; Willis and Triner 1991; Willis 1993).

From 1968 to 1982, the smearable contamination limits were set at less than 200 cpm beta-gamma and less than 500 dpm/100 cm^2 alpha. If the waste package exceeded these limits it was required to be contained in plastic (Smith 1968; Hanson et al. 1970; Masa 1982).

From 1982 to the present time, smearable contamination limits for TRU wastes have been 100 dpm/100 cm^2 alpha and 1,000 dpm/100 cm^2 beta-gamma. Beginning in 1985, the fixation of surface contamination on TRU waste containers was no longer allowed. Non-TRU waste containers have smearable contamination limits of 220 dpm/100 cm^2 alpha and 2,200 dpm/100 cm^2 beta gamma (Masa 1982; Willis 1993).

4.3.2.2 Smearable Contamination Limits. Loose radioactive material that can be easily removed or transferred through contact is considered to be smearable contamination. The limits imposed on waste container smearable contamination limits since 1967 are summarized in Table 4-3. The first recorded smearable contamination limit was established by BNW in 1967. Exterior waste package surfaces were to be free of smearable (loose) contamination within the following limits: less than 200 cpm beta-gamma and less than 1,000 dpm alpha (Smith 1967).

4.3.3 Package Fissile Content Limitations

Fissile materials are materials capable of self-sustaining a nuclear chain reaction, such as $^{233/235}U$ and $^{239/239/241}Pu$. Since 1968, Hanford Waste Acceptance Criteria documents have provided waste generators with packaging requirements limiting the mass of fissile materials within burial and storage containers. Table 4-4 chronologically summarizes the requirements for fissile content limitations of LLW and TRU waste in various packages.

4.3.4 Thermal Output Limitations

The amount of heat resulting from the radiolytic decay of particles is referred to as thermal output. Limitations on thermal output that were put into effect in 1967 by BNW state that waste containers were not to contain fission products capable of generating container surface temperatures greater than 100 °C while standing in air at ambient temperatures (Smith 1967).

During the period from 1977 to 1982, the thermal output of any waste package was not to exceed a total of 1,500 W and an average of 2,600 W/m^3 (75 W/ft^3) of waste package volume. To prevent against overloading, no one single cubic foot of waste package was permitted to exceed 200 W (Teal and Moose 1978). The radiolytic heat generated within the package at any time during transport could not affect the integrity of the package or surrounding packages at any time during transport or storage (McCall 1980).

Since 1982, the thermal output for TRU waste containers is required to be recorded if it is greater than 3.5 W/m^3 (0.1 W/ft^3). Waste materials that generate heat in excess of 3.5 W/m^3 may require special packaging and disposal requirements to prevent excessive temperatures in the buried waste. Because of the variability in the nature of the waste and the waste package, requirements for heat generating waste were developed on a case-by-case basis (Masa 1982; Willis 1993).

4.3.5 Specific Prohibited Items

Specific prohibited items are those items which are not allowed in the Hanford solid waste burial grounds. Table 4-5 lists the unacceptable materials from 1977 to 1992 according to the Hanford Waste Acceptance Criteria documents. There are instances where items were generally prohibited by a specific facility, but were not listed as a general site-wide prohibited item.

Table 4-3. Smearable Contamination Limits.

Time Period	Waste type	Beta-gamma	Alpha	Area
1967[a]	All	200 cpm	1,000 dpm	Unknown
1968 to 1982[b]	All	200 cpm	500 dpm	100 cm^2
1982 to present[c]	TRU	1,000 dpm	100 dpm	100 cm^2
1982 to present[c]	Non-TRU	2,200 dpm	220 dpm	100 cm^2

[a](Smith 1967).
[b](Smith 1968; Hanson and Oberg 1970; Anderson 1974; Anderson 1977b; McCall 1980).
[c](Masa 1982; Masa 1983a; Belgrair 1984; Pauly 1985; Pauly 1987; Amir et al. 1987; Stickney 1988; Stickney 1989a; Willis 1990; Willis and Triner 1991; Willis 1993).
TRU = transuranic.

Table 4-4. Fissile Content Requirements. (4 sheets)

Year	Waste acceptance criteria document	Package fissile content limitations	
		Low-level waste	TRU waste
1968	ARH-919 (Smith 1968)	Fissile content limitations for individual boxes for burial in the industrial waste trenches are: • 1,000 g total mass of plutonium, ^{233}U, and ^{233}Pa per burial box. Individual equipment pieces placed in burial boxes shall satisfy at least one of the following:	--
1970	ARH-1842 (Hanson and Oberg 1970)	• Contain <1,000 g total mass of plutonium, ^{233}U, and ^{233}Pa per burial box. • Contain <350 g (0.7 lb) plutonium, ^{233}U, and ^{233}Pa. • Contain <1,000 g combined mass of plutonium, ^{233}U, and ^{233}Pa at a ratio <3,000 g/ton of combined ^{233}U and thorium.	

Table 4-4. Fissile Content Requirements. (4 sheets)

Year	Waste acceptance criteria document	Package fissile content limitations	
		Low-level waste	TRU waste
1974	ARH-3032 REV 0 (Anderson 1974)	Fissile content limitations are: • 1,000 g total mass of plutonium, ^{233}U, ^{235}U, and ^{231}Pa per burial box. Individual equipment pieces place in burial box shall satisfy at least one of the following: • Contain <0.9 kg (2 lb) ^{238}U and/or thorium. • Contain <350 g (0.7 lb) plutonium, ^{233}U, ^{235}U, and ^{231}Pa. • Contain <1,000 g combined mass of plutonium, ^{233}U, and ^{231}Pa at a ratio <3,000 g/ton of combined ^{238}U and thorium.	--
1977	ARH-3032 REV 1 (Anderson 1977b)		
1980	RHO-MA-222 REV 0 (McCall 1980)	Fissile content limitations are: • 200 g/containers equal in size to a 55-gal drum. • 250 g/containers larger than a 5-gal drum. • 1,000 g/large container upon approval. • Containers smaller than a 55-gal drum require specific analysis and Rockwell Nuclear Criticality Safety approval of the fissile material content.	--
1982	RHO-MA-222 Revised 6/82 (Masa 1982)	Fissile content limitations are: • 100 g/55-gal drum containing liquid organics. • 200 g/containers equal in size or larger than a 55-gal drum, but less than a 0.8-m (2.5-ft) cube. These containers must include 23.5 kg (51.8 lb) of uniformly distributed iron in the material of construction. • 250 g/containers larger than 0.44 m^3 (15.6 ft^3). • 1,000 g/some large containers upon approval.	--

Table 4-4. Fissile Content Requirements. (4 sheets)

Year	Waste acceptance criteria document	Package fissile content limitations	
		Low-level waste	TRU waste
1983	RHO-MA-222 REV 1 (Mass 1983a)	Fissile content limitations are: • 100 g/55-gal drum containing liquid organics. • 200 g/containers equal in size or larger than a 55-gal drum. • 250 g/containers smaller than 2.5 ft cube. • 1,000 g/some large containers upon approval.	--
1984	RHO-MA-222 REV 2 (Belgrair 1984)	No requirements provided.	The fissile isotope content of individual CH TRU waste packages shall not exceed the following values in ^{239}Pu fissile gram equivalents or total fissile material, whichever is more restrictive: • 200 g/55-gal drum • 100 g/30-gal drum • 500 g/DOT 6M container • 5 g/0.028 m^3 (1 ft^3) in boxes, up to 350 g maximum.
1985	RHO-MA-222 REV 3 (Pauly 1985)	The nuclear criticality limits for all LLW containing fissile materials are: • 100 g/55-gal drum containing HEPA filters with 40 g fissile material each. • 100 g/55-gal drum containing free or absorbed liquid organics. • 200 g/55-gal drum containing all other LLW. • Natural or depleted uranium is exempt from nuclear criticality limits.*	The fissile isotope content of individual CH TRU waste packages shall not exceed the following values in ^{239}Pu fissile gram equivalents or total fissile material, whichever is more restrictive:* • 100 g/55-gal drum containing absorbed organics. • 200 g/55-gal drum containing other wastes. • 500 g/DOT 6M container. • 5 g/0.028 m^3 (1 ft^3) in boxes, up to 350 g maximum.
1987	RHO-MA-222 REV 3A (Pauly 1987)	The nuclear criticality limits for all LLW containing fissile materials are:	--

Table 4-4. Fissile Content Requirements. (4 sheets)

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Waste acceptance criteria document</th><th colspan="2">Package fissile content limitations</th></tr>
<tr><th>Low-level waste</th><th>TRU waste</th></tr>
<tr><td>1988</td><td>WHC-EP-0063 REV 0 (Stickney 1988)</td><td>Nuclear criticality limits in ^{239}Pu fissile gram equivalents for all LLW containing fissile materials are as follows:
• 180 g/waste package.
• No disposal restrictions apply if fissile material <15 g/package.
• Natural and depleted uranium are exempt from nuclear critical limits.*</td><td rowspan="5">Fissile material of individual waste packages shall not exceed the following values in ^{239}Pu fissile gram equivalents:
• 200 g/55-gal drum, 100 g is the maximum allowed in drums that are lead-lined, contain absorbed liquid organics, or where the fissile material is contained within 20% of the drum volume.
• 5 g in any cubic foot in the solid waste burial box, up to 325 g maximum.</td></tr>
<tr><td>1989</td><td>WHC-EP-0063 REV 1 (Stickney 1989a)</td><td>No requirements provided.</td></tr>
<tr><td>1990</td><td>WHC-EP-0063 REV 2 (Willis 1990)</td><td rowspan="3">Limits for waste packages that contain more than 15 g of ^{235}U will be determined by WHC Criticality Engineering Analysis on a case-by-case basis. Waste packages containing 15 g or less do not require a separate criticality safety analysis.</td></tr>
<tr><td>1991</td><td>WHC-EP-0063 REV 3 (Willis and Triner 1991)</td></tr>
<tr><td>1993</td><td>WHC-EP-0063 REV 4 (Willis 1993)</td></tr>
</table>

*Limits for other waste packages determined by WHC Criticality Engineering Analysis.
CH = contact-handled.
HEPA = high-efficiency particulate air (filter).
LLW = low-level waste.
TRU = transuranic.
WHC = Westinghouse Hanford Company.

Table 4-5. Unacceptable Waste in Hanford Site Burial Grounds. (2 sheets)

Date	Prohibited items
1977 - 1978	Liquid organic wastes - free or absorbed (included animal carcasses).
	Unreacted alkali metals.
	Flammable absorbed liquids are prohibited from disposal in caissons.
1978 - 1980	No free liquids.
	Liquid organic waste, free or absorbed, is prohibited (includes all oils and animal carcasses).
	Explosives and pyrophorics.
	Unreacted alkali metals.
1980 - 1983	Flammable liquids, free or absorbed, with flash points below 66 °C (150 °F).
	Unreacted alkali metals.
	Explosives and pyrophorics.
	Materials that generate significant amounts of gas.
1984 - 1990	Unreacted alkali metals with exceptions.
	Pyrophorics and explosives except metal fines.
	Gas cylinders containing radioactive gases.
	Compressed gases.
1990 to 1992	Liquids (except as packaged in accordance with WHC-EP-0063-2 or as allowed by WHC Solid Waste Engineering Analysis).
	Reactive metals are prohibited from disposal only; they may be received for storage and future treatment.
	Chemically incompatible materials in any waste container.
	Explosives, pyrophorics, and gas cylinders that are not permanently vented.
	Chelating compounds are prohibited from disposal only; they may be approved for storage and future treatment on a case-by-case basis.
	Unidentified, uncharacterized, or poorly characterized waste.
	No LLW exceeding Class C limits will be accepted by WHC from licensees of the NRC or Agreement States except upon specific written approval by RL with concurrence of DOE Headquarters.
	Cardboard or fiberboard boxes are prohibited for the containment of LLW.

Table 4-5. Unacceptable Waste in Hanford Site Burial Grounds. (2 sheets)

Date	Prohibited items
1992 to 1993	Mixed radioactive and hazardous waste (i.e., contaminated lead, chromates and scintillation cocktails, etc.).
	Gas generating wastes that produce toxic gases, vapors, or fumes.
	Liquids that have not been absorbed, solidified, or stabilized. No freestanding liquid in excess of 0.5% by volume. Class A radioactive liquids in individual units or vials not exceeding 50 ml that have been used for clinical or laboratory testing may be disposed of without being absorbed.
	Gaseous material unless pressure does not exceed 150 kPa (1.5 atmospheres) at 20 °C, and activity less than 100 Ci (37 x 10^{11} Bq).
	Reactive metals are prohibited from disposal only; they may be received for storage and future treatment.
	Chemically incompatible materials in any waste container.
	Explosives, pyrophorics, and gas cylinders that are not permanently vented.
	Chelating compounds are prohibited from disposal only; they may be approved for storage and future treatment on a case-by-case basis.
	Unidentified, uncharacterized, or poorly characterized waste.
	No LLW exceeding Class C limits will be accepted by WHC from licensees of the NRC or Agreement States except upon specific written approval by RL with concurrence of DOE Headquarters.
	Cardboard or fiberboard boxes are prohibited for the containment of LLW.

DOE = U.S. Department of Energy.
LLW = low-level waste.
NRC = U.S. Nuclear Regulatory Commission.
RL = DOE, Richland Operations Office.
WHC = Westinghouse Hanford Company.

5.0 WASTE HANDLING AND PACKAGING PRACTICES

The description of waste handling and packaging procedures and practices from 1944 to the present has been divided into three main sections: general packaging requirements, special packaging procedures, and waste minimization practices and facilities. Section 5.1 gives an overview of the general packaging requirements. General requirements include packaging parameters and waste types. Section 5.2 describes the special packaging procedures in the major operating areas. Waste minimization practices and facilities are examined in Section 5.3.

5.1 GENERAL PACKAGING REQUIREMENTS

Prior to the late sixties, there were no state or federal regulations on the packaging of waste for burial at Hanford. There were attempts to package waste to minimize personnel exposure and prevent the spread of uncontained radioactivity to the environment; however, these were not set guidelines and were done at the discretion of the generator. This section describes the packaging parameters and the waste types specified by historical requirements.

5.1.1 Packaging Parameters

Around the late 1970's, some very general packaging procedures were introduced. Multiple containment barriers were used in the packaging of waste. In addition more concern was given to void spaces left in waste packages. There were also guidelines set for the types of absorbents and sorbents used to contain waste. Stabilization and solidification media were used to control the adverse effects of some waste being left in its natural form. As time passed, the regulations became more focused and the disposal of waste began to follow a set standard of guidelines.

5.1.1.1 Containment Barriers. A containment barrier is described as "A single physical restriction limiting the release or inhalation of material during any single accident and which, while intact, prevented any release or inhalation" (Orton and Shirey 1980). In the early years, waste at Hanford was disposed of in the burial grounds using only a single containment barrier. This barrier was the package in which the waste was placed. Typical packages were concrete boxes, cardboard boxes, plywood boxes, or drums. As time passed it was observed that some waste was escaping the single containment barrier; for example, liquid leaking from a drum. This posed harmful effects for the environment and decreased personnel safety. Therefore, requirements for the number of containment barriers increased. Several key requirements are listed below:

- In 1968, wastes containing contamination that was easily airborne were contained by an inner container (e.g., sheet plastic) (Smith 1968).
- In 1978, a second polyethylene drum liner was placed inside the first polyethylene drum liner (ARHCO 1978).

- In 1979, 55-gal barrels used at Z Plant to store radioactive wastes were lined with a polyethylene drum liner, 99 x 137 cm (39 x 54 in.), and 0.1 mm (4 mil) thick (RHO 1979a).

- In 1980, solid radioactive waste containing asbestos had to be packaged within at least one layer of 0.15 mm (6 mil) polyethylene film. Transuranic solid waste was packaged inside at least two containment barriers, the storage container and an inner sealed liner (McCall 1980).

- In 1981, it was stated that polyethylene liners were to be "horsetailed" and then taped shut before the drum lid was installed (Foster and Carter 1981).

- In 1985, all LLW determined to be MW was packaged with at least three containment barriers (Pauly 1985).

- In 1993, PNL determined a 90-mil high density polyethylene inner liner was required for liquid RH waste. A 10-mil nylon reinforced plastic liner was required for solid RH waste. For liquid MW, inner containers were almost always glass, with a capacity of 18.9 L (5 gal) or less (PNL 1993).

5.1.1.2 Filler Materials. Filler materials became important around the early 1980's. At this point a focus was made on the void space left inside some packages and whether that void space should be filled. Benefits could be identified for both the reduction and expansion of void spaces. The primary benefit for having a low-void volume was the reduction of excavation costs and increased space utilization efficiency. Minimizing package size would have also provided economic benefits in transportation and handling operations. In contrast, the addition of nonradioactive materials to radioactive waste could result in improved heat transfer, radionuclide immobilization, physical support, etc. Void spaces within waste packages could serve functions such as: gas pressurization control, control of differential thermal expansions, and avoidance of expensive volume reduction process. Higher void volume for such reasons were beneficial, though the larger resulting packages would impose an economic penalty in terms of repository cost. After looking at the costs and benefits several regulations were made concerning void space. The following list gives an overview of the outcome of several important regulations:

- From 1978 to 1984, waste package contents were not to exceed 80% of the active volume of the waste container (Moore and Calmus 1978).

- In 1984, it was stated that to prevent subsidence in Hanford burial grounds interior void spaces within non-TRU packages were to be minimized. However void spaces did not need to be filled in containers which were to collapse during the initial backfilling process (e.g., fiberboard boxes, plastic wrapped equipment) (Belgrair 1984).

- From 1985 to 1986, interior void spaces for LLW were not to exceed 20% of the active volume of the waste container (Pauly 1985).

- In 1987, the list of items which were exempt from being filled was expanded. Items which were not to be filled were high-efficiency particulate air (HEPA) filters, which posed hazards to personnel during filling, waste packages with a total internal void space less than 0.042 m^3 (1.5 ft^3), and any specially designed reinforced-concrete burial boxes with a design life in excess of 300 years under burial conditions expected in the Hanford Site burial grounds. All MW packages accepted for storage were exempt from requirements for filling void spaces (Pauly 1985).

Prior to 1990, no specific list was provided for approved filler materials. The following list contains materials that were approved by WHC Solid Waste Engineering Analysis for use as void space filler in 1990:

- Diatomaceous earth (kitty liter)
- Soil
- Sand
- Lava rock
- Tightly packed cellulose matter (rags, cardboard, fiberboard, coveralls, etc.)
- Clay
- Concrete, cement, grout
- Gravel.

In 1991, Pyrofoam[1] was added to the list of acceptable filler material.

5.1.1.3 Absorbent Materials. An absorbent material is a material which absorbs liquid into itself. Absorbent materials have been used at Hanford for a very long time. It was recognized early on site that liquids should not be disposed of without being fully contained. One way to contain the liquid was to absorb it. From 1968 to 1990 no specifications were made on the type of absorbent to be used. Vermiculite was suggested as an example. In 1980 acceptable absorbents were those which would not result in spontaneous combustion, decomposition, or explosion and were compatible with the containers so as not to cause corrosion or degradation of the containers. A list of the approved absorbents used in 1990 is given below:

- Conwed[2] pads or equivalent (to be used with organics)

- Diatomaceous earth (to be used with inorganics, especially acids)

- Amorphous silicate (WYK[3] absorbent, absorbent Pigs, etc., used on organic or inorganic liquids other than acids)

- Hazorb[4] pillow (inorganics)

[1]Pyrofoam is a trademark of Pyrofoam, Incorporated.
[2]Conwed is a trademark of Conwed Bonded Fiber.
[3]WYK is a trademark of Upright, Incorporated.
[4]Hazorb is a trademark of Occidental Electrochemicals Corporation.

- Aquaset[1] and Aquaset II[1] (inorganics)
- Petroset[2] and Petroset II[2] (organics)
- Nontreated clay-based absorbent (inorganics).

In 1991, Solid-A-Sorb[3] mineral diatomaceous earth was added to the list.

5.1.1.4 Adsorbent Materials. Adsorbent material is much like an absorbent material except it contains the liquid on the surface instead of absorbing it into the material. Hanford began using sorbents when the technology advanced to a point were sorbents could be used economically. This began around the late 1980's. A list of the approved sorbents in 1990 is provided below:

- Speedi Dri
- Florco
- Opalex
- Superfine
- Floor Dry
- Solid-A-Sorb
- Chemsil 50
- Dicaperl HP200
- Petroset
- Aquaset.

5.1.1.5 Stabilization Media. A stabilization media is a chemical additive which immobilizes volatile waste within a solid matrix. Stabilizing volatile waste decreased the personal hazards faced while disposing of the waste. The approved stabilization media as of 1990 are:

- Aztech[4]
- Bitument (oxidized bitument only, ATI and Waste Chem)
- Chem Nuclear Cement
- Concrete
- Dow Media (Vinyl Ester Styrene)
- LN Technologies Cement
- Westinghouse Hitteman Cement.

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[1]Aquaset and Aquaset II are trademarks of Fluid Tech, Incorporated.
[2]Petroset and Petroset II are trademarks of Phillips Petroleum.
[3]Solid-A-Sorb is a trademark of Michael Wood Products.
[4]Aztech is a trademark of General Electric.

5.1.1.6 Solidification Media. Solidification combined powders, ashes, and liquids which posed environmental and personal hazards. The approved solidification media as of 1990 are:

- Aztech
- Aquaset I and II
- Bitument (Waste Chem and ATI)
- Chem Nuclear Cement
- Concrete (Structural)
- Delaware Custom Media
- Dow Media
- Hitteman Grout
- Petroset I and II
- Safe-T-Set.

5.1.2 Waste Types

With an increased knowledge about certain types of waste, new, more specific packaging practices were developed. The packaging practices for the following materials are the focus of the following sections:

- Process equipment
- Class B poisons
- Asbestos
- Sodium and alkali metals
- Oxidizing and corrosive materials
- ^{129}I, ^{14}, and ^{40}K
- Tritiated waste (tritium oxide)
- Liquid and animal wastes
- Gas generating wastes.

5.1.2.1 Process Equipment. Process equipment consisted of equipment used by several of the large plants at the Hanford Site. The equipment caused several problems when it came time for disposal. Due to the large size and odd shape of the majority of process equipment, special measures had to be taken for burial. In the early years the equipment was buried in wooden boxes. Sometimes a wooden box could not be provided and the equipment was buried with no protective covering. After it was determined that the equipment was too hazardous to bury without confinement, the equipment was wrapped in plastic prior to burial. In addition, large pieces of process equipment were cut into smaller sections and packaged prior to burial. A chronological list of different burial procedure for process equipment is given below:

- Beginning in 1964, failed process equipment was packaged in concrete boxes. PUREX process equipment that was too large to bury was stored in special railroad tunnels adjoining the PUREX Plant (Beard et al. 1964).

- Beginning in 1970, metal containers were used to bury failed equipment from the PUREX Plant and Z Plant (Hanson and Oberg 1970).

Some items of failed equipment, such as 12.2 to 15.2 m (40 to 50 ft) long pumps used in the transfer of wastes from underground storage tanks, were flushed and packaged in plastic prior to burial (Hill et al. 1970).

- As of 1980, wood, steel, and/or concrete boxes were used for the burial of process equipment.
- In 1981, large radioactive waste items from the PUREX canyon were packaged in burial boxes of precast, reinforced, concrete slabs with a concrete slab lid held in place by its own weight. A steel liner box may have been inserted, depending on the waste being packaged. Box configurations varied depending on the waste being packaged, but the most commonly used size had a void volume of 50.5 m^3 (1,782 ft^3).
- Around 1987, old gloveboxes were packaged in intact burial boxes. For a brief period of time they were sent to the 231-Z Facility to be cut up into smaller pieces. The pieces were then packaged in steel culverts, steel boxes, plywood boxes, and some of the smaller pieces were placed in 55-gal drums (Pottmeyer et al. 1993b).
- In 1993, large process equipment, including leaded glass, fluorescent lamps, and polychlorinated byphenyl (PCB) ballast, were stored in burial boxes of MW.

5.1.2.2 Class B Poisons. Class B poisons were a main focus of disposal due to the effects the poisons had on the environment and personnel safety. A complete list of Class B poisons can be found in 49 CFR 172.101 "Hazardous Materials Table." Solid waste containing Class B poisons was packaged in double containment. Small quantities were placed in small containers, which were then placed in storage or disposal containers and the small containers were fixed or surrounded by concrete on all sides. In 1980, it was determined that packaging for larger quantities was to be approved on a case-by-case basis by the Waste Management Safety Committee A for Burial (WMSCA) Approval Authority (McCall 1980).

As more research was done on mercury, a specific Class B poison, more care was taken in its packaging. In the mid-1980's mercury was confined in a culvert using concrete and the culvert was then placed in a drum. It was common to fill the space around the culverts with bagged poly bottles and other items. In 1992, liquid metallic mercury from PNL was contained in a polyethylene or glass container with a screw-type lid.

5.1.2.3 Asbestos. It was not until the late 1980's that the dangers of asbestos were made known to the public. The personnel at PFP estimated that the amount of asbestos that was part of the solid waste disposal was small (Duncan et al. 1993).

After learning of the hazardous effects of asbestos, PNL wetted the waste containing asbestos, placed it in a 0.1-mm (4-mil) or heavier plastic bag, and sealed it wet using a 5 cm wide, fabric-reinforced tape or approved equivalent. The material was then packaged in a leak-resistant container which met applicable shipping requirements (PNL 1993).

5.1.2.4 Sodium and Alkali Metals. Prior to 1977 there were no documented packaging requirements for sodium and alkali metals. Beginning in 1977, special approval of any waste package containing sodium or other alkali metal was required. Unreacted alkali metals in solid waste was not accepted for disposal. The shipper had to specify quantities, concentrations, and contamination levels of each alkali metal, to assure that the appropriate methods of handling, storage, and/or disposal were used (Anderson 1978). The requirements established in the early years are still being observed to this day.

5.1.2.5 Oxidizing and Corrosive Materials. Oxidizing and corrosive materials are of special interest because they break down the integrity of the container in which they are packaged. In addition during the break down of the containers, gases are generated. It was not until the late 1960's that oxidizing material were not to be packaged with combustible wastes or in combustible containers. Rags used to cleanup oxidizing materials had to be well-rinsed to remove all oxidizing materials before they were discarded.

Beginning in 1984, wastes containing corrosives were to be treated to eliminated their corrosive properties and to form a chemically stable compound or were to be packaged such that the storage container was not exposed to the corrosive agent during its 25-year design life. To enhance the corrosive protection, the interior and exterior of the waste containers were galvanized or painted with a two-component epoxy-polyamide paint system or functionally equivalent paint (Belgrair 1984).

5.1.2.6 Iodine-129, Carbon-14, and Krypton-85. Any waste containing ^{129}I, ^{14}C, or ^{85}Kr was to be evaluated on a case-by-case basis to determine whether to package and label the waste for disposal or for long-term retrievable storage. In the latter case, requirements for TRU waste may have been imposed, regardless of whether any of these radionuclides existed in combination with TRU waste. A waste package used to contain unstable ion exchange resins was to comply with all applicable requirement for solid radioactive waste packages.

5.1.2.7 Tritiated Waste (Tritium Oxide). It was not until the early 1980's that there were defined procedures for dealing with tritium wastes. Tritiated waste, including tritium oxide, in liquid form was to be packaged in steel or concrete containers. Waste containing tritium or tritium oxide was packaged in 55-gal drums as follows:

- For quantities of 500 Ci (185×10^{11} Bq) or less per drum, tritium oxide was absorbed on silica gel in a leak-tight 1-gal metal can which was then surrounded by asphalt. The absorbent was at least twice the quantity required to absorb the tritium or tritium oxide. Several 1-gal cans were placed in a 30-gal drum, lined with 0.1 mm (4 mil) of polyethylene.

- For quantities greater than 500 Ci (185×10^{11} Bq), the 30-gal drum was surrounded by asphalt and finally placed inside a 55-gal drum.

Waste packages with heat output greater than 3.53 W/m^3 (0.1 W/ft^3) required a special thermal analysis by the Waste Process Design Team to determine whether special separation distances for the waste within the burial trench were required.

In 1993, the tritium waste was defined as waste containing greater than 20 mCi (74×10^{6} Bq) of tritium/m^3 of waste. The disposal of tritium waste was changed slightly. The new techniques are as follows:

- Tritiated waste with less than 100 Ci (37×10^{11} Bq) tritium/m^3 in either absorbed liquids or solids was to be sealed in one layers, of 4-mil (nominal) or thicker polyethylene and disposed of in a steel or concrete package.

- Containment systems for tritiated waste with greater than or equal to 100 Ci (37×10^{11} Bq) tritium/m^3 were to be documented in the storage/disposal approval record (SDAR).

5.1.2.8 Liquid and Animal Wastes. Due to the increased knowledge about the waste and the better packaging techniques the guidelines of liquid and animal wastes have changed throughout time. Table 5-1 summarizes the changes in packaging since 1967. Regulations established in 1987 are still in use today.

5.1.2.9 Gas Generating Materials. Gas generating waste is defined as waste materials which release gases during their decomposition by radiolysis, pyrolysis, chemical reactions, or bacterial decay. Gas producing materials include virtually all combustibles and noncombustibles, such as concrete, steel, certain process sludges, papers, rags, plastic, etc. Pressurization of containers is defined as the generation or accumulation of gases within the container that causes sufficient pressure to deform the container and lead to a safety hazard during the 20 years of storage required for TRU waste. The accumulation of certain gases (H_2, NO_2, NO_3) poses a threat of explosion or container corrosion both of which endanger safety and environment. The waste was to be packaged in such a nature that pressurization of waste containers would not occur and/or the waste container would not show "any observable or measurable breach of containment" caused by pressurization for the 20-year retrieval period following receipt to the burial ground (McCall 1980).

Table 5-2 provides the packaging requirements for gas generating materials as specified in the waste acceptance criteria.

5.2 SPECIAL PACKAGING PROCEDURES

Many facilities or areas implemented practices or standard operating procedures that were in addition to the required Hanford specifications and standards. This section describes the different packaging procedures for the major areas. Additional information on specific packaging procedures are described in the following characterization reports.

- *Characterization of Past and Present Solid Waste Streams from the Plutonium Finishing Plant*, WHC-WP-0621 (Duncan et al. 1993)

- *Characterization of Decontamination and Decommissioning Wastes Expected from the Major Processing Facilities in 200 Areas*, WHC-EP-0787 (Pottmeyer et al. 1994)

Table 5-1. Liquid and Animal Waste Packaging Practices.

Date	Packaging procedures
1967	Liquid waste was accepted when absorbed by an inert absorbent material. Deceased laboratory animals or other materials attractive as food for wildlife had to be sealed in plastic and packaged in wooden or metal containers which prevented retrieval of the buried material by wildlife (Smith 1967).
1974	Battelle-Northwest Laboratories packaged carcasses in a waterproof inner container with sufficient inert absorbent material to completely absorb the liquid as the carcasses decayed. Additionally, the waste was treated with a material, such as unslacked lime, to suppress gas generation during decay, thus assuring that the integrity of the approved outer container was maintained (Stocking 1974).
1977	Damp and wet waste was only permitted when vaporization would not pressurize or corrode the container. Containers had to withstand the credible internal pressures generated by the waste or be fitted with pressure modifying devices. Animal carcasses, since they contained liquid organics, were considered organic liquid waste and were not accepted (Anderson 1978).
1980	Liquid organic waste [flashpoint greater than 66 °C (150 °F)] was acceptable if properly packaged. Liquid organic waste was to be placed unabsorbed into a seal-tight container (preferably 5 to 10 gal). The inner container was overpacked into one 55-gal drum with a rigid 0.1-mm (4-mil) polyethylene liner. The drum was filled to the top with acceptable absorbent necessary to completely absorb the liquid if the inner container was breached. Liquid organics, as a general rule, were to be limited to fissile content of 100 g or less per 55-gal drum (McCall 1980).
1982	To meet specifications no more than 1.7 L of organic were transferred to a polybottle. The polybottle was vented and contained two Conwed absorbent pads. The filled polybottles were sealed into vented and filtered polyethylene bags. The bagged polybottles were then packaged for 20 year retrievable storage (RHO 1982).
1987	A volume of diatomaceous earth was added equalling four times the estimated volume of a liquid.

Table 5-2. Gas Generating Material Packaging Requirements. (5 sheets)

Year	Waste acceptance criteria document	Gas generating materials packaging requirements
1968	ARH-919 (Smith 1968)	Chemicals which are incompatible (e.g., those which could react vigorously or explode on combination) shall not be packaged in the same waste container.
1970	ARH-1842 (Hanson and Oberg 1970)	
1974	ARH-3032 REV 0 (Anderson 1974)	Chemicals which are incompatible (e.g., those which could react vigorously, or possibly explode in combination) shall not be packaged in the same waste container.
1977	ARH-3032 REV 1 (Anderson 1977)	Materials which are incompatible (e.g., those which could react vigorously, or possibly explode in combination such as radiolytic hydrogen, organics and HNO_3) shall not be packaged in the same waste container.
1980	RHO-MA-222 REV 0 (McCall 1980)	The waste packaged shall be of such nature that pressurization of the waste container shall not occur and/or such that the waste container shall not show "any observable or measurable breach of containment" caused by pressurization for the 20-year retrieval period following receipt in the burial grounds.
1982	RHO-MA-222 REV 6/82 (Masa 1982)	Certain materials that generate significant amounts of gas during storage such as oxidizers, alkali metals, or concrete (when mixed with certain quantities of alpha emitters for waste immobilization) are prohibited. The accumulation of certain gases such as H_2, NO_x, or O_2 pose the threat of rupturing or corroding away containers, either of which endangers safety and environment. To minimize such occurrences, the waste generator must examine the waste to determine if there is a potential for gas generation.
1982	RHO-MA-222 REV 6/82 (Masa 1982) (cont.)	For high organic content waste associated with high alpha emitter content or other waste suspected of being potentially gas generating, the waste generator is required to do one of the following: • Complete an analysis to show that the waste is not gas generating. • Provide vent clips and/or a recombining catalyst package. Rockwell Solid Waste Storage and Disposal Team and/or WMSCA will examine the proposed packaging system with the supporting analysis for the choice made and will either approve, disapprove, or suggest modifications necessary to receive approval. Each unique packaging system will require WMSCA Approval Authority approval.

Table 5-2. Gas Generating Material Packaging Requirements. (5 sheets)

Year	Waste acceptance criteria document	Gas generating materials packaging requirements
1983	RHO-MA-222 REV 1 (Masa 1983a)	Gas generation in waste may be caused by a high water and/or organic content that is exposed to a high alpha emitter content or high beta-gamma activity, chemical reactions, solar heat, etc. If the waste is gas generating, the waste generator is required to do one of the following: • Complete an analysis to show that the waste is not gas generating. • Provide a recombining catalyst package for hydrogen and/or a means of venting the container. Venting may be accomplished by a special vented filter, vent clips, gaskets, a container which collapses after backfilling, etc.
1984	RHO-MA-222 REV 2 (Belgrair 1984)	Each TRU waste generator shall provide the following data and documentation of the method of measurement or estimation for each waste package: • Total alpha activity • Waste form description • Mass of organic content.
1984	RHO-MA-222 REV 2 (Belgrair 1984) (cont.)	The Rockwell SWP&DU must be informed of any radioactive waste package containing solid waste with a potential for gas generation, regardless of the cause, which may be: a high water and/or organic content in combination with high exposure rate material, chemical reactivity, solar heating, or curing concrete. A waste package containing such waste must either vent the generated gas safely, or otherwise prevent pressure build up. • Venting may be accomplished by a special vented filter, vent clips, gaskets, or similar devices approved by the SWP&DU. • A recombining catalyst package for hydrogen may be required.
1985	RHO-MA-222 REV 3 (Pauly 1985)	The following requirements apply to all TRU waste packages.
1987	RHO-MA-222 REV 3A (Pauly 1987)	• The total alpha curie content, description of waste form (matrix), and volume percentage and mass of organic content in each waste package shall be determined and reported in the corresponding documentation. This information may be determined by assay, records, measurements or calculations.

Table 5-2. Gas Generating Material Packaging Requirements. (5 sheets)

Year	Waste acceptance criteria document	Gas generating materials packaging requirements
1987	RHO-MA-222 REV 4 (Amir et al. 1987)	• Each waste package containing waste forms known or suspected to generate gas shall be vented in such a manner as not to jeopardize the capacity of the waste package to meet all applicable DOT shipping requirements. All LLW with the potential to generate sufficient gas to pressurize the waste package or to reach flammable concentrations of hydrogen and oxygen shall be vented. Rockwell SWP&DU may require the use of hydrogen-oxygen recombinant catalysts to deplete free oxygen in LLW packages and shall determine the acceptability of individual venting devices and recombinant catalysts.
1988	WHC-EP-0063 REV 0 (Stickney 1988)	The following requirements apply to all waste packages: • Each waste package shall be vented in an approved manner to prevent jeopardizing the ability of the waste package to meet all applicable DOT shipping requirements. • Hydrogen-oxygen recombinant catalysts to deplete oxygen and prevent explosive concentrations of hydrogen and oxygen may be required in TRU waste packages. If required, the use of catalysts will be specified in the applicable SDAR. • For purposes of transportation and storage, there shall not be mixtures of gases in any package which could, through any spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging. • Any liner other than plastic bagging shall be provided with positive gas communication to the outer container.
1989	WHC-EP-0063 REV 1 (Stickney 1989)	The following requirements apply to all waste packages: • Each waste package shall be vented as approved in the applicable SDAR to prevent jeopardizing the ability of the waste package to meet all applicable DOT shipping requirements. Multiple vents may be required to accommodate high gas generation rates. Noncertified waste packaged in boxes before the issuance of this manual may not be vented. Such packages will be evaluated for acceptance on a case-by-case basis (by Engineering and Safety) and requirements for them will be contained in the applicable SDAR.
1990	WHC-EP-0063 REV 2 (Willis 1990)	

Table 5-2. Gas Generating Material Packaging Requirements. (5 sheets)

Year	Waste acceptance criteria document	Gas generating materials packaging requirements
1991	WHC-EP-0063 REV 3 (Willis and Triner 1991)	• Hydrogen-oxygen recombinant catalysts to deplete oxygen and prevent explosive concentrations of hydrogen and oxygen may be required in TRU waste packages. If required, the use of catalysts will be specified in the applicable SDAR. • For purposes of transportation and storage, there shall not be mixtures of gases in any package which could, through any spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging. • Any liner other than plastic bagging shall be provided with positive gas communication to the outer container. • All plastic bagging shall be closed using the "twist and tape" or "horsetailing" method. Other methods of closure must be approved in advance of their use in the applicable SDAR. NOTE: Limits for other waste packages determined by WHC Criticality Engineering Analysis.
1993	WHC-EP-0063 REV 4 (Willis 1993)	The following requirements were specified for LLW: All LLW with the potential to generate sufficient nonradioactive gas to pressurize the waste package greater than 1.5 atmospheres or to reach explosive concentrations of hydrogen and oxygen or other explosive gases shall be vented. Vents shall be sized to ensure adequate passage of generated gas. Catalyst packs to deplete free oxygen in LLW packages and prevent flammable concentrations of hydrogen and oxygen may be required in addition to, or in lieu of, vents. If required, the use of catalysts and/or vents will be specified in the applicable SDAR. If used, the catalyst packs will be palladium on alumina or platinum on silica, depending on the potential amount of moisture present in the waste package. The amount of catalyst required will be based on the amount of potential hydrogen generation and will be specified in the applicable SDAR. Liners other than plastic bags shall be provided with positive gas communication to the outer package.

Table 5-2. Gas Generating Material Packaging Requirements. (5 sheets)

Year	Waste acceptance criteria document	Gas generating materials packaging requirements
1993	WHC-EP-0063 REV 4 (Willis 1993) (cont.)	The following requirements were specified for TRU waste: Liners such as the 22.5-mm (90-mil) liner, will be vented with an approved filter, venting device, or will have a minimum 0.8 cm (0.3 in.) hole in the lid. In the unfiltered ports of the solid waste burial box, a "plugged" label will be affixed. All filters and plugs will be installed internally. The maximum number of confinement layers in the waste package shall be known. For purpose of transportation and storage, there shall not be mixtures of gases or vapors in any package which could, through any spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging. All plastic bagging shall have a positive gas communication to the outer package.

DOT = U.S. Department of Transportation.
LLW = low-level waste.
SDAR = storage/disposal approval record.
SWP&DU = Solid Waste Processing and Disposal Unit.
TRU = transuranic.
WMSCA = Waste Management Safety Committee A.

- *Characterization of Past and Present Waste Streams from the 325 Radiochemistry Building*, WHC-EP-0696 (Pottmeyer et al. 1993a)
- *Characterization of Past and Present Solid Waste Streams from 231-Z*, WHC-EP-0659 (Pottmeyer et al. 1993b)
- *Characterization of Past and Present Solid Waste Streams from the Plutonium-Uranium Extraction Plant*, WHC-EP-0646 (Pottmeyer et al. 1993c)
- *Radioactive Waste Shipments to Hanford Retrievable Storage from Westinghouse Advanced Reactors and Nuclear Fuels Divisions, Cheswick, Pennsylvania*, WHC-EP-0718 (Duncan et al. 1994b)
- *Radioactive Waste Shipments to Hanford Retrievable Storage from Babcock and Wilcox, Leechburg, Pennsylvania*, WHC-EP-0719 (Duncan 1994a)
- *Radioactive Waste Shipments to Hanford Retrievable Storage from the General Electric Vallecitos Nuclear Center, Pleasanton, California*, WHC-EP-0672 (Vejvoda et al. 1993).

5.2.1 100 Area

In 1967, DUN operated the 100 Area for the AEC. Waste categories established by DUN were slightly different than the rest of the site. Waste generated by DUN facilities was sorted and packaged into "soft" and "hard" wastes. Soft or combustible waste primarily consisted of material such as paper, rags, absorbent swabs, plastic, and wood. Hard or metallic wastes included aluminum, iron and zircaloy, and structural concrete and steel. The metallic solids had diverse configurations ranging from small tools and 20 cm (8 in.) long fuel element spacers to large equipment pieces such as 12 m (40 ft) long irradiated control rods and uranium contaminated fuel fabrication equipment (Hill et al. 1970). This segregation and packaging practice permitted the select burning of soft wastes with the exception of those wastes contaminated with highly toxic TRU radionuclides or beryllium. Personal communications indicate that this method of segregation was continued even after DUN no longer operated the 100 Area.

5.2.2 200 Area

The PFP and the PUREX Plant, two of the major solid waste generating facilities within the 200 Area, had Plant Operating procedures that complied with Hanford specifications and standards, but also implemented additional administrative controls within the facility. Since both of these facilities had the potential for containing plutonium in measurable quantities, the solid waste was segregated as it was generated and packaged in color coded drums.

Standard Operating Procedures released in 1976 define "hood" wastes and "room" wastes. Hood wastes were wastes generated inside processing hoods and were considered highly contaminated with plutonium (ARHCO 1976). Room wastes were wastes generated from operations outside the processing hoods and were considered potentially contaminated with plutonium. Solid wastes were segregated into combustible hood waste, combustible room waste, and noncombustible room and hood waste.

5.2.2.1 Combustible Hood Waste. Combustible hood waste was comprised of material such as plastic, rubber gloves, rags, and cardboard. It did not contain metal, glass, or process materials such as powder, sludge, acid soaked rags or solutions of any type. After the waste was double-bagged, the waste package was enclosed in a special yellow lard can identified for hood waste. The lard can was used only for transporting hood waste and was not used for storage. The was received in a drum with a yellow spring-loaded door mounted to the drum (ARHCO 1976).

5.2.2.2 Combustible Room Waste. Combustible room waste included combustible waste generated outside of hoods. This waste could contain low-level contaminated, but should not have contained an appreciable amount of plutonium. The waste was stored in drums topped with a silver dome. These drums were required to be located at least 0.9 m (93 ft) from active hoods and significant quantities of plutonium (>15 g). This waste was destined for long-term underground storage unless it contained too much plutonium as measured on the nondestructive assay (NDA) drum counter (ARHCO 1976).

5.2.2.3 Noncombustible Hood and Room Waste. Both noncombustible hood and room wastes were collected in drums topped with red domes. Noncombustible hood waste was comprised of metal and glass which was removed from the hoods and handled separately from combustible hood waste. This waste was ultimately buried for long-term storage (ARHCO 1976).

5.2.3 300 Area

Laboratory combustible wastes (paper, plastic, etc.) in the 300 Area were not segregated from noncombustible wastes since the practice did not include incineration, but burial only, as the means of storage or disposal. However, combustible solid wastes were segregated and packaged separately from noncombustible solid wastes since they required special storage requirements to reduce the potential of combustion.

Laboratory contaminated wastes having high radiation fields were packaged and transported in special shielded casks using a system which minimized personnel exposure. The contents were discharged directly to caissons located in the burial grounds (Hill et al. 1970). More information on caissons is included in Section 7.0.

In PNL laboratories where only small or trace quantities of radionuclides were used, uncontrolled waste receptacles were provided on the basis that accidental discard of contaminated waste to these would not constitute an exposure or a waste disposal problem (Hill et al. 1970).

Animal carcasses, generated as a result of scientific research, were treated in an underground storage tank containing caustic. Contaminated oil was adsorbed in sawdust and disposed as a solid waste.

5.3 WASTE MINIMIZATION PRACTICES AND FACILITIES

Disposal and storage of Hanford waste has always been a topic that attracted concern regarding optimal land usage. As early as the 1940's and 1950's, studies were conducted to evaluate various volume reduction techniques. Waste incineration and compaction are two such methods that were used at Hanford.

The first incineration of contaminated solid waste at the Hanford Site took place during the late 1940's in two burning grounds (trenches) in the 300 Area. When they were established during World War II, these burning grounds were designated for the burning of uncontaminated trash only. One site was located 700 m (2300 ft) north of the 333 Building, and the other site was located 120 m (400 ft) north of the North Process Pond. When burning was ceased in these two areas in 1951 and 1953, respectively, clean soil was placed over them and radiation signs were posted. In 1961 and 1962, they were designated and marked as the 618-4 and 618-5 Burial Grounds (Gerber 1992b).

In 1949 and the early 1950's, combustible wastes were burned on a few occasions in the 100 Area trenches. In 1956, the combustible materials within a trench in the 100-K Burial Ground were incinerated in place. Trenches were also burned in the 100-K and 100-Areas throughout the 1960's. In addition, deep pit incineration of wastes occurred at the DR Reactor during the late 1950's (Hill et al. 1970).

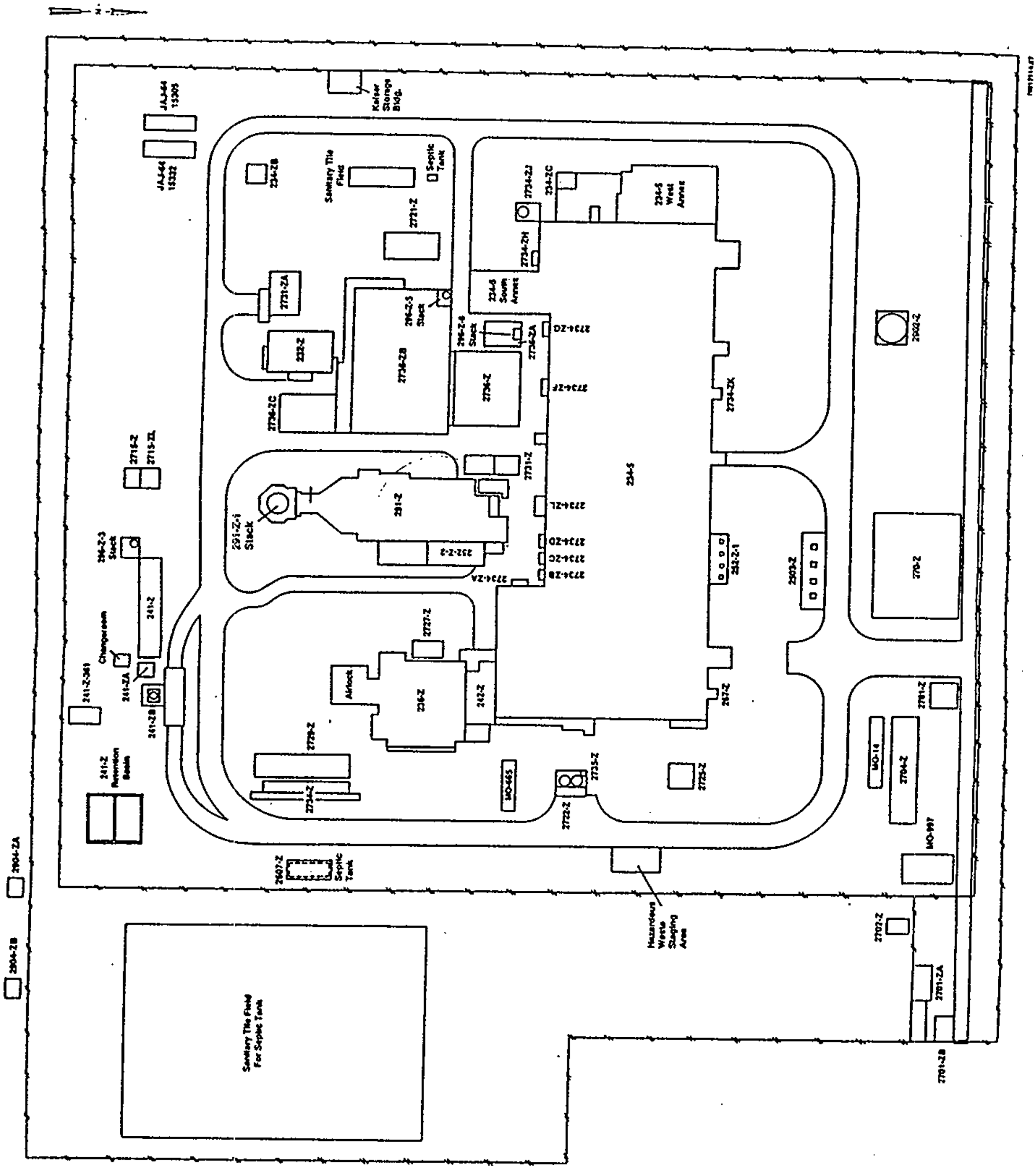
A Contaminated Waste Recovery Facility, commonly called the "Incinerator" included both incinerator and leaching equipment and was constructed in 1961 under Project CGC-013 (Knights 1969). The process was designed to recover plutonium from plutonium-bearing scrap that was produced as a by-product of the purification process.

The incinerator was housed in the 232-Z Building located at PFP. The 232-Z Building is approximately 60 m (200 ft) south of the main portion of the 234-5Z Building and approximately 30 m (100 ft) west of the 291-Z-1 stack (Carlson et al. 1994). It is oriented with its major axis on a north-south line. A layout of the PFP grounds, including 232-Z Building, is shown in Figure 5-1.

The small continuous-type incinerator consisted of a burning chamber and a "wet" exhaust gas system, which involved bubbling the effluent gas through a caustic solution to remove particulates. After long periods of service, this "wet" exhaust system encountered severe corrosion problems (Parks 1966). The unit was partially replaced due to mechanical and material failures in 1967 (Sloat 1967).

The incinerator was initially planned to recover plutonium primarily from Z Plant (PFP); however, excess capacity allowed other site waste, primarily PUREX waste, to also be processed (Hill et al. 1970). Cardboard cartons from ARHCO operations containing measurable quantities of plutonium equal to or in excess of 2 g were introduced into the incinerator for processing (Hill et al. 1970).

Figure 5-1. Layout of the Plutonium Finishing Plant, Including the 232-Z Building (WHC 1991).



The Z Plant incinerator complex included a sorting hood, a leaching hood, and an incinerator hood, as shown in Figure 5-2. Waste cartons were introduced to the sorting hood where noncombustibles (including rubber and plastics) were separated for leaching. The combustibles were then chopped to small pieces (in a commercial "hogger") and fed to the incinerator. Volume reduction of the material incinerated was reported as approximately 98 percent. The ash produced was dissolved and/or leached to recover about 98 percent of the plutonium. Unrecovered plutonium was either recycled in the system or routed to burial (Hill et al. 1970). Operation of the complex continued until 1973 when the incineration unit was shut down. Partial D&D of this facility occurred in 1984 (Duncan et al. 1993).

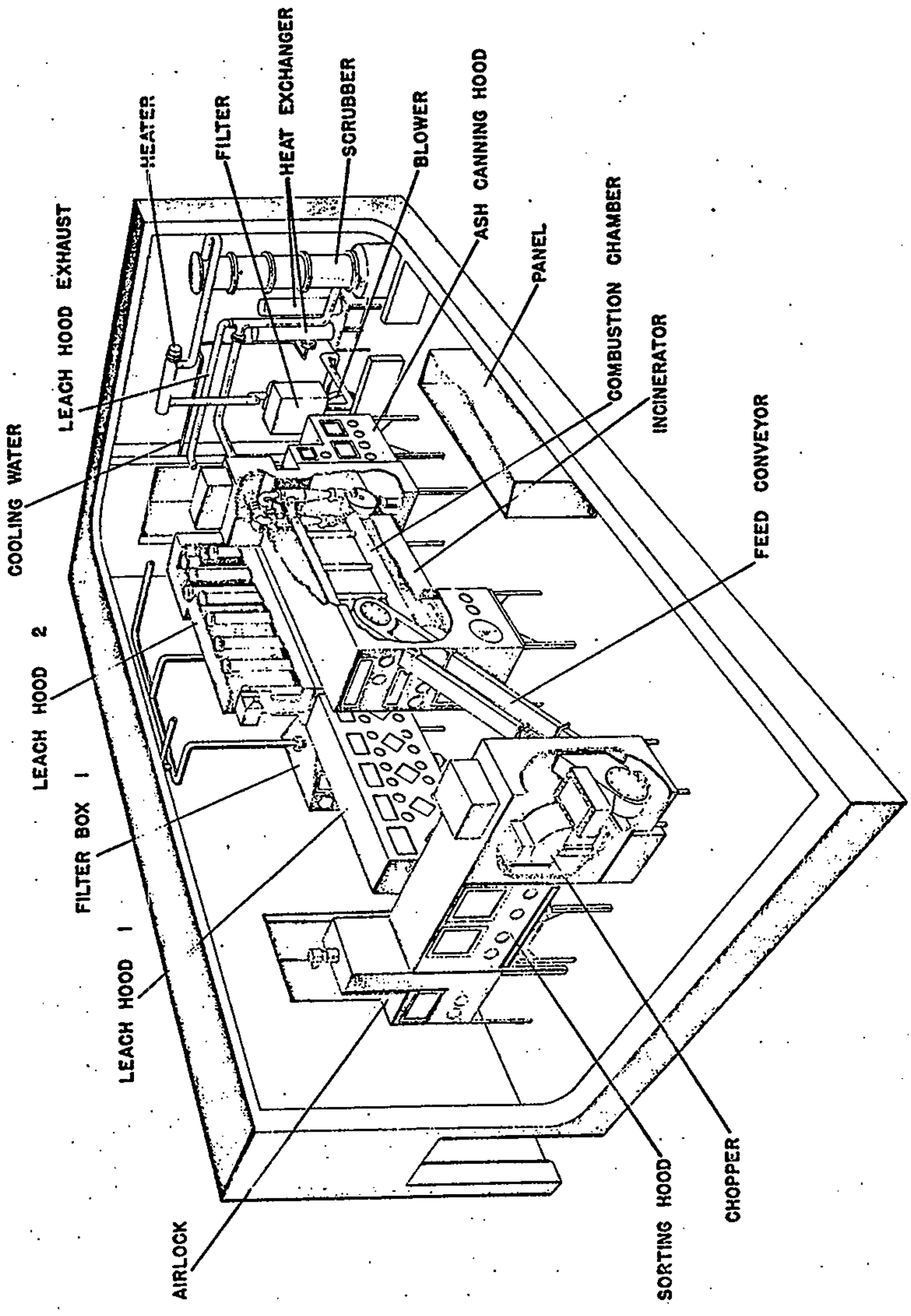
After years of in-trench incineration in the 1950's and 1960's, an "improved" prototype waste incinerator was constructed in 100-C Area in 1967. In 1968, a similar incinerator was constructed in 100-K Area. These incinerators had stacks designed to allow air sampling during operation so that more precise air activity results could be gathered. Both were natural draft incinerators installed above ground over ash pits. However, the K Area prototype was modified to permit burning in the ash pit. Air was pumped to the bottom of the ash pit through a pipe to improve combustion. This modification allowed the operator to fill the pit with boxes instead of burning them two or three at a time on the incinerator grating above the pit. No provision was made for smoke treatment. Experience with this equipment showed that all of the smoke did not go up the stack. High temperatures warped the doors and smoke poured out of all unsealed cracks (Hill et al. 1970). These incinerators are believed to have operated until they were phased out, in approximately 1971, when stricter federal air regulations were imposed (Kennedy 1971b).

Compaction facilities were considered in several studies in the 1960's; however, the direct compaction was not considered cost effective at the time because the implementation and maintenance costs were not justified by the cost of the acres saved (Hill et al. 1970). The only method of compaction practiced prior to the 1970's was in situ compaction. In situ compaction was initiated in 1966. The system was simple and effective. A 1.2-m- (4-ft-) square concrete block was picked up by a hydrocrane and dropped on the soft wastes in the trench. A reduction factor of 2:1 was gained (Hill et al. 1970).

DUN employed in situ compaction in both the 300 and 100 Areas. In the 300 Area, some in situ compaction was accomplished through use of a D8 caterpillar. In-place compaction in the 300 Area was simplified because there were no radiation dose rates to cope with and the trenches were designed accordingly. In the 100 Area, dose rates of the wastes prevented caterpillar compaction before backfilling. Because of limited crane use for other purposes, this method was discontinued in the 1970's (Hill et al. 1970).

Eventually, direct compaction became more cost effective. Around 1972, small kitchen-type compactors were tested in ARHCO analytical laboratories and decontamination facilities. Preliminary results were good, and the volume of waste being sent to the burial grounds from these generating locations was reduced substantially. The waste was compacted into bags supplied by the manufacturer and four bags were packed into the

Figure 5-2. Cutaway of the Contaminated Waste Recovery Facility (Incinerator) (Knights 1969).



standard 0.1-m³ (4.5-ft³) cardboard box used for radioactive wastes. The cost of about $200 each for these compactors not only was a small capital expenditure, but it also made it possible to replace a failed compactor with a new unit instead of having the problem of attempting to perform maintenance on contaminated equipment (Strand 1972).

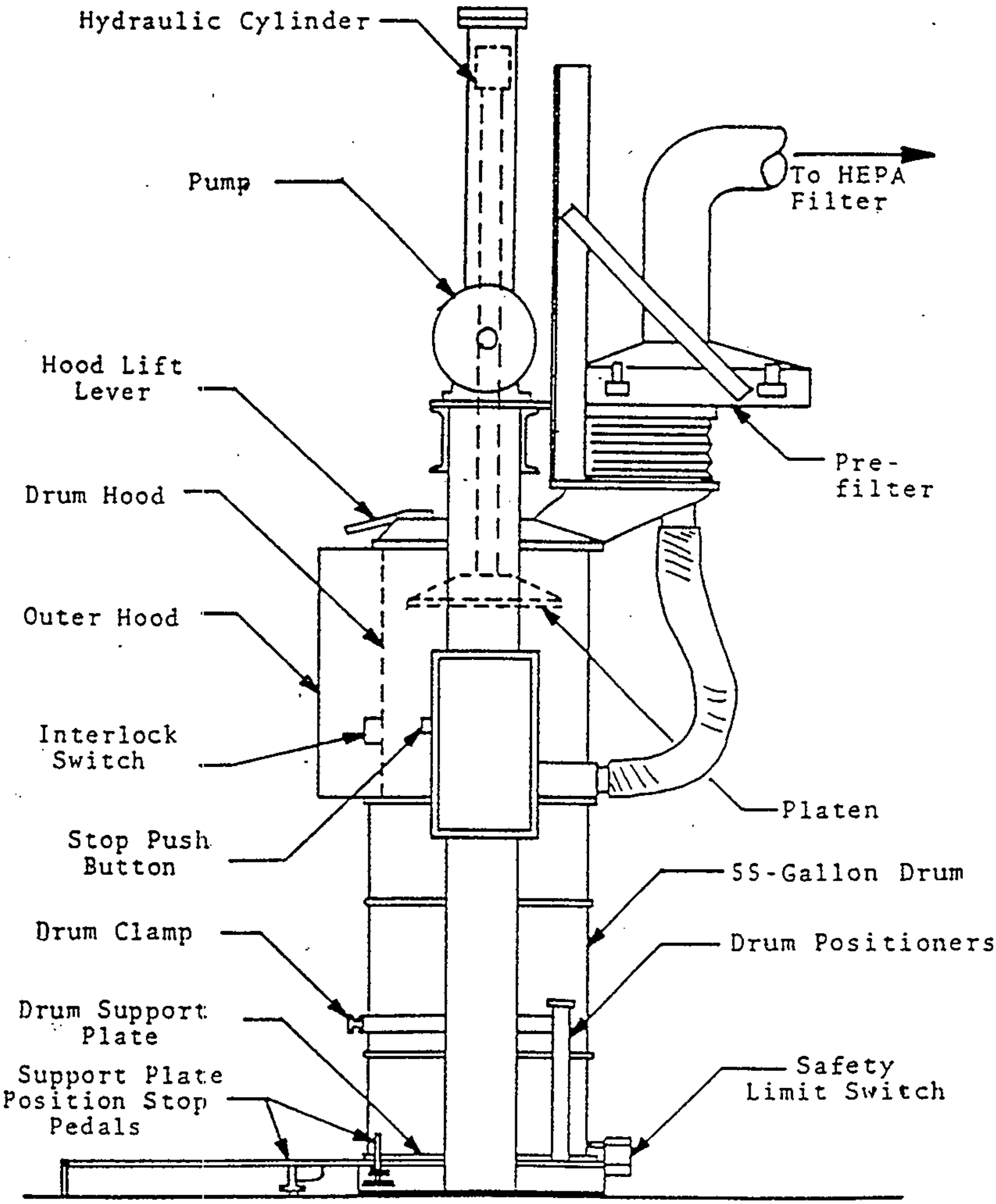
At the PFP's 234-5Z Building in the 200 West Area, a prototype compactor for use on combustible transuranic wastes became operational in September 1972. This compactor, which had a goal of reducing the volume of waste by a factor of 4, is shown in Figure 5-3 (Strand 1972). Wastes compacted by this compactor were from the rooms and offices in radioactive areas and, therefore, were potentially contaminated (Anderson 1972).

This prototype compactor used a 9.1 metric ton (10 English ton) hydraulic press for compaction directly into 55-gal drums for 20-year retrievable storage. It was a modification of a commercial compactor sold by Consolidated Baling Machine Company (Model DOS-RAW Type II[X]) of Brooklyn, New York. It was basically a two-column, openside, downstroke, hydraulic baler, made for use with standard 55-gal drums. The total compression force was 9,000 kg (20,000 lb), and the compression pressure on the wastes material was 340 kPa (50 lb/in²). The hydraulic cylinder had a 10-cm (4-in.) bore, a 107-cm (42-in.) stroke, and operated on a line pressure of 11,000 kPa (1,600 lb/in²) created by a 3,700-W (5-hp) pump motor. Wastes to be compacted in this facility consisted of waste paper, plastic sheet, cardboard containers, plastic containers, rags, and other compressible waste materials. The majority of the material was to be paper products. No metal, wood, or large amount of liquid were to be compacted (Anderson 1972).

In 1985, a *Dry Waste Compactor Hazard Identification and Evaluation*, WHC-SD-WM-SAR-009, was released for the Dry Waste Compaction Facility, 213-W Building. The facility was planned in response to the DOE-RL Order 5820.2, which required waste volume reduction to the extent technically and economically practical. The building is a 79-m² (853-ft²) pre-engineered, self-framing structure located adjacent to the 272-WA Operations Support Facility within the 200 West Area. The building consists of three rooms designated as personnel entry, package inspection, and compaction (Koontz 1985).

The compactor in Building 213-W was designed to provide volume reduction for a limited quantity of compactible wastes. A compaction force of 130,000 kg (60,000 lb) compressed LLW directly into steel burial boxes which had a capacity of approximately 3 m³ (90 ft³). Compactible waste consisted of rags, paper products, rubber, glass, plastic and other cellulosic materials that were not rigid and were contaminated with non-TRU radioactive material. Administrative controls at the locations where the waste was generated excluded noncompactible waste and hazardous or dangerous waste. Wastes for compaction were normally packaged in polyethylene bags and then placed in double-wall corrugated fiberboard boxes. The wastes were compacted into special metal boxes and stored. In addition to the compacting function, the facility functions were expanded in 1993 to include temporary confirmation/verification of the contents of newly generated LLW 55-gal drums.

Figure 5-3. Operation Features — Prototype Waste Compactor (Strand 1972).



6.0 WASTE CONTAINERS

This section summarizes the waste containers that have been disposed or retrievably stored in the Hanford Site burial grounds and storage facilities. Section 6.1 discusses general container requirements, including design specifications, vents, seals, shielding, lifting devices, and labeling. The containers used by onsite and offsite generators fall into 22 categories; these container types are described in detail in Section 6.2.

6.1 GENERAL CONTAINER REQUIREMENTS

The general container requirements for waste containers accepted by the Hanford Site burial grounds and storage facilities are provided below. Additional information on containers has been provided in the appendices of this report. Appendix A contains a list of drawing numbers and titles for approved burial containers. Appendix B provides more specific information such as weight limits, dose rate limits, and authorized contents for approved burial containers in the early 1980's.

6.1.1 Design Specifications

Design specification criteria for waste containers prior to the mid-sixties were nonexistent. In 1964, specifications for high-integrity containers (containers with fissile material) had to be such that the chances of an accidental release of the contents to the external environment were minimal. The primary purpose of a fission waste container was to keep the waste in and let the heat out. Waste for burial was packaged in containers which were designed to contain the contamination and withstand normal transfer and handling without rupture. Containers had to be designed for an extremely long life to prevent leakage of harmful fission products to the external environment (Barnes 1964).

The *Design Criteria for Transuranic Dry Waste Steel and Reinforced Concrete Burial Containers*, ARH-CD-353, released in 1976, stated that individual containers were limited in size and weight only by the capacity of the equipment available to move them to the burial ground and into the burial trench (Hammond 1976). Whereas, offsite commercial waste generators sent waste in containers specifically designed to have a standard dimension for maximum utilization of the storage space (Moore and Calmus 1978).

In the early 1980's design specifications were expanded. The *Functional Design Criteria for Modular TRU Waste Storage Containers*, RHO-CD-1086, released in 1980 provided the following design specification criteria (Orton and Shirey 1980):

- The design criteria required that containers have adequate structural strength to withstand the maximum forces anticipated due to soil and live loads, stacking loads, and side loads.

- Containers were to be designed to be filled from the top, with a removable lid to expose the entire volume.

- The interior space of each container was to have no intrusion by structural members or any obstruction that would inhibit the placement or removal of packaged solid waste.

- Containers required sufficient integrity to meet normal conditions of transport.

Additional design specification requirements provided in *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, RHO-MA-222, the Hanford Waste Acceptance Criteria document released in 1980 are listed below (McCall 1980):

- Containers were to be constructed of noncombustible, compatible materials that would not corrode or degrade to the point that containment integrity was breached or that the container would not support the weight of the contents when lifted.

- Wooden containers were to be fire retardant.

- Containers were to be designed to withstand stacking of similar containers to a total height of 3.7 m (12 ft).

- The container was to have no permanent instrumentation.

- The container was to be designed to resist the effects of weather that were common to the Hanford area, including the climate outdoors and the climate within the storage module.

- No neutron absorbers or moderators were needed in conjunction with the waste package for non-TRU, nonfissile waste materials.

- Once buried, no reliance was placed on the container for the confinement of solid waste materials. Packages were designed to remain intact, contamination-free, and able to withstand onsite transport at the end of the 20-year period.

6.1.2 Vents

Up until the 1970's, there were no requirements for venting burial containers to allow for the release of built up pressure. If waste materials were known to generate gases, they were placed within containers constructed of a material known to collapse under the weight of backfilling. Once the integrity of the container was no longer intact, it was considered vented.

The *Design Criteria for Transuranic Dry Waste Steel and Reinforced Concrete Burial Containers*, ARH-CD-353, released in 1976, stated that burial containers were provided with vents if there was a requirement that they be protected against variations in internal pressure. Such vents would be discharged through HEPA filters. The vents and filters were protected from damage caused by the container contents and by the transportation, burial, and retrieval operations (Hammond 1976).

The first specification for vent clips were provided in April 1979, Drawing 4-2-28798. By 1979, vent clips had been installed on all onsite drums. Shipments of offsite drums equipped with vent clips were first documented as being received in 1980.

According to the *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, RHO-MA-222, the Hanford Waste Acceptance Criteria document released in 1980, each container was to be designed to provide the option of a vent or test connection capable of being fitted with or adapted to accept an air or vacuum hose, or gaseous diffusion vent. Such an opening was to provide positive sealing when not in use, was to be designed and located so as not to interfere with container handling or stacking, and was not to adversely affect structural characteristics (McCall 1980).

In a document released in 1981, titled *Non-Transuranic, Non-Fissile Radioactive Waste Transportation in 55-Gallon Drums*, it was determined that waste materials packaged in 55-gal drums did not emit sufficient radioactive decay heat to require package design provisions for heat dissipation, such as cooling fins or coolant flow devices (Foster and Carter 1981). However, the drums still required venting to reduce the build up of internal pressure.

In 1983, it was determined that venting could be accomplished by a special vented filter, vent clips, gaskets, or a container that collapsed after backfilling (Masa 1983a). Around the same time, limits on repressurization were established. Containers that could become repressurized to more than 48 kPa (7 lb/in^2 gage) within 25 years required venting through a HEPA filter (Belgrair 1984).

6.1.3 Seals

The first mention of seals was made in the *Design Criteria for Transuranic Dry Waste Steel and Reinforced Concrete Burial Containers*, ARH-CD-353, released in 1976. It was stated that any gasket material used to provide closure had to be compatible with the closure seal design and was selected for a 20 year life in the burial trench environment (Hammond 1976).

Beginning in 1980, the seam between the lid and the body of the container was required to be capable of being fitted with a seal or other device which was not readily breakable and, while intact, would be evidence that the lid had not been illicitly opened during shipment (McCall 1980). Seals were designed to function under all conditions of surface transport, handling, and stacking and not leak because of container deflection or minor deformation (Orton and Shirey 1980).

A tamper-indicating seal was a device designed to be affixed to a container for the purpose of detecting tampering or unauthorized entry. Use of tamper-indicating seals on Nuclear Material Containers (NMC) provided the capability of verifying the integrity of the contained items through seal inspections. Labels were used on nuclear material containers to provide information relative to inventory data, material identification, type, and quantity during container handling and storage (Ellis 1983).

"Cup-wire" seals were used for the confirmation of sealed nuclear material items only. The cup-wire seal consisted of two metallic parts that, when snapped together, formed a numbered enclosure around the joined ends of a length of wire. The wire was attached to the object to be sealed in a manner that required breaking the wire or destroying the seal to open the object. Figure 6-1 provides a series of pictures depicting how the cup-wire seal is positioned on a container. A cup-wire seal was applied to the following approved container types immediately after the nuclear material was packaged in the container and the container was closed prior to storage or transfer if the container was used as an outermost container (Ellis 1983).

LLD-1	55-gal drum
Model 10 Birdcage	L10, 10L
Model 60 Birdcage	RC Can
Type A Birdcage	3L
PR Can	6M
PR Mark IV	M6
PR Emergency	M-101, M-102
L3	FL10-1, ALM6

"Pressure-Sensitive Label/Seals," that were yellow in color, were issued to organizations for sealing small nuclear material items only. The Pressure-Sensitive Seal was a label/seal combination that was die-cut and printed on vinyl-film pressure-sensitive label stock. The seal was peeled away from a backing material to expose the adhesive coating on the back of the seal and applied to the container or other object to be sealed in a manner that required tearing the seal to open the object. A picture of this seal is shown in Figure 6-2. A Pressure-Sensitive Seal was applied to the following approved container types immediately after the nuclear material was packaged in the container if the container was used as an outermost container (Ellis 1983):

Seven-inch can	paint can
Food pack can	bucket
Two-pound slip lid	fifty-pound lard can
Five-pound slip lid	

Application of a Pressure-Sensitive Seal was required on container types not listed, but these were similar to and performed the same function as those listed and were acceptable for use of the Pressure-Sensitive Seal. Unless otherwise specified, paper or cardboard containers, such as cardboard boxes and ice cream cartons, were not considered acceptable for use of the Pressure-Sensitive Seal. The locations of a Pressure-Sensitive Seal on a tall, short, and lard type can are shown in Figure 6-3, 6-4, and 6-5, respectively.

6.1.4 Shielding

Shielding is defined as "a physical barrier to protect from radiation exposure" and was used primarily for the protection of transportation and disposal workers, as well as the environment. Shielding or the lack of shielding was justified in terms of ALARA (McCall 1980). Shielding was designed such that handling, transportation, credible accidents, or storage/disposal methods would not result in loss of shielding (Shord 1979). Also, shielding was required to maintain acceptable dose rates for the contained waste. Typically, shielding consisted of concrete blocks, rubber mats, lead, steel and, in some cases, shielded overpacks or other containers.

Figure 6-1. Cup-Wire Seal.

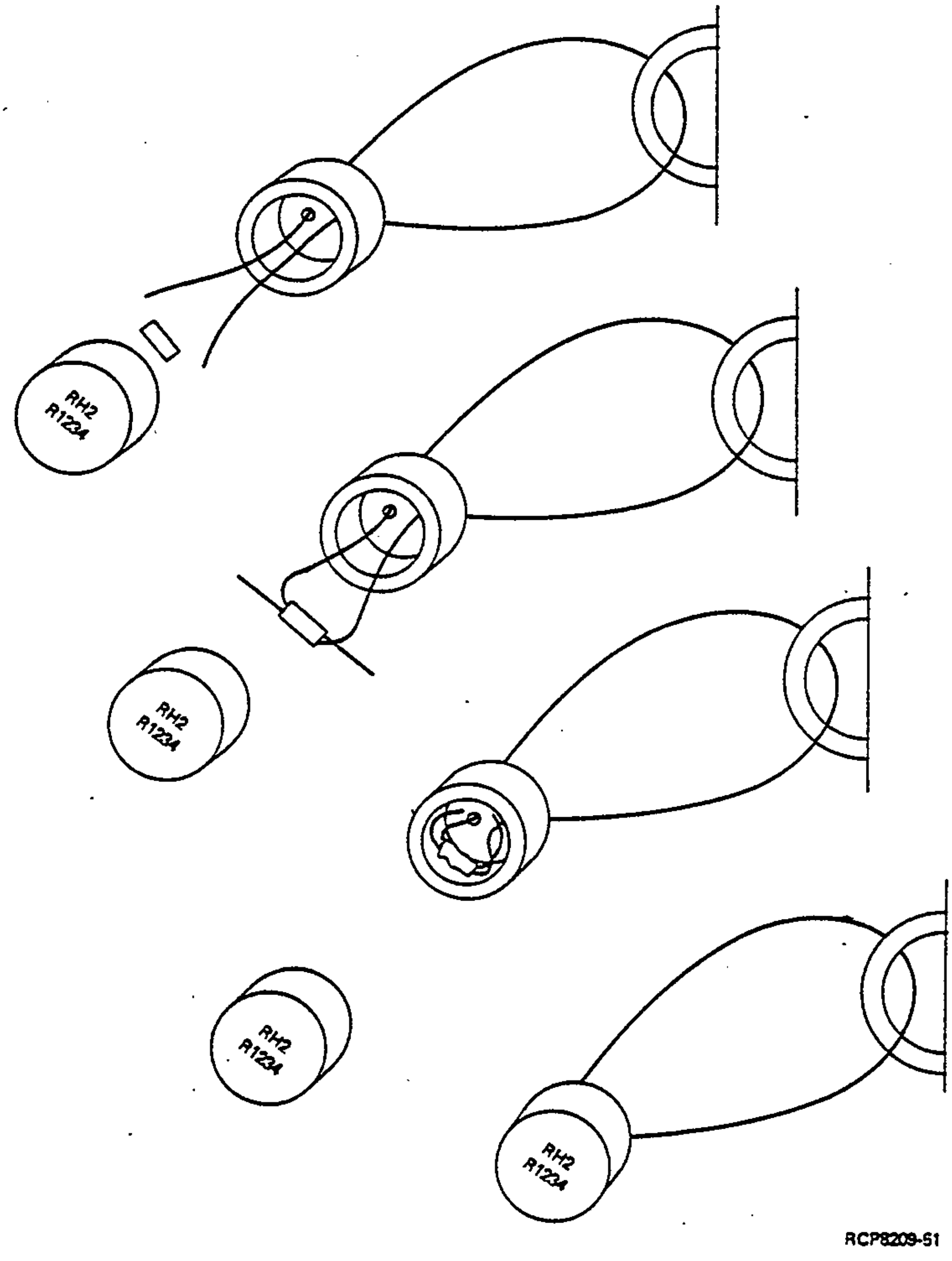


Figure 6-2. Pressure-Sensitive Seal.

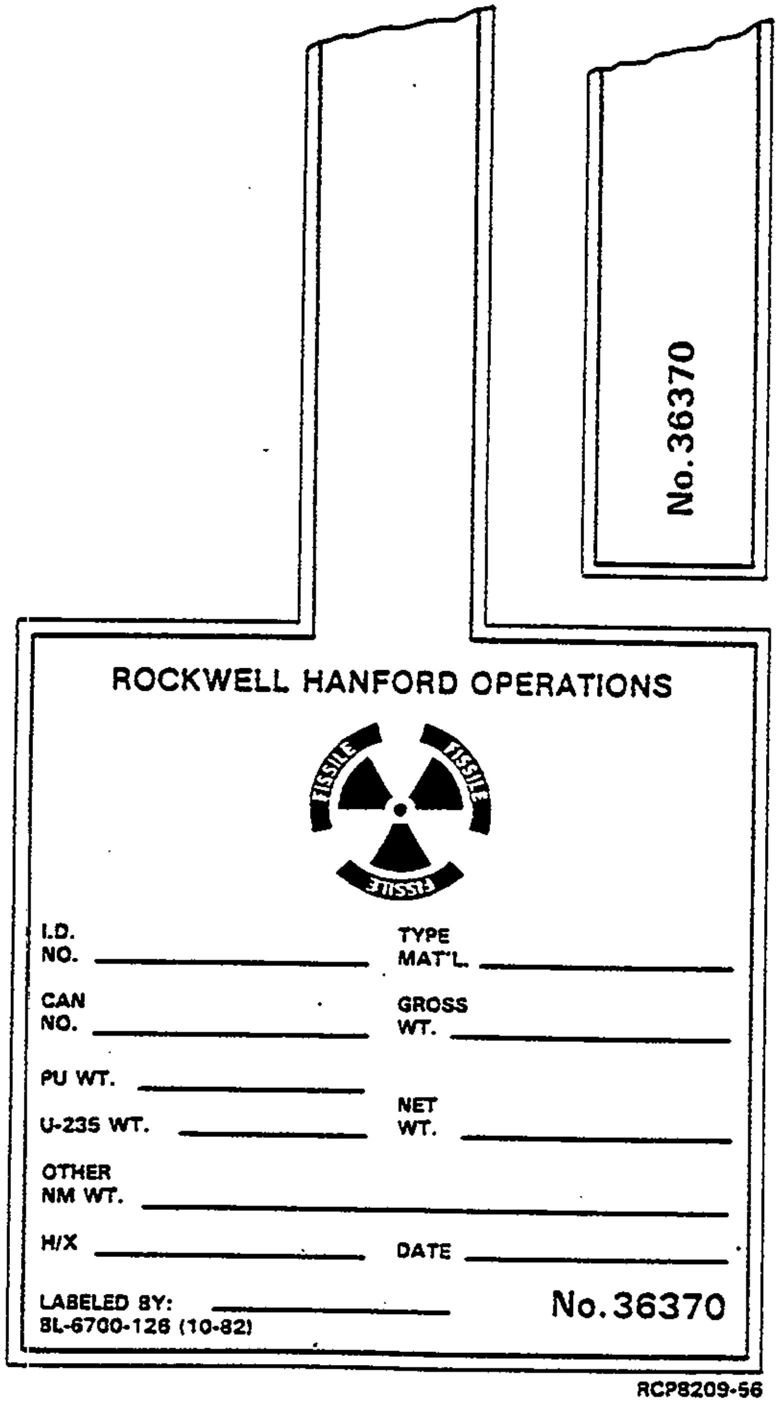


Figure 6-3. Pressure-Sensitive Seal Application for Taller Can.

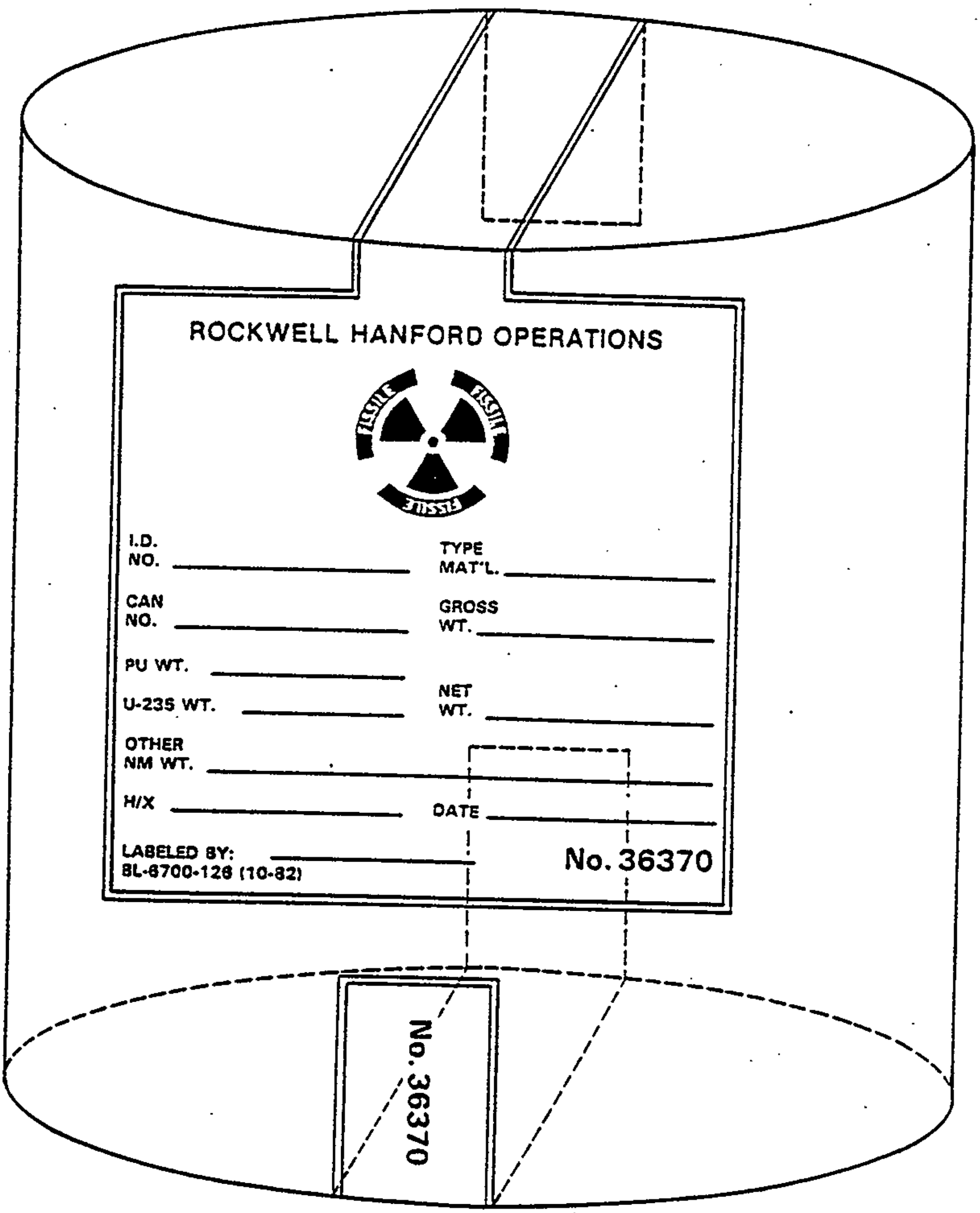


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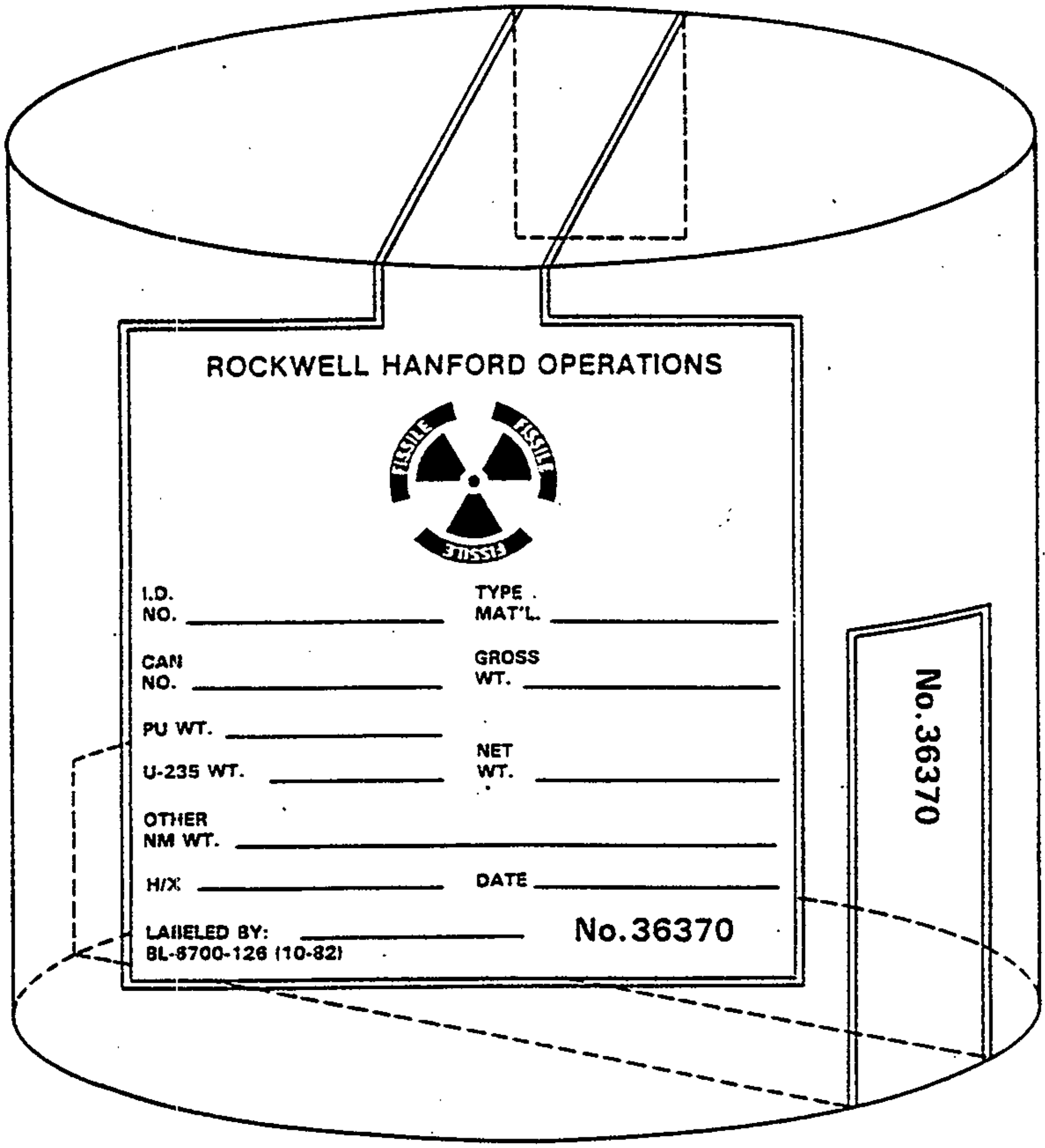
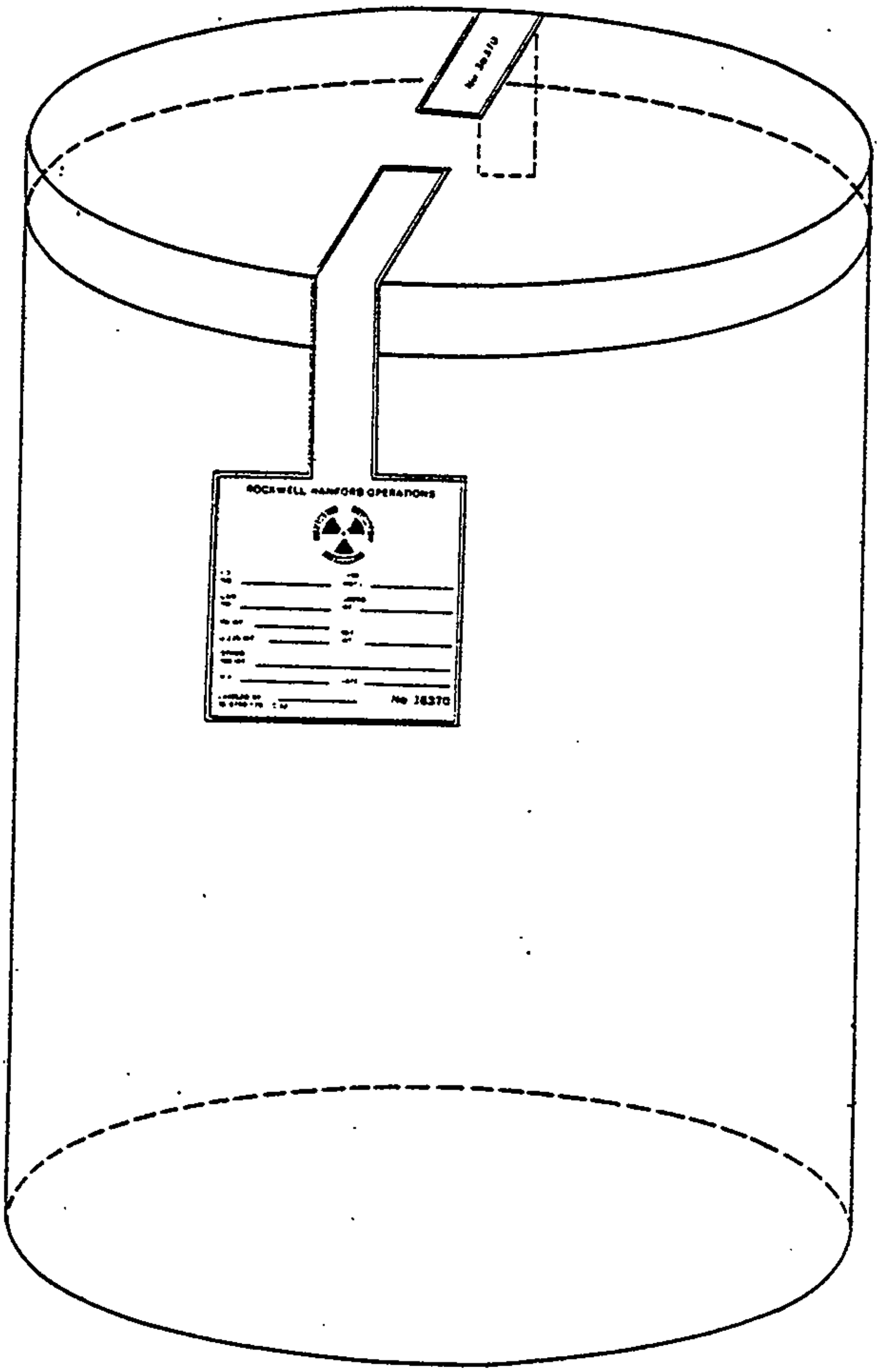
Figure 6-4. Pressure-Sensitive Seal Application for Shorter Can.



RCP8209-55

Figure 6-5. Pressure-Sensitive Seal Application for Lard Can.



RCP8209-54

Table 6-1 provides the Hanford Waste Acceptance Criteria documents' requirements for shielding waste containers at Hanford. These documents did not specify the type nor thickness of shielding used, but did specify that adequate shielding was determined by the type of material and quantity of radioactive material contained inside the package. Reference was made to container design criteria, but no mention was made in these criteria to shielding thickness. Requirements for shielding waste containers were scarce in the Hanford Waste Acceptance Criteria documents, as these requirements were determined on a case-by-case basis in the individual container's SDARs.

6.1.4.1 Container Shielding for Offsite Shipment. To protect workers and the environment, closed transport (attached exterior enclosure restricting access) vehicles were used to ship containers. This reduced external radiation dosage to the vehicle and protected the container from accidental impact and fire (Moore and Calmus 1978). The closed vehicle, however, was seldom used as a second containment but provided shielding and protection from impact (La Riviere 1978). Railroads also transported material to the burial ground. Spacer cars separated the waste from the crew members (Smith and Hanson 1969).

Solid HLWs were transported in shielded containers, such as lead-filled casks, but not necessarily buried in them. An example of offsite shielded shipping containers would be irradiated experimental fuel elements, doubly contained in aluminum and steel cylinders embedded in reinforced concrete blocks (Elgert 1969). More heavily contaminated drums could be shielded themselves or transported in shielded containers (Smith and Hanson 1969). Design specifications for the shielded 55-gal drum used to ship and bury wastes can be found in the 1983 drawing number H-1-44784. This drawings specified that if TRU waste was present, then a U.S. Department of Transportation (DOT) 17-C galvanized drum was used instead of a DOT 17-C standard drum. Precast standard concrete was put around the bucket of waste (10 or 15 gal, or 5 gal for TRU waste) and high density concrete was used to fill the void around the top of the 55-gal drum. A lead sheet or lead shot was used around the 5-gal bucket as required.

6.1.4.2 Container Shielding for Onsite Shipment. Another example of the difficulty in finding the exact thickness of shielding was in a concrete walled burial box design plan. This plan required that the radiation shielding be comprised only as necessary to maintain a total burial weight of under 40 tons (Koontz 1964). For protection in the 221-U Building, waste liners were in concrete containers with 50.8 cm (20 in.) of shielding on the sides and bottom, 6.99-cm (2.75-in.) lead plug on top and 2.54-cm- (1-in.-) thick steel flange (Van der Cook 1974).

Double containment type shielding for TRU waste during the period of 1970 to 1987 was similar to the above H-1-44784 container - a sealed 10-lb lard can put into a DOT 17-C specific 55-gal drum of 16 gauge or 0.16 cm (0.062 in.) steel-wall thickness (see Section 6.2.15.3). This had a 15.24-cm- (6-in.-) thick concrete liner. Drums were put inside a standard burial box with shielding from 1.9 to 5.08 cm (0.75 to 2 in.) of lead, keeping the dose rate under 6 mrads/hour for the driver by stacking and the arrangement of the drums in the transport truck (McCall 1980). Lead blankets were used in storage as external shielding on long length equipment from tank farms (i.e., lances - 17.47 m (57 ft long]) but this was a rare instance (Boynton 1994).

Table 6-1. Shielding of Waste. (2 sheets)

Hanford Waste Acceptance Criteria	Year	Requirements
HW-83959 (Koontz 1964)	09/64	Containers were to provide shielding if that was required. Individual design requests specified a minimum concrete wall thickness and minimum soil cover for safe burial equipment.
ARH-183 (Koontz 1964)	12/67	Solid HLW was shipped in shielded containers, such as lead; fissile material was packaged in metal containers. No specific shielding thickness requirement is mentioned.
ARH-919 (Smith 1968)	12/68	No shielding thickness requirement is mentioned.
ARH-1842 (Hanson and Oberg 1970)	12/70	Waste containers were required to minimize exposure. TRU waste was packaged in 55-gal drums with cement shielding as required. No specific shielding thickness requirement is mentioned.
ARH-1516 (Henry and Ritter 1971)	01/71	No shielding requirement is mentioned.
ARH-3032 (Anderson 1974)	04/74	HLW was packaged in concrete, steel, or lead to provide adequate shielding. Fissile material limits were provided and waste volume was minimized to meet these limits. All containers must be on approved container list.
ARH-3032 Rev. 1 (Anderson 1977)	04/77	Waste was minimized and the container must serve as a contamination barrier. Containers used were 55-gal drum, steel/concrete containers, FRP plywood, and 1 gal paint cans.
RHO-MA-222 Rev. 0 (McCall 1980)	05/80	Shielding or lack of shielding must be justified in terms of ALARA.
RHO-MA-222 Revised (McCall 1982)	06/82	TRU wastes had to be inside at least 2 barriers (plastic bags, ice cream cartons, cardboard boxes, etc. and the outer barrier had to meet Type A DOT, DOE, NRC, and International Atomic Energy Association requirements).
RHO-MA-222 Rev. 1 (Masa 1983)	12/83	Pre-rigged RH packages may be shielded by other containers, concrete blocks or overpacked for shipping.
RHO-MA-222 Rev. 2 (Belgrair 1984)	07/84	Shielding or lack of shielding must be justified in terms of ALARA.
RHO-MA-222 Rev. 3 (Pauly 1985)	08/85	Lead use was discouraged in burial containers in favor of concrete, steel, high-density concrete. Overpacking, remote handling, waste segregation and separation was encouraged. TRU waste packaged in DOT 17-C 55-gal drums had to meet DOT Type A testing criteria.
RHO-MA-222 Rev.4 (Amir et al. 1987)	06/87	Specific requirements for shielding of RH TRU waste packages was provided in the SARP for individual waste packages. Lead shielding was approved only if justified by ALARA and, when used, two containment barriers were not required.
WHC-EP-0063 (Stickney 1988)	09/88	This manual does not provide specific requirements for shielding. Specific requirements for shielding of RH TRU waste packages was provided in the SDAR for individual waste packages. Lead use for shielding was not acceptable for burial and used only if approved by overriding technical justification (i.e., ALARA) when steel or concrete were not suitable.

Table 6-1. Shielding of Waste. (2 sheets)

Hanford Waste Acceptance Criteria	Year	Requirements
WHC-EP-0063 Rev. 1 (Stickney 1989) WHC-EP-0063 Rev. 2 (Willis 1990) WHC-EP-0063 Rev. 3 (Willis and Triner 1992) WHC-EP-0063 Rev. 4 (Willis 1993)	09/89 09/90 09/91 11/93	These manuals do not provide specific criteria for RH TRU. Specific criteria for acceptance of RH TRU waste packages was developed on a case-by-case basis and provided to waste generators in the SDAR for each individual waste stream. The preferred method of packaging RH TRU was to shield the waste to contact handled levels and store it until facilities are available to treat this waste form.

ALARA = as low as reasonably achievable.
DOE = U.S. Department of Energy.
DOT = U.S. Department of Transportation.
FRP = fiberglass reinforced polyester.
HLW = high-level waste.
NRC = U.S. Nuclear Regulatory Commission.
RH = remote-handled.
SARP = safety analysis report for packaging.
SDAR = storage/disposal approval record.
TRU = transuranic.

6.1.5 Lifting Devices

Information describing waste container lifting devices was not available prior to 1980. A document titled *Functional Design Criteria for Modular TRU Waste Storage Containers*, which was released in 1980, stated that TRU waste storage containers were to be designed with two sets of lifting devices. One set of lifting devices was required to be a structural part of the lid and capable of handling three times the weight of the lid. The other set of lifting devices was to be a structural part of the container and capable of handling three times the weight of the container and its contents. Permanently attached lifting devices were not to extend outside the nominal external dimensions of each container far enough to inhibit stacking or modularization (Orton and Shirey 1980).

6.1.6 General Labeling Requirements

Labeling requirements were first mentioned in the *Design Criteria for Transuranic Dry Waste Steel and Reinforced Concrete Burial Containers*, released in 1976. All burial container labels were required to provide the following information:

- Gross total weight
- Body weight
- Lid weight
- Contents weight.

The lettering on the container was required to be no less than 7.6 cm (3 in.) high and was to be painted on the lid and on one side of the container (Hammond 1976).

During the years of Rockwell operations, packages containing TRU waste were be identified with a unique number using a numbering system assigned by Rockwell. This number was used to cross reference waste with burial or storage records. It generally identified points of origin, year and month assigned, and a container number.

In 1977 the labeling practices were extended. In the case where generators had containers of hazardous or toxic waste, they were required to identify the contents on the container label and provide a container inventory list to the Environmental Protection Section of ARHCO (Anderson 1978). All transuranic waste containers, with the exception of caisson containers, were to be labeled so that the waste they contained could be identified by cross-reference to permanent records. The originator was to label the waste container with a specified prefix followed by consecutive numbers. The prefix designations were obtained from the Tank Farm Process Engineering subsection. Each container was to be labeled with the estimated gross weight when the weight of the container exceeded 35 kg (55 lb) (Anderson 1978).

In addition to providing labels on containers, waste generators implemented container color coding systems to aid in the disposal of solid waste. In 1979, the domes placed on 55-gal drums at Z Plant were colored according to the following criteria (RHO 1979):

- A silver dome was used for barrels with **combustible room** waste.
- A yellow dome was used for barrels with **combustible hood** waste.
- A red barrel was used to receive **noncombustible hood and room** waste.

Combustible and noncombustible hood waste barrels had four fissile labels attached to the outside of the barrels. One label was attached to the center of the barrel lid and three labels, equally spaced 120° apart, to the side of the barrel. Combustible room waste barrel had four radiation zone labels attached on the outside of the barrel in the above manner (RHO 1979). Though the lids were colored, the drums themselves were usually black during this time.

Labeling requirements were updated with the release of the *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements* in 1980. Small non-TRU burial packages (i.e., drums, fiberboard cartons) with low dose rates and of minimal hazard to personnel and environment required hazardous material labels (e.g., radioactive, corrosive, etc.), facility identification, and weight if over 35 kg (55 lb) in at least 5 cm (2 in.) high lettering on one side of the container (McCall 1980). Lettering was to be legible and in English; water and corrosion resistant for TRU waste and liquid organics; and of a contrasting color with the background being of a long lasting, nonfading, durable quality for the service life of the container. All packages containing one or more grams of fissile material were to be identified with an appropriate fissile material label (McCall 1980). In 1980, the required paint for labeling galvanized drums was a two component epoxy-polyamide type paint or equivalent (McCall 1980).

Beginning in 1981, sufficient area on the external surface of one side and the lid of the container was painted with a corrosion resistant white paint to serve as a background for identifying marks, signs, and weight information (McCall 1981). Seals, labels, and standard labels had space provided for the following entries:

- Identification number
- Type of material
- Can number
- Gross weight
- Element weight
- Net weight
- Atomic ratio of hydrogen to fissile isotopes (H/X)
- Seal number
- Date
- Signature of individual who affixed the label to the container.

The Rockwell standard label is shown in Figure 6-6 (Ellis 1983). Also in 1981, the TRU retrievable containers were identified by painted numbers and stick-on labels on the containers, as well as tamper-proof numbered seals.

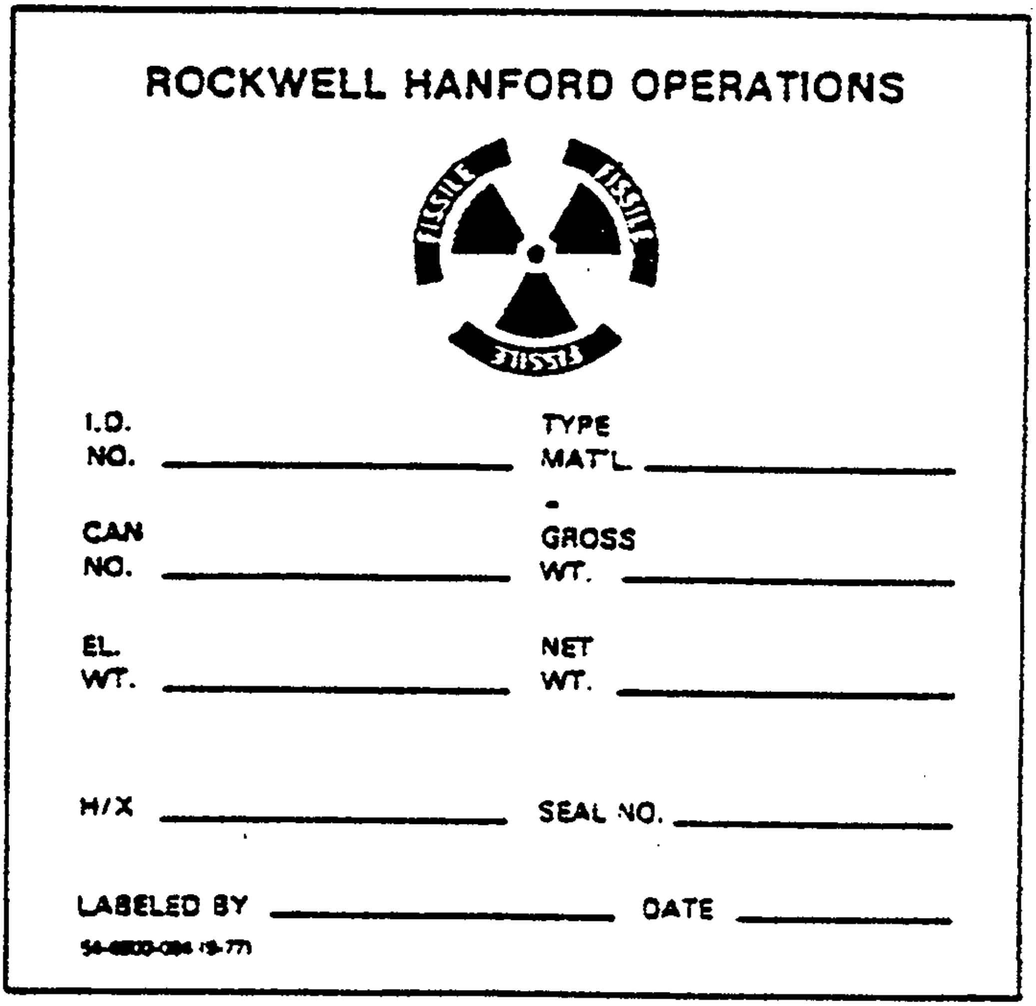
In 1982, an acceptable paint list for labeling galvanized drums was issued. Since it is possible that the earlier Krylon paint may have deteriorated, the painted numbers on drums may not aid in positive identification of drums or other containers emplaced before 1983 (Anderson et al. 1991).

Around 1984, it was a practice that if more than one hazard class was contained within a waste package, each hazards class was to be identified on the package labeling (Belgrair 1984). In addition, the following information, in the stated order, was to be permanently affixed or painted on all solid waste containers (McCall 1980):

- Package identification number
- Point of origin (i.e., building)
- Gross weight
- Weight of body (not required for 55-gal drums)
- Weight of lid (not required for 55-gal drums)
- Maximum weight of contents (not required for 55-gal drums)
- Grams of plutonium, if greater than or equal to 1 g
- "Animal Waste" if applicable
- "Liquid Organic Material" if applicable
- Flashpoint range if applicable
- Hazardous material labels as appropriate
- Labels "Transuranic" or "Transuranic Waste."

In 1984, information about the solid waste container was required once on the body and once on the lid. The drum identification number was to also appear on the lid with letters being at least 5 cm (2 in.) high.

Figure 6-6. Rockwell Standard Label.



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It is anticipated that stick-on labels most likely will not provide verifiable proof of containers as most of the labels deteriorate 7 to 10 years after application (Anderson et al. 1991). Copper alloy, tamper-proof seals were attached to drums (and some other containers) with stainless steel wire starting in 1981. The seals will most likely provide a positive one-to-one identification of containers at retrieval even if the storage location is not accurately noted on storage records (Anderson et al. 1991).

Labeling requirements specified in the *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, WHC-EP-0063, released in 1988, were much more detailed and are the requirements followed today, with exceptions noted below. General labeling and marking requirements for waste packages include the following (Stickney 1988):

- All labels and markings shall be permanently applied to the waste package with epoxy-polyamide paint or other approved materials that have a predicted 20 year life for and are compatible with the container and protective coating.

- All labels and markings shall be in clear, legible English in a color contrasting with the background.

- All labels and markings shall be nonfading and nonsmearing.

Character size requirements include the following:

- All characters used in marking 55-gal drum or smaller waste packages shall be at least 2.54 cm (1 in.) high.

- All characters used in labeling and marking waste packages larger than 55-gal drums shall be at least 5.08 cm (2 in.) high.

All labeling was required to be placed on waste packages in the following locations:

- Cylindrical waste packages — all markings and labels shall be placed once on the upper one-third of the side of the package. The package identification number (PIN) and gross weight shall also be placed on the top of the package.

- Rectangular waste packages — all markings and labels shall be placed once on the upper one-third of each side of the package. The PIN and gross weight shall be placed on the top of the package.

All waste packages shall be labeled with the following information:

- WRM Number — (Non-Hanford Site generators)
- Point of Origin — (Hanford Site waste generators)
- PIN — Each waste container shall bear a unique PIN
- Gross weight in pounds or kilograms
- DOT radioactive hazard class label — required on opposite sides of the waste package.

Additional labeling requirements that apply to only LLW packages are:

- Packages containing inner containers of liquid shall be marked on the sides and near the top with "this end up," or directional arrows to indicate proper package orientation. Inner containers shall be marked as to their contents.

- Packages containing asbestos shall bear the following warning on the sides of drums or on at least two sides of rectangular packages:

<u>CAUTION</u>
Contains Asbestos
Avoid Opening or
Breaking Container.
Breathing Asbestos is Hazardous
to Your Health.

The following information shall be marked on the side of each drum containing free or absorbed organic liquids:

- "LIQUID/ORGANIC WASTE"

- The flashpoint or flashpoint range (for flammable or combustible materials) of the material in degrees fahrenheit, e.g., "FLASHPOINT 160 - 180°"

With the first revision to WHC-EP-0063 in 1989, additions were made to the labeling requirements for TRU waste packages (Stickney 1989a). All labeling and marking for Solid Waste Burial Boxes shall be placed on waste packages in the following locations:

- All markings and labels shall be placed once on the upper two-thirds of both flat sides of the waste package.

- The PIN and gross weight shall be placed on the top of the package.

- No markings or labels are to be placed within the bottom 15 cm (6 in.) of the waste package to leave a clear space for the required WIPP barcode label.

All labels and markings for LLW packages shall:

- Be permanently applied with paint or other materials.

- Have a predicted 20-year life expectancy and be compatible with the container and protective coating.

- Have a predicted 1-year life expectancy in the Hanford Site environment (uncovered).

Pictures of the labels used for hazardous waste, polychlorinated biphenyls (PCBs), properly labeled MW drum, and properly labeled MW box are shown in Figures 6-7, 6-8, 6-9, and 6-10, respectively.

Figure 6-7. Hazardous Waste Label.

HAZARDOUS WASTE

STATE AND FEDERAL LAW
PROHIBITS IMPROPER DISPOSAL
IF FOUND, CONTACT THE NEAREST POLICE, OR
PUBLIC SAFETY AUTHORITY, AND THE
WASHINGTON STATE DEPARTMENT OF ECOLOGY,
OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

PROPER D.O.T.
SHIPPING NAME ______ UN or NA# ______

GENERATOR INFORMATION:

NAME U.S. DEPARTMENT OF ENERGY

ADDRESS P.O. BOX 550, 2355 STEVENS DR.

CITY RICHLAND STATE WA ZIP 99352

EPA ID NO. WA7890008967 EPA WASTE NO. ______

ACCUMULATION START DATE ______ MANIFEST DOCUMENT NO. ______

HANDLE WITH CARE!

CONTAINS HAZARDOUS OR TOXIC WASTES

STYLE WMSPEC-P

Printed by LABELMASTER, Div. of AMERICAN LABELMARK CO., CHICAGO, IL 60646 (800) 621-5808

Figure 6-8. Polychlorinated Byphenyl Labels.

CAUTION
CONTAINS

PCBs

(Polychlorinated Biphenyls)

A toxic environmental contaminant requiring special handling and disposal in accordance with U.S. Environmental Protection Agency Regulations 40 CFR 761-For Disposal Information contact the nearest U.S. E.P.A. Office.

In case of accident or spill, call toll free the U.S. Coast Guard National Response Center:

800-424-8802

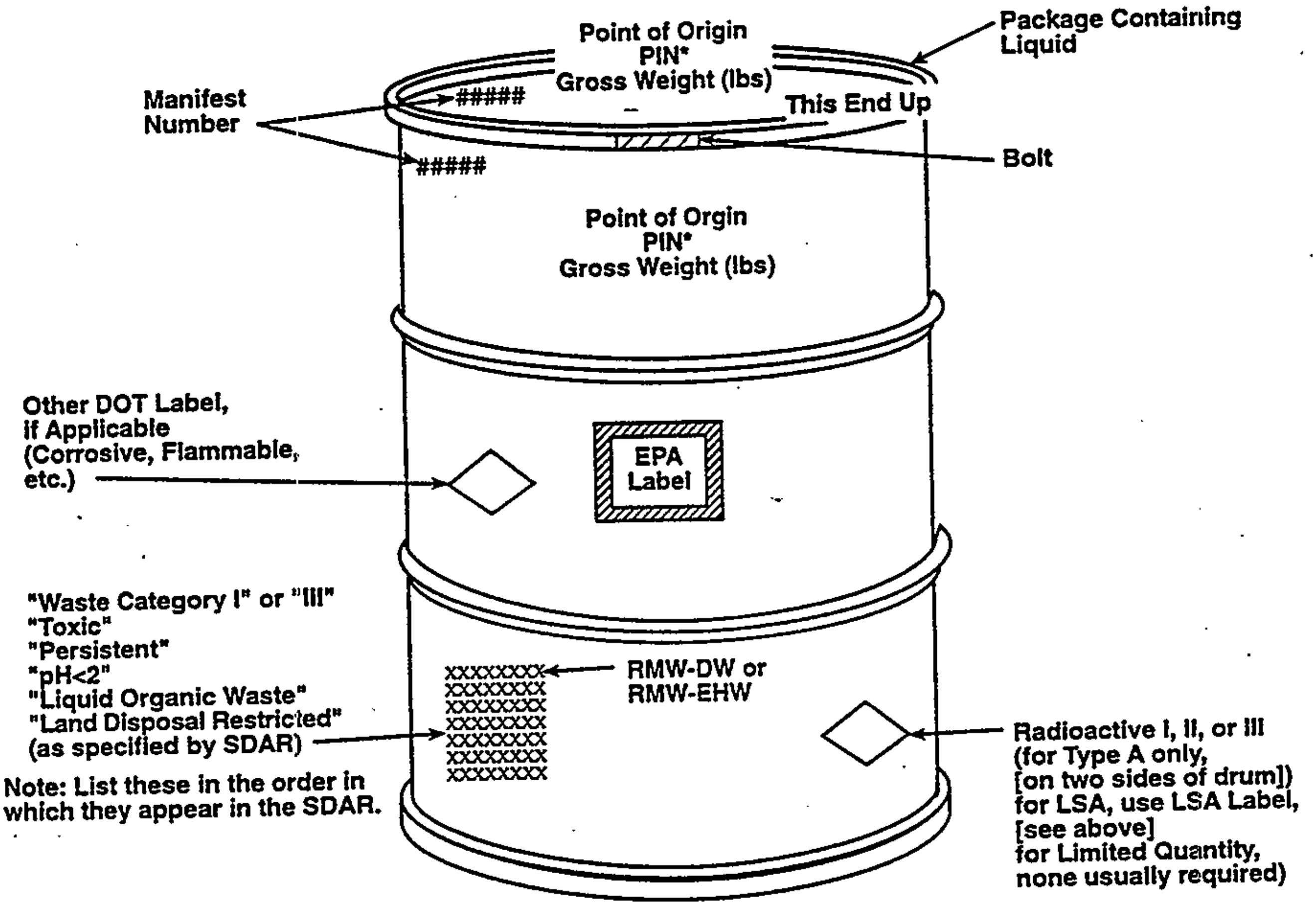
Also contact: ______________________

Tel. No. ______________________

Lab Safety Supply, Inc.

Reorder No. G98

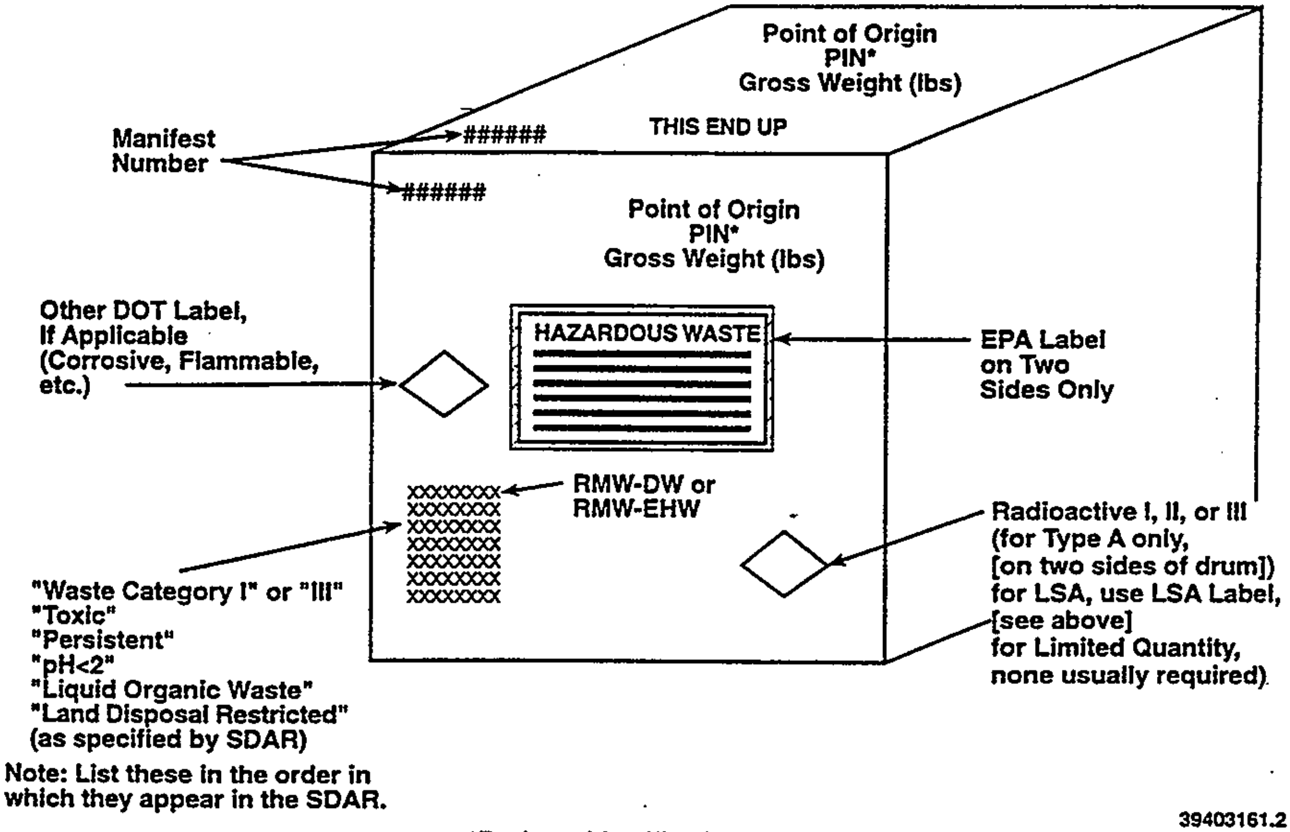
Figure 6-9. Properly Labeled Radioactive Mixed Waste Drum.



*Package Identification Number (obtained from WM)

39403161.1

Figure 6-10. Properly Labeled Radioactive Mixed Waste Rectangular Box.



*Package Identification Number (obtained from WM)

6.2 CONTAINER TYPES

The container types used for final storage/burial are described in detail in the following sections. Table 6-2 provides the number of each container type, the percentage of the total containers, and the section in which the container type is discussed. Each of these container types is currently found in the SWITS database, and much of the information found in the following material has been extracted from this database and its predecessor, the Richland - Solid Waste Information Management System (R-SWIMS). (Both of these databases are discussed in greater detail in Section 8.5.) Information about the container types used prior to 1968 has been included as appropriate; however, this information is scanty.

The amount of data being entered into the SWITS database and uses of this data have changed since the database's development. Because of this, certain limitations and assumptions need to be recognized when using the data:

- All past maintenance and operations contractors have been rolled up under the current site contractor and waste that may have originated from a past contractor is listed in the database as originating from the current contractor, (i.e., wastes from ARHCO and Rockwell are attributed to WHC).

- Certain Hanford facilities have served as staging areas for offsite and onsite waste at various times in the past. It was the practice to indicate the shipper of the waste on the burial record, rather than the generator of the waste. Usually, these were the same facility, but in the case where waste was staged before disposal, the generator file in the database lists the shipper rather than the generator. For example, PFP was a designated staging area in the 200 West Area; therefore, other facilities wastes are attributed as PFP waste in the database.

In addition to specific information about each container type, the sections that follow contain a brief discussion in the following areas:

- Types of specific containers in each general container category and their numbers (where applicable)

- A breakdown of the use of the container type by year from 1968 to the present

- The generators that packaged waste in the container type

- The type of waste (i.e., LLW, TRU, Industrial) that was buried/stored in the container type

- The physical contents buried/stored in the container type

- The burial/storage locations of the waste container type.

Table 6-2. Container Types Listed in the Solid Waste Information and Tracking System.

Container description	Count	Percent of total	Section
Burlap, cloth, paper or plastic bags	11,078	1.7	6.2.1
Concrete boxes	1,344	0.2	6.2.2
Concrete cylinders, casks	35	<0.1	6.2.3
Dump truck waste	5,801	0.9	6.2.4
EBR II casks	39	<0.1	6.2.5
Fiberboard/plastic boxes, carton, cases	427,030	65.8	6.2.6
Fiberboard/plastic drums, barrels, kegs	810	0.1	6.2.7
FRP boxes	280	<0.1	6.2.8
Gloveboxes	62	<0.1	6.2.9
HEPA filters	6,556	1.0	6.2.10
Ion exchange columns	336	<0.1	6.2.11
Lead bricks	36	<0.1	6.2.12
Metal boxes, cartons, cases	4,900	0.8	6.2.13
Metal cylinders, casks	371	<0.1	6.2.14
Metal drums, barrels, kegs	156,462	24.1	6.2.15
Miscellaneous scrap	7,265	<0.1	6.2.16
Naval core barrels	69	<0.1	6.2.17
Self-contained equipment	6,166	1.0	6.2.18
Submarine reactor compartments	42	<0.1	6.2.19
Tanks, portable	338	<0.1	6.2.20
Trucks, flatbeds, compactor, loadlugger	8,960	1.4	6.2.21
Wooden boxes, cartons, cases	11,538	1.8	6.2.22

FRP = fiberglass reinforced polyester.
HEPA = high-efficiency particulate air (filter).

With each of the container descriptions, a figure is provided that depicts the relative percentage of a specific waste container being disposed each year. This percentage should not be misconstrued as the percentage of burlap bags (for example) out of a total of all the waste containers.

During the conversion of the R-SWIMS database to the SWITS database, various sizes of containers were grouped together within container categories. Since the R-SWIMS data provides a more detailed description of container sizes, it was used in several tables in this section that describe container, rather than the SWITS, data.

6.2.1 Burlap, Cloth, Paper or Plastic Bags, Wrap

Burlap, cloth, paper, plastic bags, and wrap (hereafter referred to as bags) were most commonly used at Hanford from 1975 to 1983. There were 11,078 bags listed in the database. Figure 6-11 provides the relative percentages of bags used each year. The main type of container that was classified as a bag in the SWITS database was plastic bags/tubes. Out of the total 11,078 bags, approximately 150 were laundry bags.

The primary waste types packaged in bags were radioactive and MW, with approximately 96% being nonindustrial LLW. There were instances of other types of LLW and MW being buried prior to RCRA restrictions on hazardous waste disposal, but they accounted for a very small percentage of the waste.

Plastic and polyurethane material; metal, iron, galvanized and sheet material; and paper or cardboard material comprised approximately 60% of the bags' physical contents. It is assumed that the metal materials were wrapped in plastic and not placed directly into bags. Figure 6-12 provides a complete overview of the physical contents packaged in bags.

The SWITS database indicated that the majority of the bags were generated by WHC and only 20% of all waste placed in bags being generated by offsite facilities. A large percentage of the waste was buried in the 200 West Area burial grounds with about 69% of the bags being placed in 218-W-3A.

Figure 6-11. Percentage of Burlap, Cloth, Paper or Plastic Bags By Year.

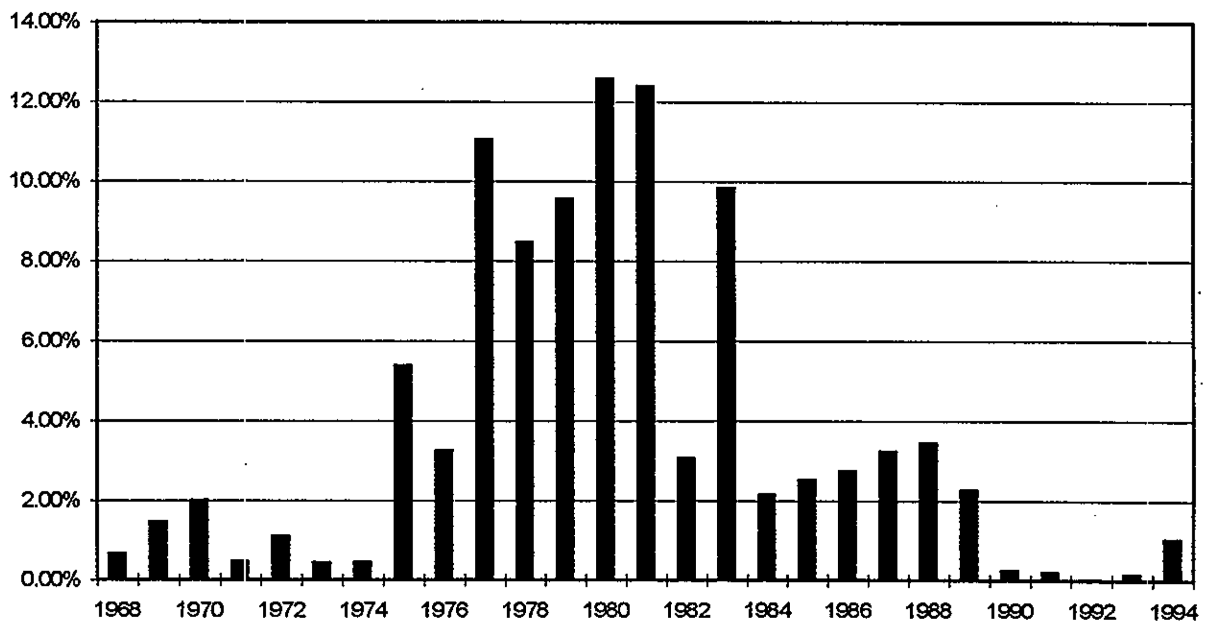
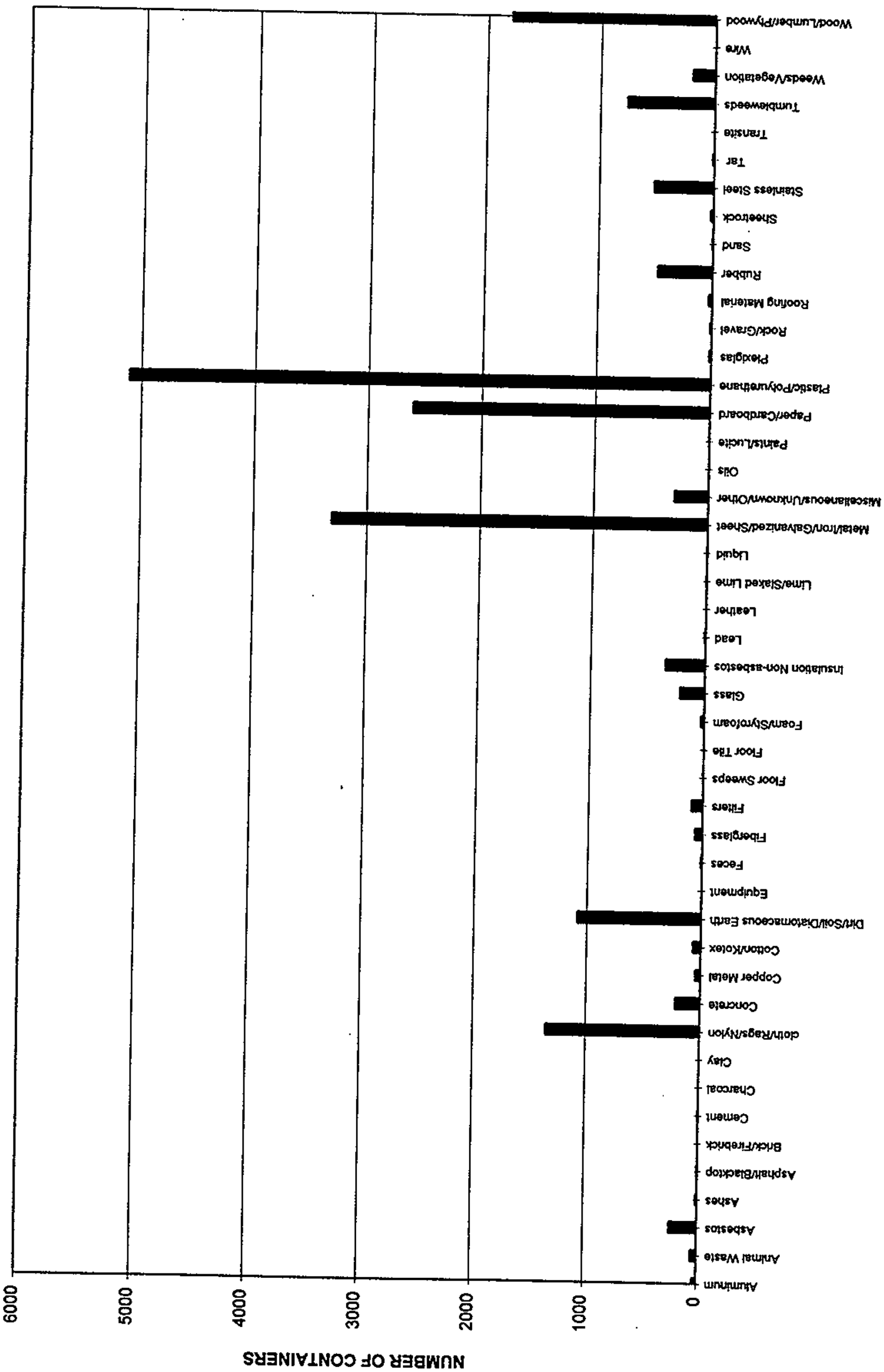


Figure 6-12. Occurrence of Physical Contents in Burlap, Cloth, Paper, or Plastic Bags.



6.2.2 Concrete Boxes

Concrete boxes make up less than 1% of all waste burial containers used at Hanford since 1968. This does not seem like a significant number, however, due to the large sizes of the concrete boxes they take up a large portion of the space in the burial grounds. A complete list of the number of boxes and size of boxes is given in Table 6-3. Also, drawing numbers are provided for the concrete boxes where available.

The highest percentage of concrete boxes were used during the years 1975 and 1983. Figure 6-13 provides the relative percentages of concrete boxes used each year. The primary waste types packaged in the concrete boxes were radioactive and MW, with the majority of the waste being industrial and nonindustrial LLW.

Concrete materials; metal, iron, galvanized, and sheet material; and plastic and polyurethane materials made up more than 50% of the concrete boxes' physical contents. Figure 6-14 provides a complete overview of the physical contents packaged.

The SWITS database indicated that the majority of the concrete box waste was generated by WHC and approximately 18% of the waste was produced by Brookhaven National Laboratory. Concrete boxes were buried in the 200 Area burial grounds with approximately the same percentage going to the East and West burial grounds.

Figure 6-13. Percentage of Concrete Boxes By Year.

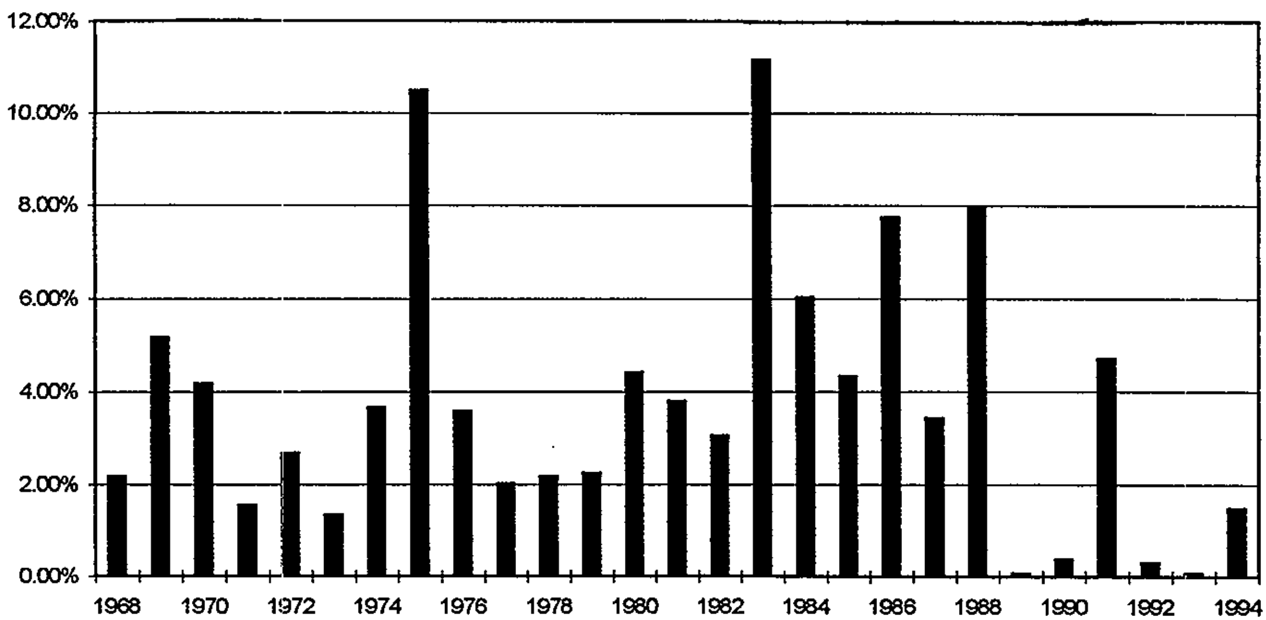


Figure 6-14. Occurrence of Physical Contents in Concrete Boxes.

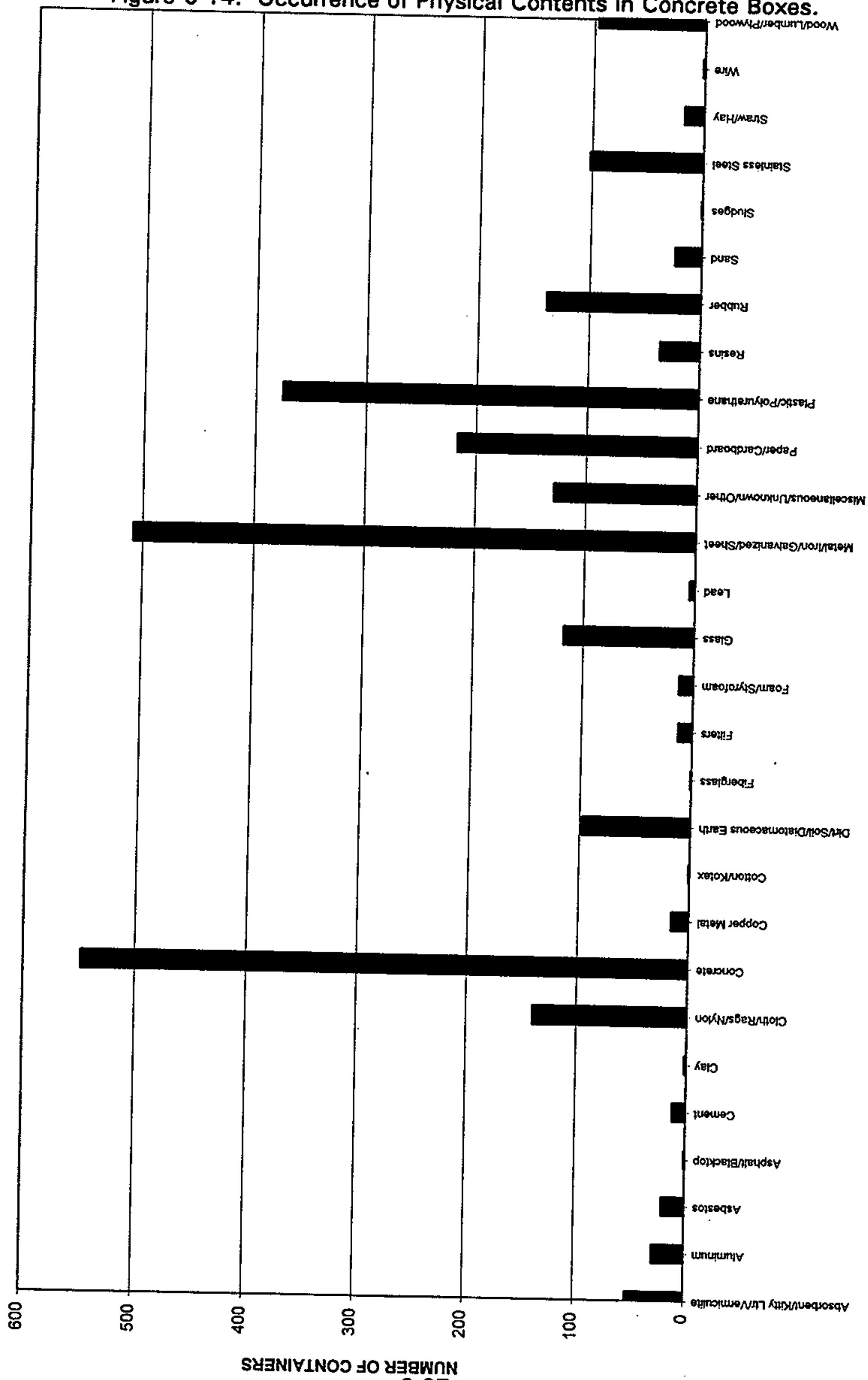


Table 6-3. Specific Container Information for Concrete Boxes. (2 sheets)

Container description	Number in R-SWIMS	Dimensions (ft)	Volume (ft³)	Drawing number
Concrete boxes/blocks	763	Unknown	Unknown	N/A
Concrete boxes	20	5.46 x 5.46 x 6.29	187.51	H-2-37434
Concrete boxes	4	Unknown	121	N/A
Concrete boxes	53	4 x 4 x 8	128.00	N/A
Concrete boxes	2	4 x 7 x 9	252.00	N/A
Concrete boxes	5	2 x 3 x 6	36.00	N/A
Concrete boxes	1	5 x 6 x 18	540.00	H-2-30998
Concrete boxes	2	Unknown	250	N/A
Concrete boxes	2	8 x 10 x 12	960.00	H-2-34163
Concrete boxes	14	Unknown	1,672	N/A
Concrete boxes	1	12 x 12 x 19	2,736.00	H-2-57923
Concrete boxes	9	Unknown	1,728	N/A
Concrete boxes	87	3 x 3 x 3	27.00	N/A
Concrete boxes	47	4 x 4 x 4	64.00	H-1-02424
Concrete boxes	6	3 x 5 x 8	120.00	N/A
Concrete boxes	9	1 x 4 x 8	32.00	N/A
Concrete boxes	6	Unknown	1,470	N/A
Concrete boxes	2	2.5 x 12 x 14	420.00	N/A
Concrete boxes	3	3 x 10 x 12	360.00	H-2-34511
Concrete boxes	4	4 x 7 x 13	364.00	N/A
Concrete boxes	1	3 x 12 x 20	720.00	N/A
Concrete boxes	6	7 x 11 x 23	1,771.00	H-2-95423
Concrete boxes	1	5 x 9 x 18	810.00	N/A
Concrete boxes	2	10 x 12 x 19	2,280.00	H-2-58160
Concrete boxes	3	8 x 12 x 19	1,824.00	H-2-72200
Concrete boxes	1	5 x 11 x 17	935.00	N/A
Concrete boxes	2	7.5 x 8 x 31	1,860.00	H-2-62998
Concrete boxes	12	8 x 10 x 19	1,520.00	H-2-68182
Concrete boxes	1	10 x 11 x 19	2,090.00	H-2-93173
Concrete boxes	2	Unknown	396	N/A
Concrete boxes	15	5 x 7 x 8	280.00	N/A
Concrete boxes	3	7 x 8 x 10	560.00	N/A
Concrete boxes	1	7.6 x 10.7 x 19.7	1,602.00	H-2-58526
Concrete boxes	1	10 x 10 x 19	1,900.00	H-2-38720
Concrete boxes	94	5 x 5 x 6	150.00	N/A
Concrete boxes	9	10 x 12 x 23	2,760.00	H-2-93173
Concrete boxes	8	4 x 5 x 8	160.00	H-2-34162

Table 6-3. Specific Container Information for Concrete Boxes. (2 sheets)

Container description	Number in R-SWIMS	Dimensions (ft)	Volume (ft^3)	Drawing number
Concrete boxes	4	4 x 5 x 6	120.00	H-1-72013
Concrete boxes	1	14 x 17 x 39	9,282.00	N/A
Concrete boxes	20	7 x 10 x 19	1,330.00	H-2-68182 H-2-38720
Concrete boxes	13	10 x 12 x 22	2,640.00	H-2-66094
Concrete boxes	1	3 x 5 x 5	75.00	H-2-37511
Concrete boxes	1	5 x 10 x 20	1,000.00	H-2-817864
Concrete boxes	2	8 x 11 x 25	2,200.00	H-2-38431
Concrete boxes	5	2.5 x 2.5 x 2.5	15.63	N/A
Concrete boxes	5	7 x 10 x 22	1,540.00	H-2-38720
Concrete boxes	1	27.5 x 10.8 x 7	2,079.00	H-2-38179

R-SWIMS = Richland - Solid Waste Information Management System.
ft = 0.3 m
ft^3 = 0.03 m^3

6.2.3 Concrete Cylinders, Casks

Concrete cylinders and casks account for less than 0.1% of all containers buried at Hanford since 1968. Items classified within the concrete cylinders and casks category in the SWITS database are concrete liners and concrete culverts.

Approximately 35% of all concrete cylinders and casks were used at Hanford in 1988. Figure 6-15 provides the relative percentages of concrete cylinders and casks used by year. The primary waste types packaged in the containers was nonindustrial LLW. Concrete materials and metal, iron, galvanized, and sheet materials accounted for over 40% of the physical contents packaged in concrete cylinders and casks. Figure 6-16 provides a complete overview of the physical contents packaged.

The majority of the waste placed in the concrete cylinders and casks was generated by Three Mile Island and RKD according to the SWITS database. All of the containers were buried in the 200 West burial grounds, with the largest percentage, approximately 49%, being buried in 218-W-3A.

Figure 6-15. Percentage of Concrete Cylinders, Casks By Year.

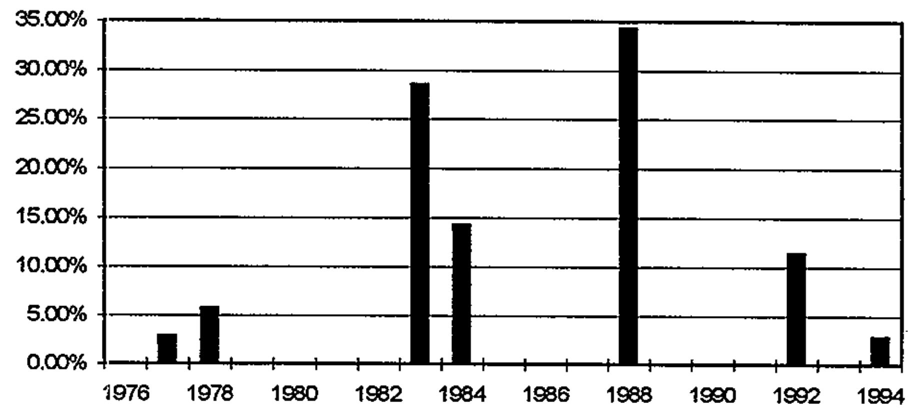
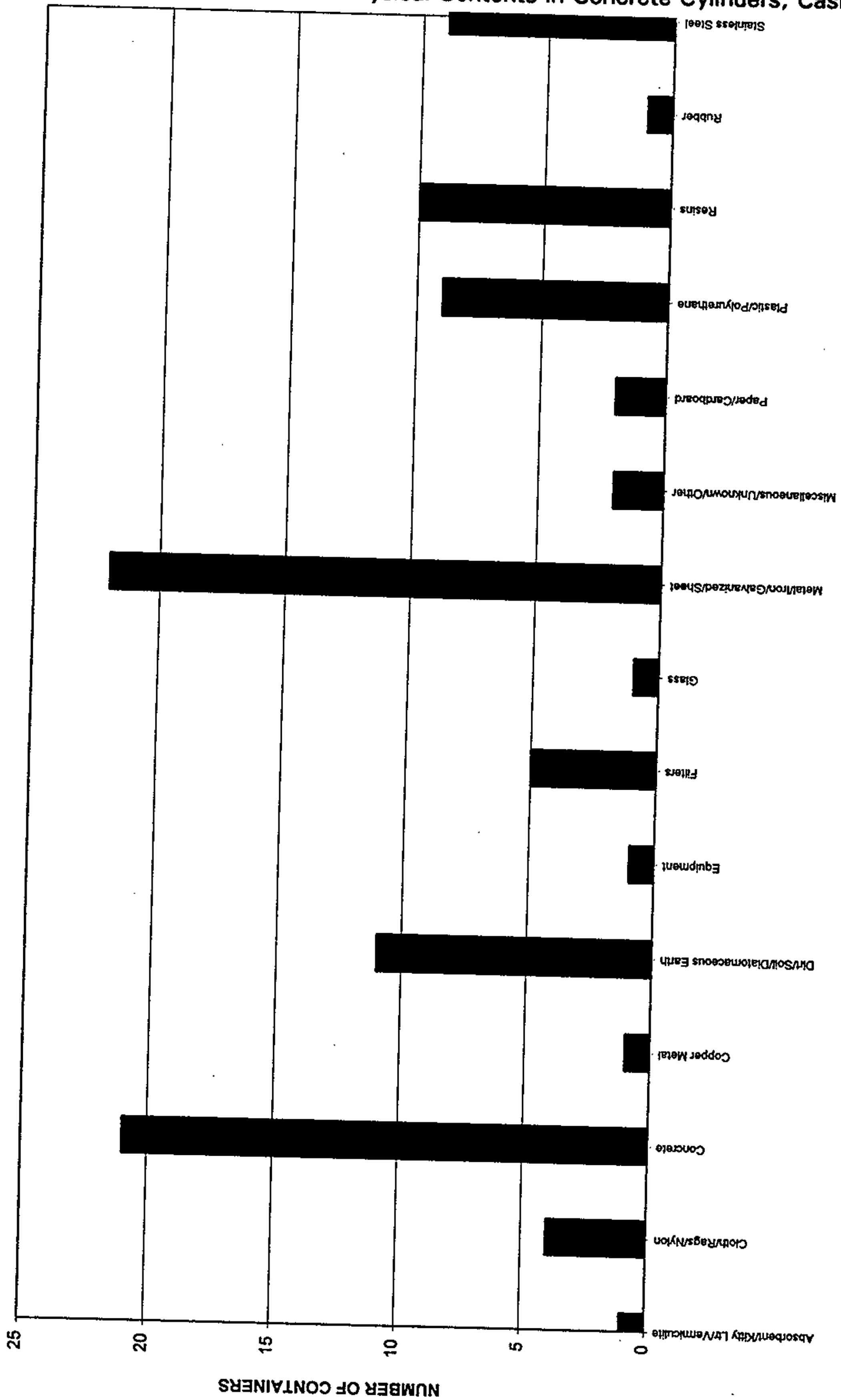


Figure 6-16. Occurrence of Physical Contents in Concrete Cylinders, Casks.



6.2.4 Dump Truck Waste

Waste classified as dump truck waste contributed to less than 1% of all waste buried at Hanford since 1968. Nearly 20% of dump truck waste was disposed in a single year, 1979. Figure 6-17 provides the relative percentages of waste from dump trucks by year. The primary waste types were radioactive and mixed, with the majority being nonindustrial LLW.

The majority of the waste consisted of contaminated dirt and plastic/polyurethane material. Figure 6-18 provides a complete overview of the physical contents of dump truck waste.

WHC generated over half of the waste placed in dump trucks. Over 62% of the waste was disposed of in the 200 West burial grounds, with a significant portion, 32%, of the waste being placed in 218-E-12B.

Figure 6-17. Percentage of Dump Truck Waste By Year.

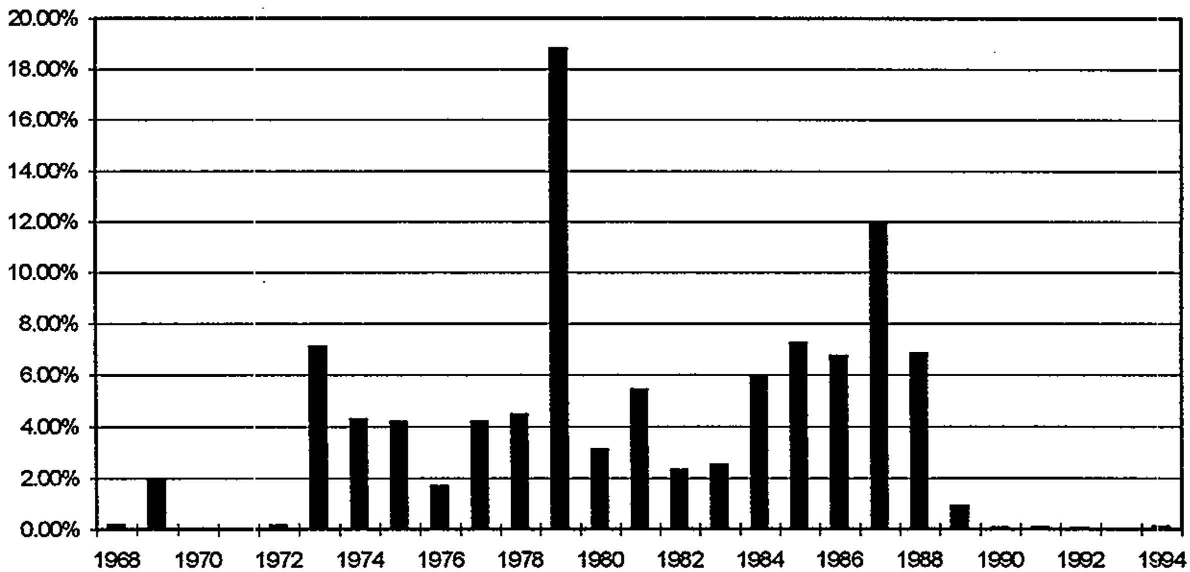
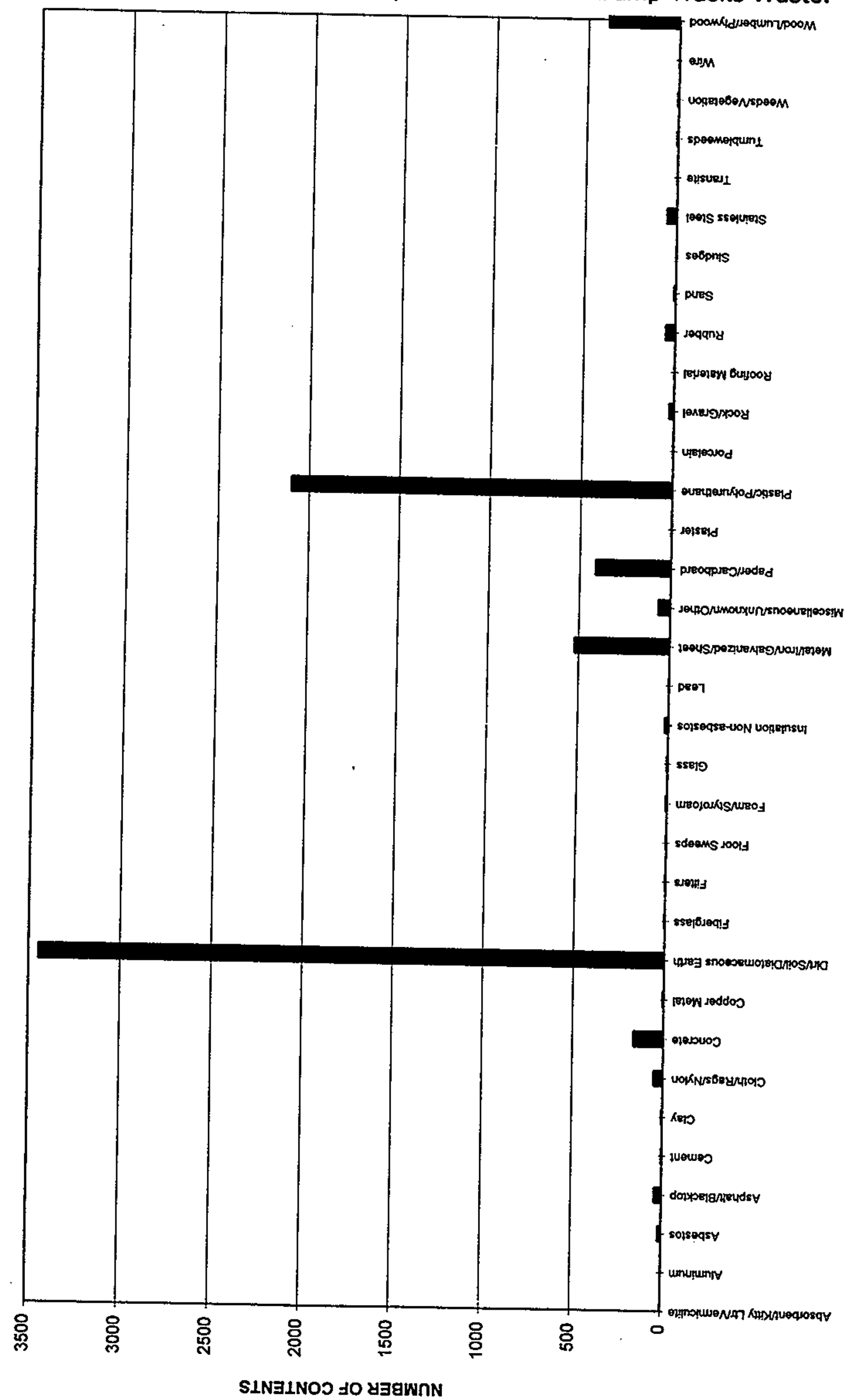


Figure 6-18. Occurrence of Physical Contents in Dump Trucks Waste.



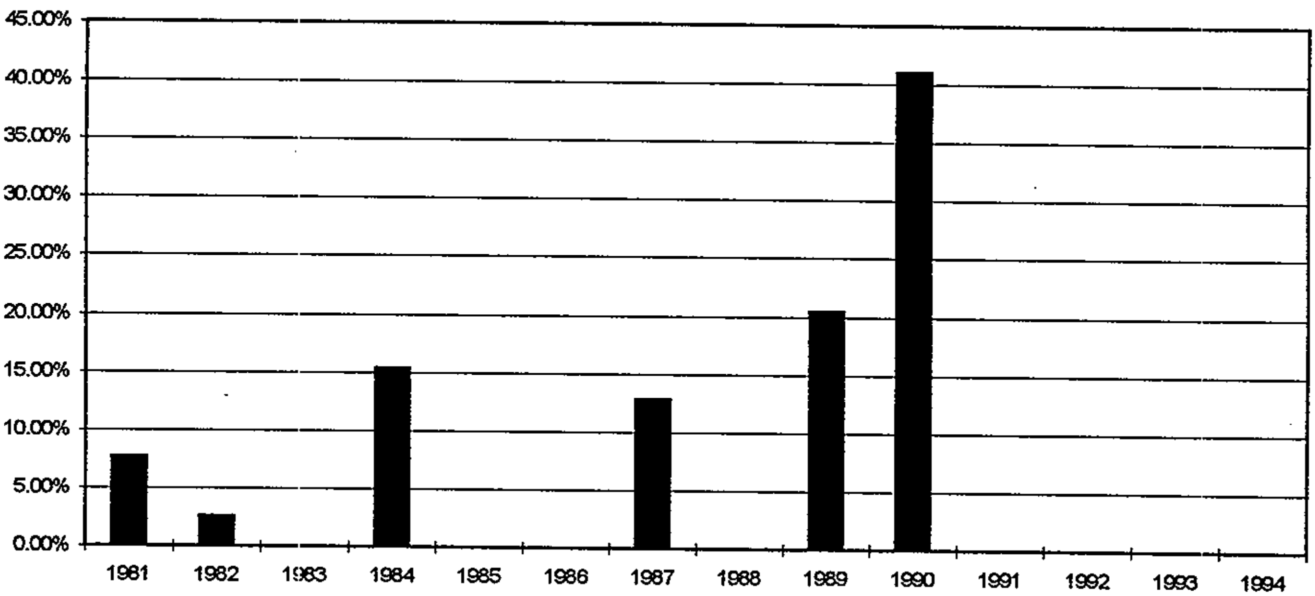
6.2.5 EBR II Casks

EBR II casks account for less than 0.1% of all containers buried at Hanford since 1968. The use of EBR II casks for burial has consistently increased since 1987, with the largest percentage of these casks, approximately 40%, being used in 1990. Figure 6-19 provides the relative percentages of casks used each year.

The primary waste types packaged in the containers were radioactive and mixed high level waste. Approximately 80% of all the waste was mixed spent fuel. The casks' physical contents consisted of fuels/pins or rods; lead; lead shielding; metal, iron, galvanized, sheet material; and stainless steel.

The majority of the waste placed in the EBR II casks was generated by PNL according to SWITS. All of the casks have been disposed of in the 200 West burial grounds, with 88% of the casks being placed in 218-W-4C.

Figure 6-19. Percentage of EBR II Casks By Year.



6.2.6 Fiberboard/Plastic Boxes, Cartons, and Cases

Over 67% of all waste containers disposed of at Hanford since 1968 are fiberboard and plastic boxes, cartons, and cases. The R-SWIMS database breaks the category down into more specific types of containers. The containers classified as fiberboard/plastic boxes, cartons, and cases are small boxes, plexiglass boxes, large cardboard boxes, cardboard boxes, and king pacs. A king pac is a corrugated fiberboard triple-walled container with eight sides (Masa 1983a). Approximately 80% of the containers are considered small boxes (around 0.06 m^3 [2 ft^3]).

A large portion of the boxes were used in 1968. From 1969 to 1972 there was a decrease in the use of the boxes. Beginning in 1973 the use of fiberboard boxes increased. In 1985, there were more boxes used than in any other year. In 1990, the use of fiberboard cartons was prohibited, resulting in the decline of their use for that year. Figure 6-20 provides the relative percentages of containers used each year.

The primary waste type packed in the boxes was nonindustrial LLW. Paper/cardboard material and plastic/polyurethane material comprise nearly 40% of the containers' physical contents. A complete breakdown of the physical contents of fiberboard/plastic boxes, cartons, and cases is shown in Figure 6-21.

According to the SWITS database the two major generators of these containers were PNL and WHC. The majority of the waste was buried in the 200 West Area with 54% of the waste going directly into 218-W-3A.

Figure 6-20. Percentage of Fiberboard/Plastic Boxes, Cartons, Cases By Year.

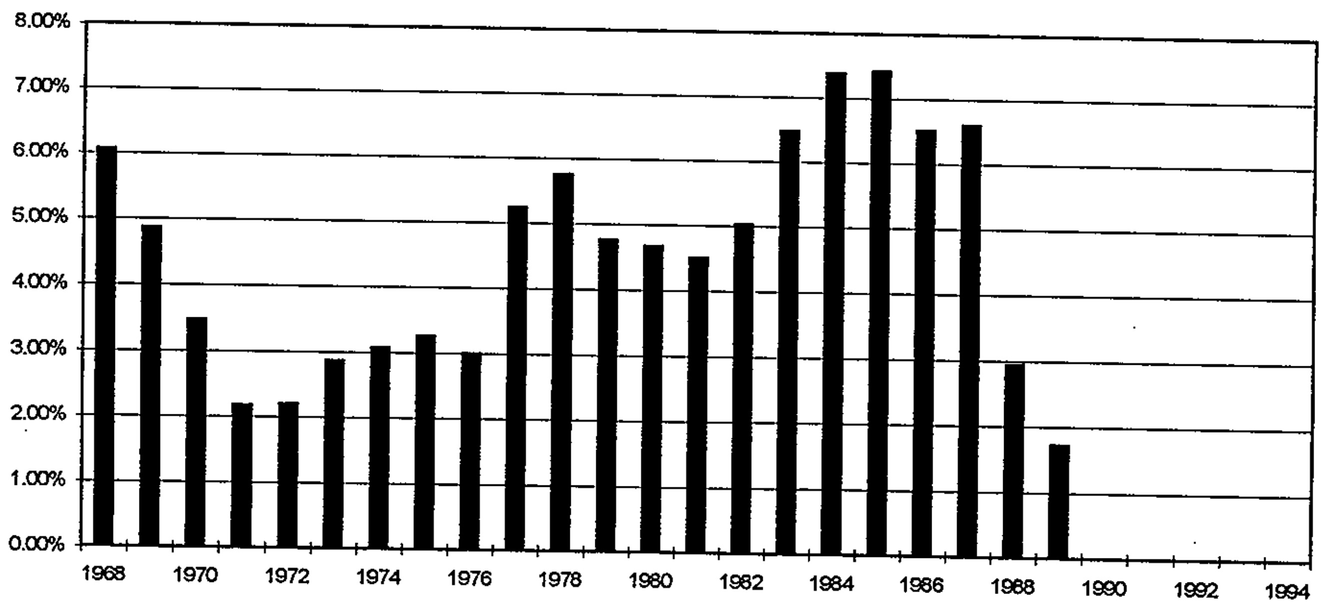
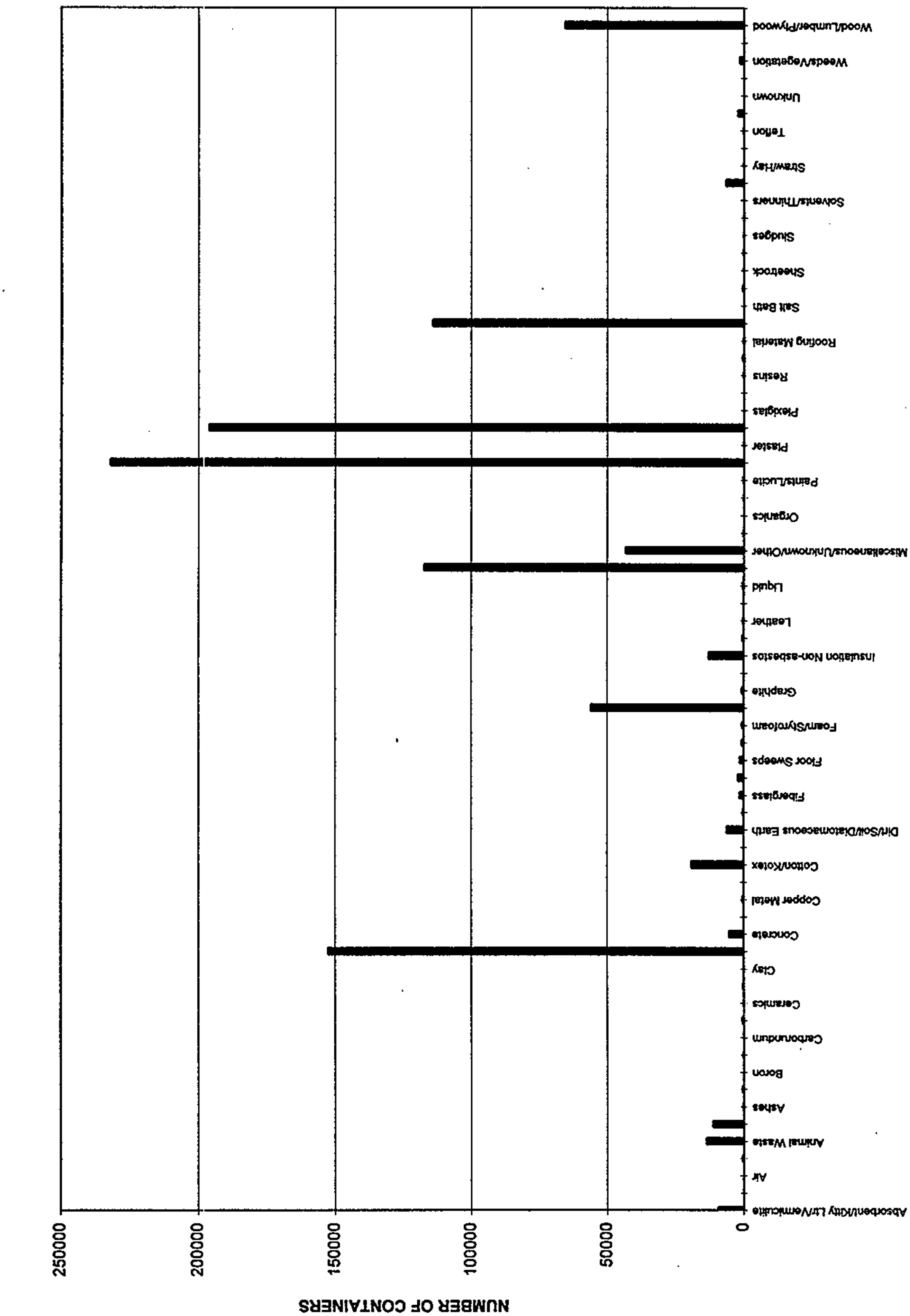


Figure 6-21. Occurrence of Physical Contents in Fiberboard/Plastic Boxes, Cartons, Cases.



6.2.7 Fiberboard/Plastic Drums, Barrels, and Kegs

A small portion of the waste containers buried at Hanford since 1968, around 0.1%, are fiberboard and plastic drums, barrels, and kegs. The R-SWIMS database indicates that the majority of containers considered as fiberboard/plastic drums, barrels, and kegs are cardboard drums. A small percentage, less than 0.5%, were poly casks.

The majority of the containers were disposed from 1969 to 1972 and from 1977 to 1981. From 1982 to 1993 there was a decrease in the use of the fiberboard/plastic drums, barrels, and kegs. Figure 6-22 identifies the relative percentage of containers disposed by year.

Waste buried in the drums consisted mostly of nonindustrial LLW. Paper, cardboard, and rubber materials comprise nearly 50% of the containers' physical contents. A complete breakdown of the physical contents buried in fiberboard/plastic drums, barrels, and kegs is shown in Figure 6-23.

According to the SWITS database the most significant contributor of fiberboard/plastic drums, barrels and kegs was WHC. About 40% of the waste was buried in the 200 West burial grounds, with the largest percentage of the waste being placed in 218-E-12B.

Figure 6-22. Percentage of Fiberboard/Plastic Drums, Barrels, Kegs By Year.

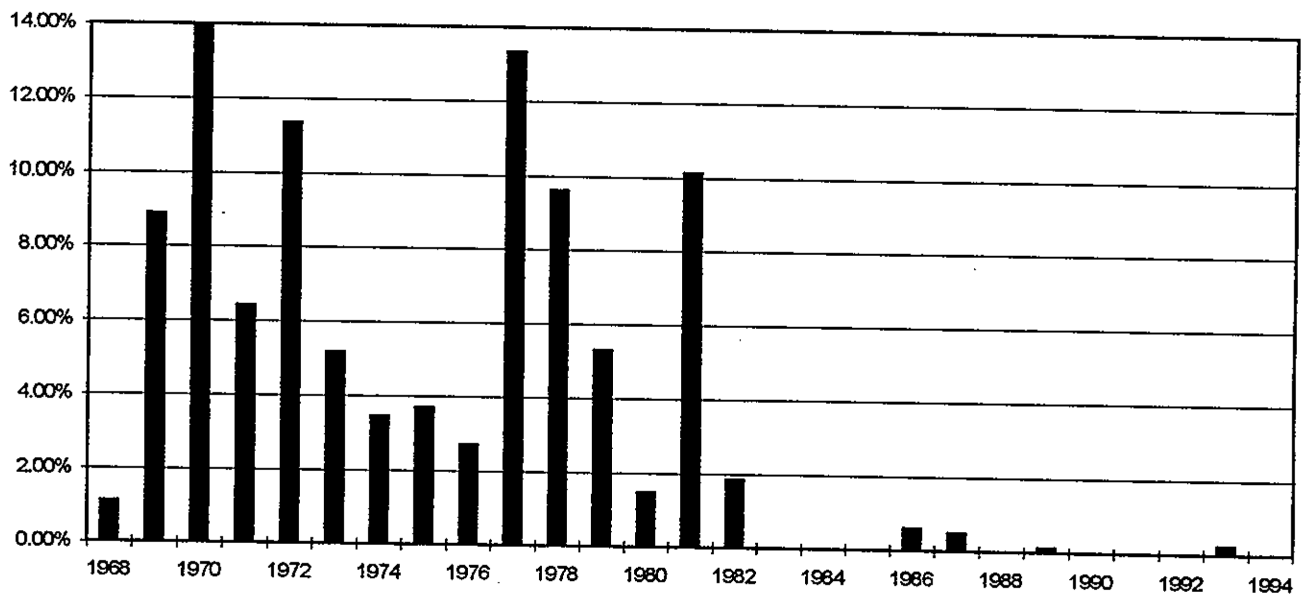
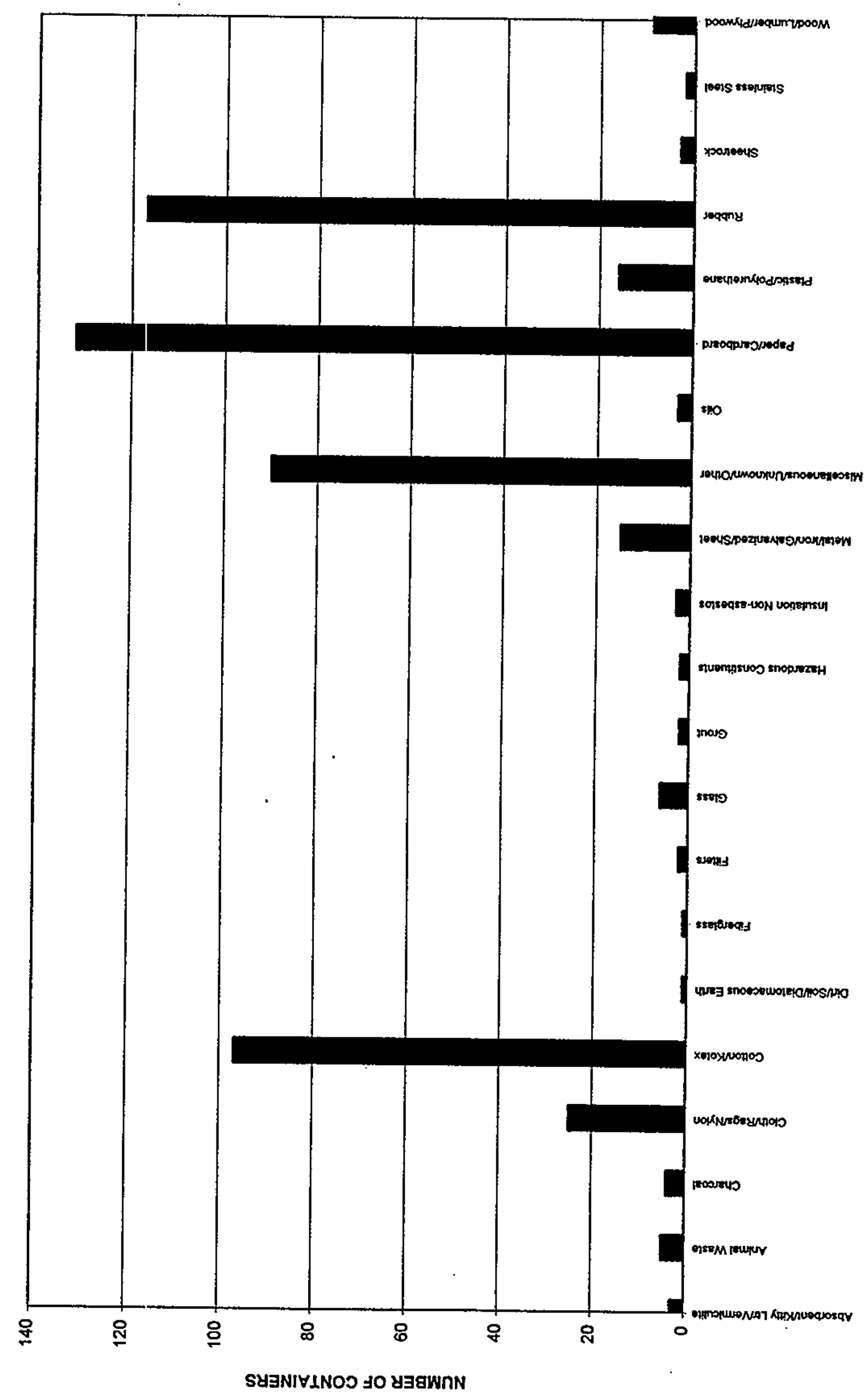


Figure 6-23. Occurrence of Physical Contents in Fiberboard/Plastic Drums, Barrels, Kegs.



6.2.8 Fiberglass Reinforced Polyester Plywood Boxes

Less than 0.1% of the waste containers buried at Hanford since 1968 are fiberglass reinforced polyester (FRP) plywood boxes. There were several large boxes, approximately 113 m^3 (4,000 ft^3), buried in the burial grounds. A complete breakdown of the number and sizes of FRP boxes is listed in Table 6-4. Also drawing numbers of the boxes are provided where available.

In 1975 there were more FRPs buried than in any other single year. From 1978 to 1982 there was a span of time when FRPs were being used frequently, before declining greatly in 1983. Figure 6-24 provides the relative percentages of FRPs used by year.

Waste buried in the boxes consisted mostly of nonindustrial LLW. Metal, iron, galvanized, and sheet materials and plastic/polyurethane materials comprise nearly 40% of the boxes' physical contents. Figure 6-25 provides a complete breakdown of the specific waste types.

The SWITS database reported that the most significant generator of waste placed in FRPs was WHC. Approximately 99% of all of the waste was buried in the 200 West burial grounds in 218-W-3A.

Figure 6-24. Percentage of Fiberglass Reinforced Polyester Plywood Boxes By Year.

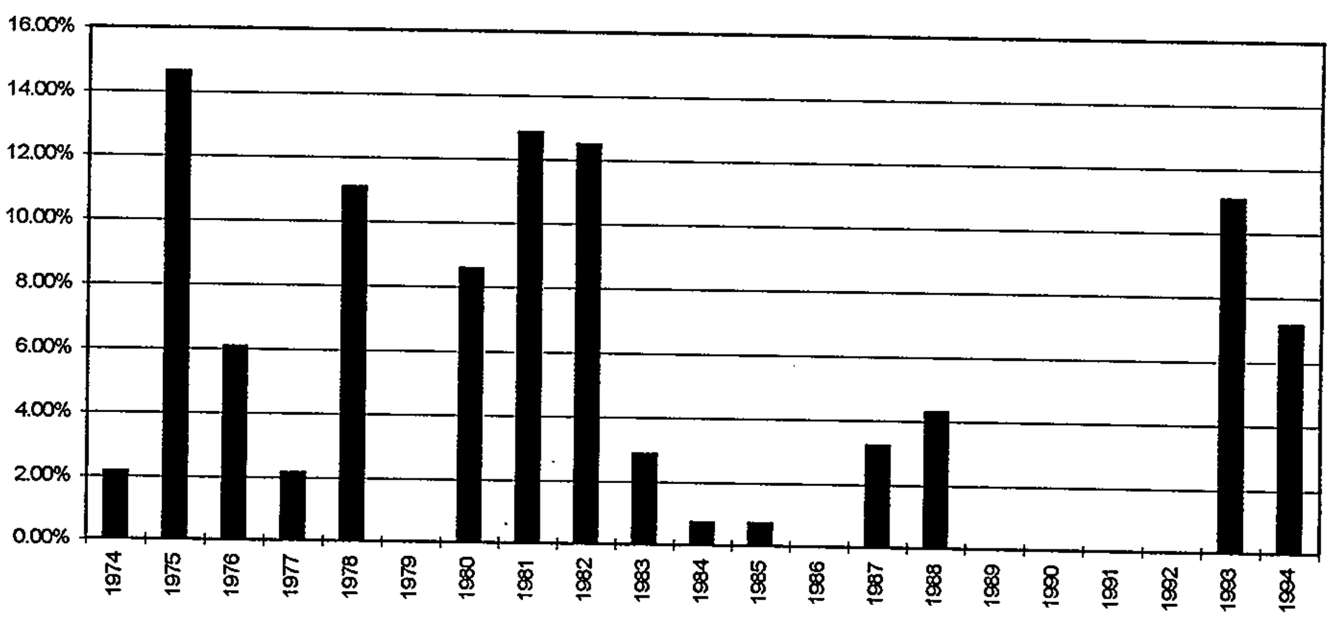


Figure 6-25. Occurrence of Physical Contents in Fiberglass Reinforced Polyester Plywood Boxes.

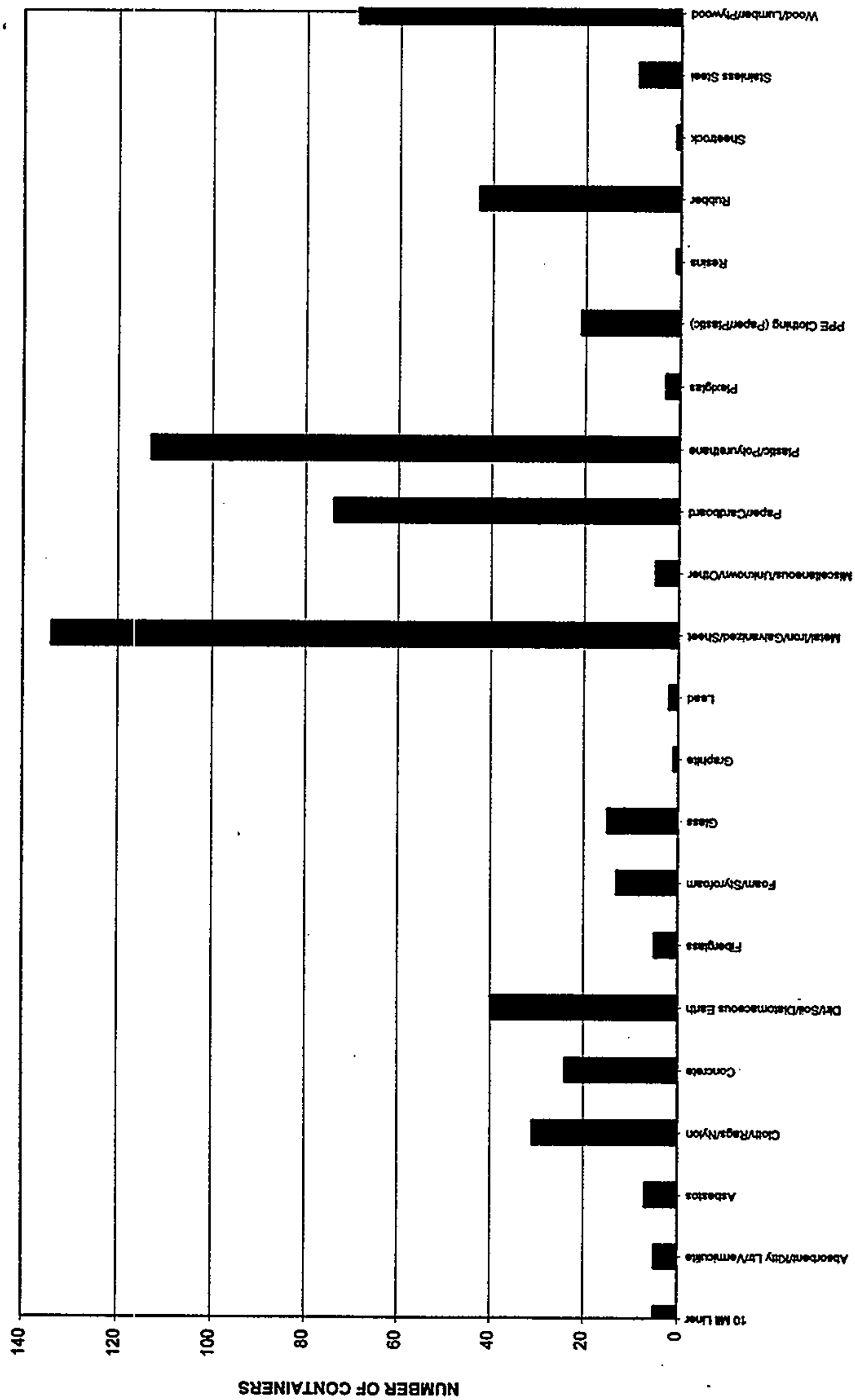


Table 6-4. Specific Container Information for Fiberglass Reinforced Polyesters.

Container description	Number in R-SWIMS	Dimensions (ft)	Volume (ft^3)	Drawing number(s)
FRP	55	4 x 4 x 7	112.00	H-2-37254 P-14060-1-7
FRP	1	5 x 6 x 16	480.00	H-2-30757
FRP	9	6.5 x 8 x 14.6	759.20	H-2-27441
FRP	3	6.5 x 8 x 18.5	962.00	H-2-27440
FRP	17	9 x 10.67 x 20	1920.60	H-2-27440
FRP	1	4.6 x 5.1 x 11.8	276.83	N/A
FRP	23	9 x 10.67 x 16	1536.48	H-2-27441
FRP	2	4.83 x 5 x 8	193.20	H-2-58349
FRP	7	9 x 11.67 x 20	2100.60	H-2-69550
FRP	17	9 x 10.67 x 12	1152.36	H-2-30174
FRP	5	10.5 x 10.67 x 12	1344.42	H-2-27445
FRP	1	9 x 12 x 12.67	1368.36	H-2-34520
FRP	16	5.6 x 7.3 x 10.1	412.89	N/A
FRP	1	6.33 x 8 x 14.67	742.89	H-2-27441
FRP	2	Unknown		N/A
FRP	7	8 x 10 x 16	1280.00	H-2-69549
FRP	2	8 x 8 x 10.7	684.80	H-2-27442
FRP	1	9.5 x 9.94 x 12	1133.16	H-2-02767
FRP	7	9 x 12.67 x 20	2280.60	H-2-69550
FRP	1	8.25 x 10.58 x 19.58	1709.04	N/A
FRP	7	5.8 x 5.8 x 9.6	322.94	N/A
FRP	2	5.8 x 5.8 x 10.6	356.58	N/A
FRP	6	5.3 x 5.7 x 9.8	296.06	N/A
FRP	1	6 x 6.1 x 9.6	351.36	N/A
FRP	7	6 x 6 x 6	216.00	N/A
FRP	3	5.3 x 5.7 x 7.3	220.53	N/A
FRP	3	5.5 x 5.7 x 11.2	351.12	N/A
FRP	11	4.7 x 7.8 x 11	403.26	N/A
FRP	4	6.2 x 6.2 x 9	345.96	N/A
FRP	3	5.6 x 7.4 x 11.3	468.27	N/A
FRP	1	3.8 x 4.3 x 12.5	204.25	N/A
FRP	4	4 x 4 x 8	128.00	H-1-42701 H-1-42702 H-2-38647

FRP = fiberglass reinforced polyester.
R-SWIMS = Richland - Solid Waste Information Management System.
ft = 0.3 m.
ft^3 = 0.03 m.

6.2.9 Gloveboxes

A small number of gloveboxes have been disposed of in the burial grounds since 1968. There have been some cases where the gloveboxes have been broken down and buried by themselves; and other cases where the gloveboxes have been filled with waste and then disposed. The exact dimensions of the disposed gloveboxes are unknown.

There have been two years during which large percentages of gloveboxes were disposed, 1974 and 1979. The relative percentages of gloveboxes disposed each year are provided in Figure 6-26. Waste buried in the gloveboxes consisted mostly of nonindustrial LLW. Metal, iron, galvanized, and sheet metal; plastic/polyurethane; and miscellaneous materials comprised the majority of the gloveboxes' physical contents. Figure 6-27 provides the number of occurrences of each physical content types in the gloveboxes.

The SWITS database reports that the majority of disposed gloveboxes came from WHC and PNL. A few, seven, came from J.A. Jones. Gloveboxes were most commonly disposed of in the 200 West burial ground. About 54% of the gloveboxes were specifically disposed of in 218-W-3A. Approximately 1% of the gloveboxes were disposed of in the 200 East burial ground.

Figure 6-26. Percentage of Gloveboxes By Year.

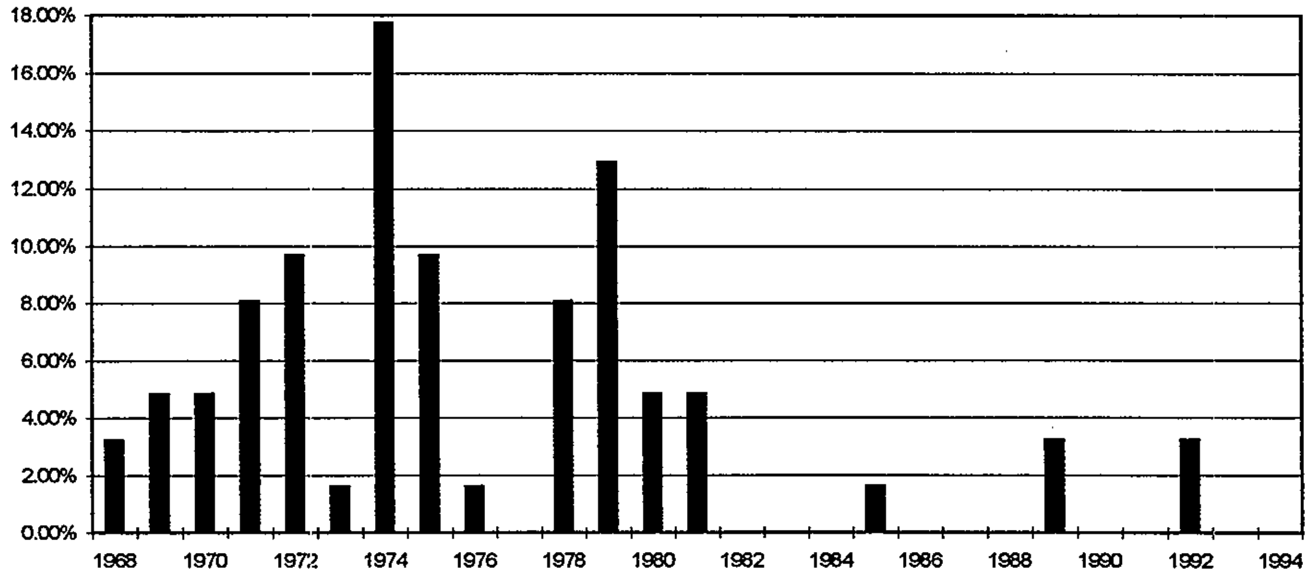
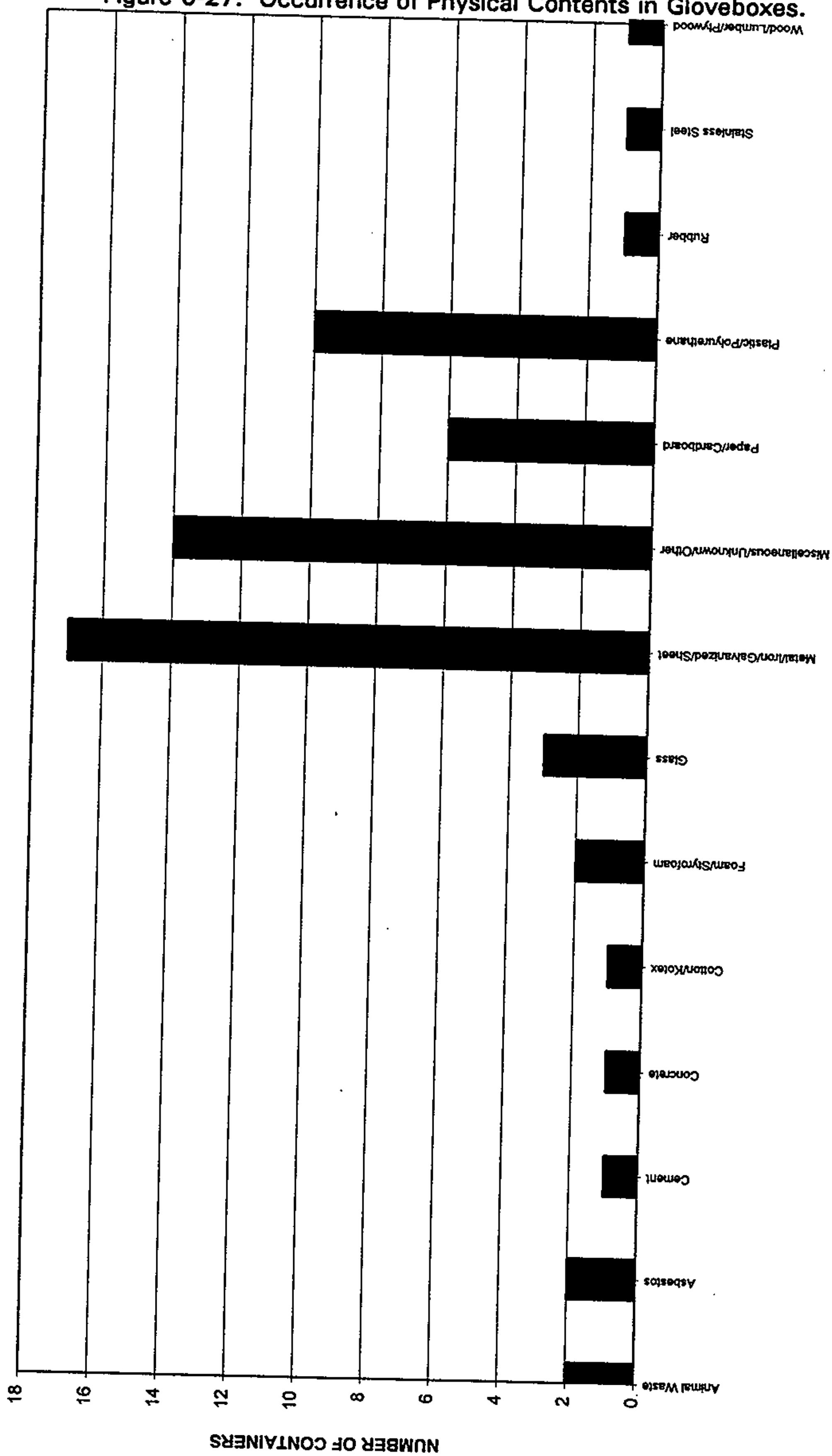


Figure 6-27. Occurrence of Physical Contents in Gloveboxes.



6.2.10 High-Efficiency Particulate Air Filters

About 6,500 HEPA filters have been disposed of in the burial grounds since 1968. The majority of the filters were disposed of between 1978 and 1988. The relative percentages of HEPA filters disposed by year are shown in Figure 6-28.

HEPA filters consisted mostly of nonindustrial LLW. Plastic and polyurethane material; metal, iron, galvanized, and sheet material; paper and cardboard; and wood/lumber/plywood materials comprised the majority of the physical contents reported as being disposed of in the HEPA filters. It is not likely the HEPA filters were used as a waste container for these physical contents. It is more likely that these items were disposed along with HEPA filters, rather than actually within the filters. Other physical contents and their number of occurrences are shown in Figure 6-29.

The two most significant contributors of HEPA filter waste according to SWITS are WHC and PNL. The majority of the waste was buried in the 200 West Area burial ground. Almost 59% of the waste was buried in 218-W-3A.

Figure 6-28. Percentage of High-Efficiency Particulates Air Filters By Year.

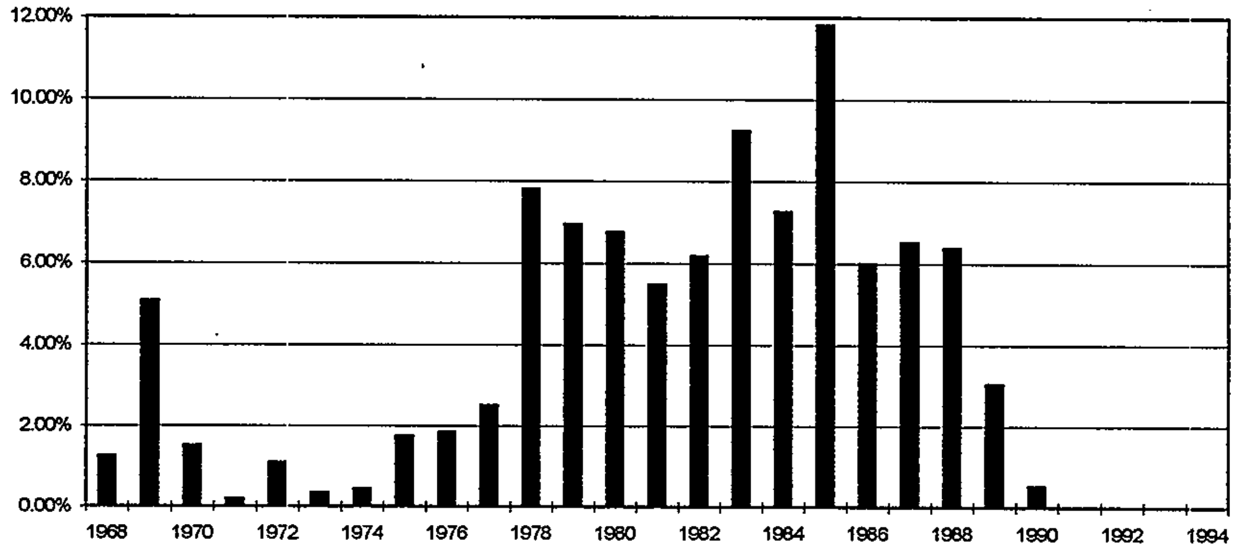
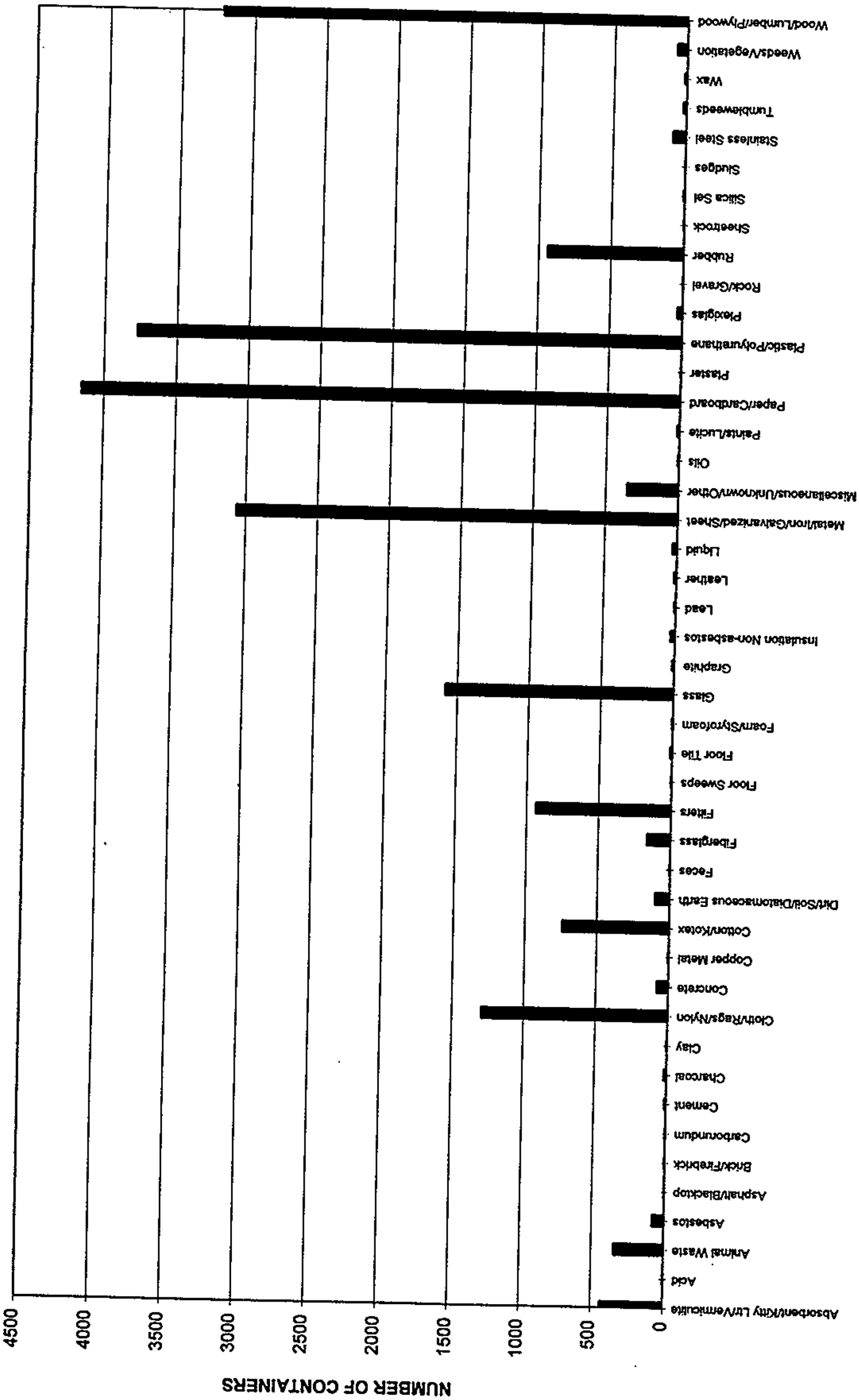


Figure 6-29. Occurrence of Physical Contents in HEPA Filters.



6.2.11 Ion Exchange Columns

Ion Exchange Columns constitute less than 0.1% of all the waste buried at Hanford since 1968. The majority of the columns were buried prior to 1989. In 1983, approximately 16% of all ion exchange columns were disposed, as depicted in Figure 6-30.

The columns consist of nonindustrial LLW. Metal, iron, galvanized, and sheet material and some types of resins comprise the majority of the ion exchange columns' physical contents. Figure 6-31 provides a complete breakdown of physical contents.

The major contributor of ion exchange columns was reported in SWITS as WHC. Around 99% of the columns were buried in the 200 West burial grounds, with 77% of the waste being placed in 218-W-3A.

Figure 6-30. Percentage of Ion Exchange Columns By Year.

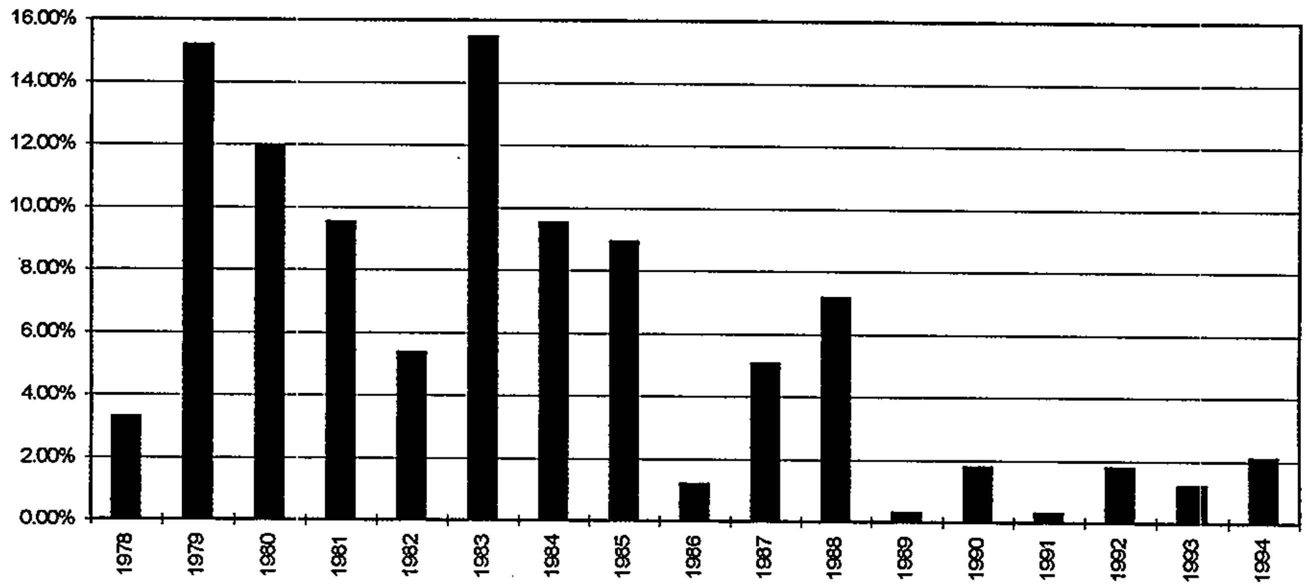
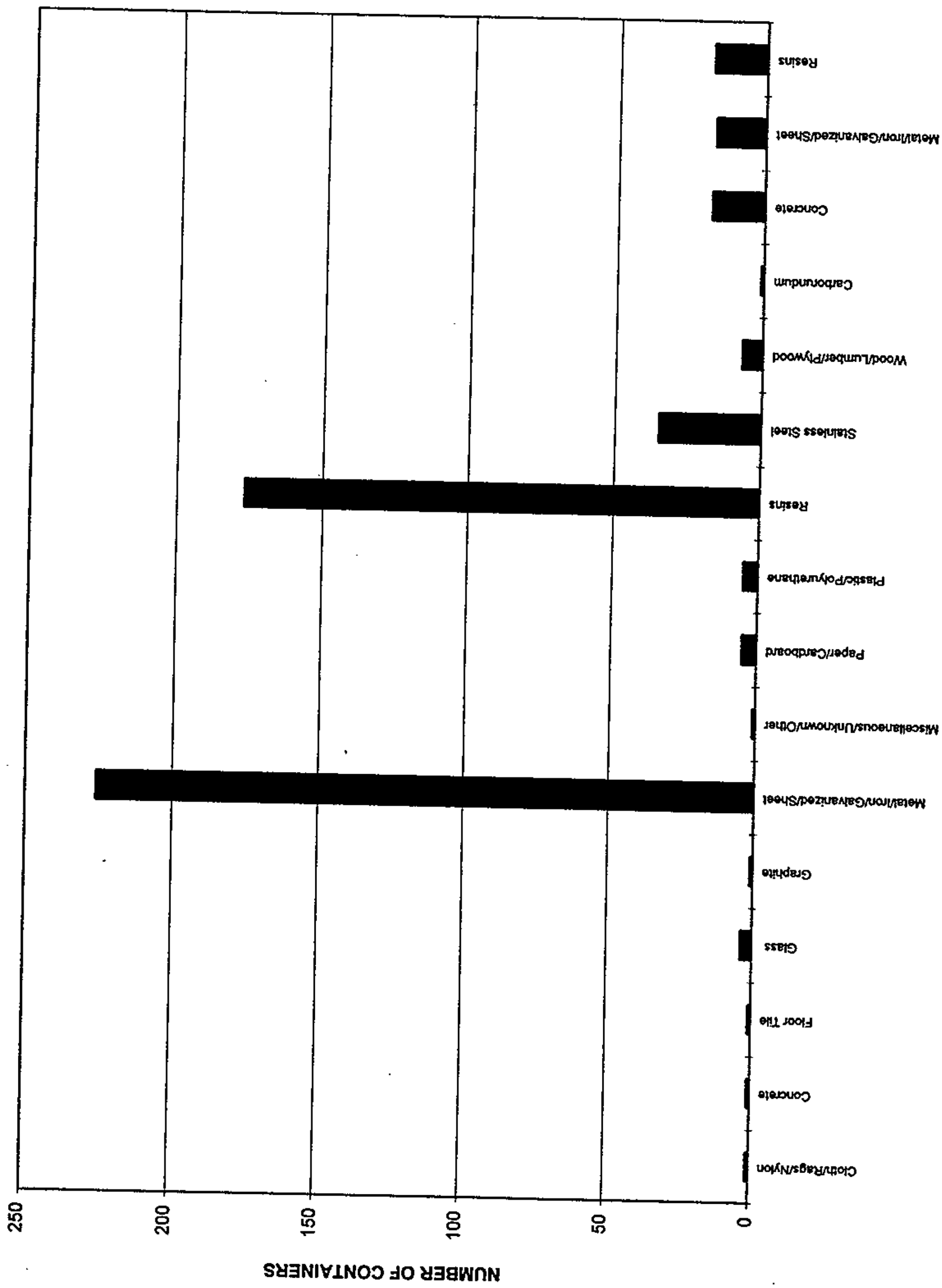


Figure 6-31. Occurrence of Physical Contents in Ion Exchange Columns.



6.2.12 Lead Bricks

Lead bricks make up less than 0.1% of all waste buried at Hanford since 1968. The bricks were only disposed of in 1978 and 1980. Approximately 83% of all of the bricks were disposed of in 1980.

Lead bricks were classified as nonindustrial, mixed LLW. WHC was the only generator of lead bricks. The bricks were buried in the 218-E-12B and 218-W-3A burial grounds.

6.2.13 Metal Boxes, Cartons, Cases

Approximately 4,900 metal boxes, cartons, and cases have been buried at Hanford since 1968. The boxes come in various sizes. The largest number of boxes, around 1,100, are approximately 3.7 m^3 (112 ft^3). Table 6-5 lists all the containers listed in R-SWIMS with their dimensions, volume, and, where available, drawing numbers.

The majority of boxes were used around the late 1980's and early 1990's with very few being used prior to 1981. The relative percentages of containers disposed each year are provided in Figure 6-32.

Radioactive, radioactive with PCB, mixed, and mixed with PCB were the primary waste types contained within metal boxes, cartons, and cases. The majority of the waste consisted of industrial LLW. Metal, iron, galvanized, and sheet material; plastic/polyurethane material; and paper/cardboard materials comprised the majority of the containers' physical contents. Figure 6-33 provides more detail on the physical content of metal boxes, cartons, and cases.

There were numerous facilities which disposed waste in metal boxes, cartons, and cases in the burial ground. A large portion of the boxes came from WHC. Other large contributors were Shippingport Atomic Power Station and PNL. The majority of the waste was disposed of in the 200 West burial grounds, with approximately 53% of the waste going directly to 218-W-5.

In 1976, the external surfaces of steel burial containers were painted with corrosion resistant paint. Paint on the containment skin which was damaged during handling was to be touched up at the burial trench. If the waste to be buried contained corrosive materials that could migrate to the containment boundary, the interior of the container was also painted (Hammond 1976).

In 1993, steel burial boxes were painted on the inside as well as the outside so that no bare metal was exposed. A box may have been lined with a 6-mil polyethylene liner. Boxes were designed to be watertight and were kept closed when not filled. Once filled, boxes were bolted shut with bolts tightened to specified torques, and security seals were applied and inspected by the Quality Control staff (Duncan et al. 1993).

Figure 6-32. Percentage of Metal Boxes, Cartons, Cases By Year.

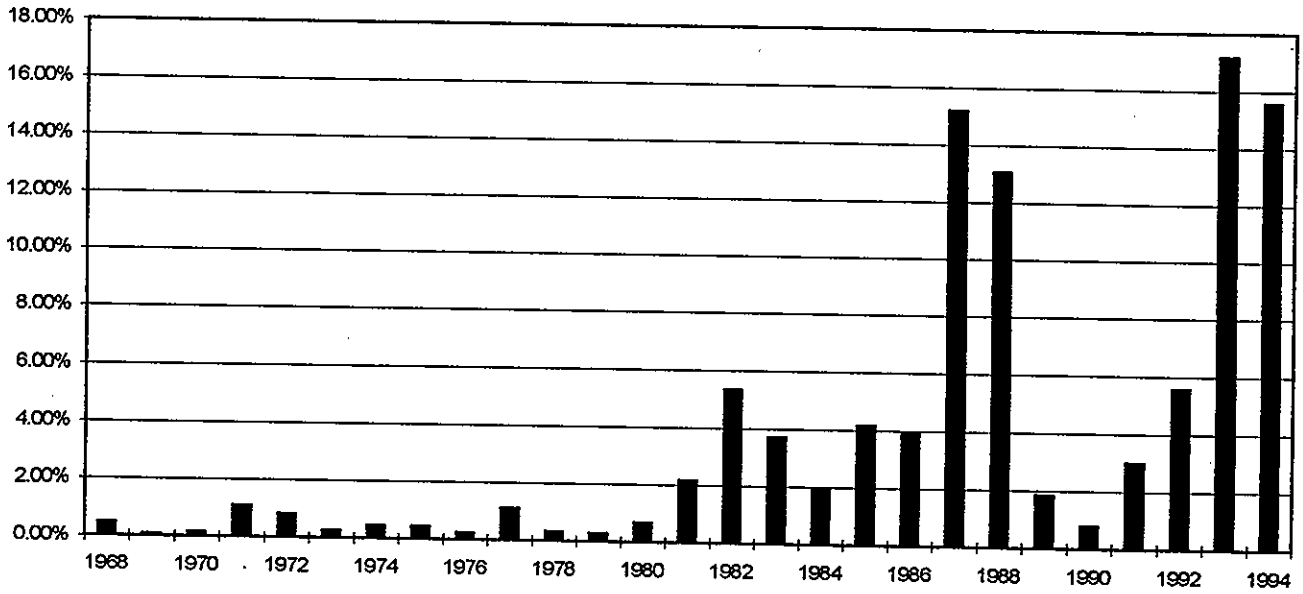


Figure 6-33. Occurrence of Physical Contents in Metal Boxes, Cartons, Cases.

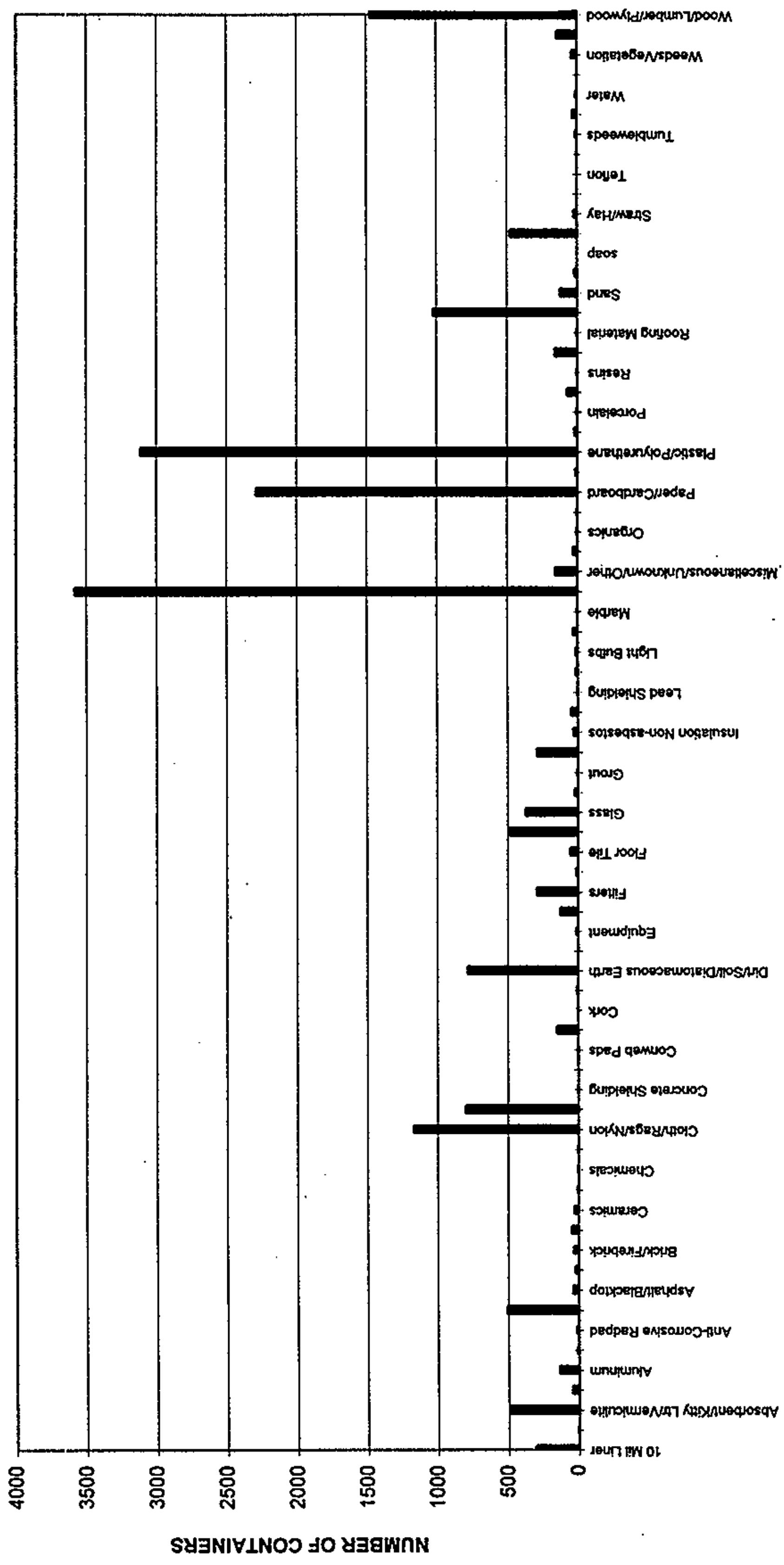


Table 6-5. Specific Container Information for Metal Boxes. (3 sheets)

Container description	Number in R-SWIMS	Dimensions (ft)	Volume (ft^3)	Drawing number(s)
Bins	320	4 x 5 x 6	120	N/A
Metal boxes	328	Unknown	--	N/A
Metal box/sample	82	--	--	N/A
Metal box	1	4 x 5 x 10	200	H-2-24483
Metal box	3	3.08 x 3.5 x 6.17	66.51	N/A
Metal box	1	3.08 x 3.5 x 7.33	79.02	N/A
Metal box	1	3.08 x 3.5 x 8.33	89.79	N/A
Metal box	2	5.5 x 5.6 x 11.5	354.2	--
Metal box	1	6.2 x 6.4 x 24	952.32	N/A
Metal box	6	4 x 4.42 x 8.25	145.86	N/A
Metal box	21	8 x 8 x 20	1,280	N/A
Metal box	1	7.6 x 9.3 x 15	1,060.2	N/A
Metal box	2	3 x 4 x 6	72	N/A
Metal box	1	5 x 8 x 10	400	N/A
B25 Metal box	17	4.3 x 3.9 x 6	100.62	N/A
Metal box	5	4.5 x 4.5 x 7.3	147.82	N/A
Metal box	11	5.6 x 6.5 x 9.3	338.52	N/A
Metal box	6	5.2 x 5.3 x 9.2	253.55	N/A
Metal box	1	7.62 x 7.95 x 10.45	633.05	N/A
Metal box	1	3.67 x 6.5 x 13.17	314.17	N/A
Metal box	2	4 x 4 x 10	160	N/A
Metal box	1	2 x 2 x 2	8	N/A
Metal box	1	2 x 4 x 4	32	N/A
Metal box	1	7 x 8 x 9	504	N/A
Metal box	3	4 x 6 x 15	360	N/A
Metal box	1078	4 x 4 x 7	112	N/A
Metal box	12	5 x 6 x 11	330	N/A
Metal box	2	4.17 x 6.25 x 15.56	405.53	H-2-35001
Metal box	1	4.6 x 8.7 x 9.4	376.18	N/A
Metal box	2	5.7 x 7.2 x 9.3	381.67	N/A
Metal box	4	5.43 x 7.7 x 11	459.92	H-2-99199
Metal box	3	6 x 7.1 x 12	511.2	N/A
Metal box	41	6 x 6 x 7	252	H-2-91888
Metal box	1	7 x 12 x 16	1344	N/A

Table 6-5. Specific Container Information for Metal Boxes. (3 sheets)

Container description	Number in R-SWIMS	Dimensions (ft)	Volume (ft^3)	Drawing number(s)
Metal box	14	5.4 x 5.6 x 6.8	205.63	N/A
Metal box	1	10.5 x 11.2 x 11.3	1,328.88	N/A
Metal box	1	9.8 x 11.2 x 11.3	1,240.28	N/A
Metal box	11	5 x 5 x 9	225	H-2-27045
Metal box	23	2.31 x 3.92 x 6.08	55.05	N/A
Metal box	10	2.4 x 2.5 x 7	42	N/A
Metal box	1	1.5 x 2 x 14	42	N/A
Metal box	1	4 x 8 x 16.5	528	N/A
Metal box	1	4 x 6.5 x 14	364	N/A
Metal box	1	3.5 x 6.5 x 10	227.5	N/A
Metal box	4	4.25 x 2.63 x 2.63	29.39	N/A
Metal box	2	4 x 8 x 10	320	N/A
Metal box	2	2 x 3 x 15	90	N/A
Metal box	4	5.21 x 7.13 x 16.5	612.93	N/A
Metal box	8	4 x 8 x 16	512	N/A
Metal box	9	5.21 x 7.13 x 10.5	390.04	N/A
Metal box	3	6 x 8 x 12	576	H-2-36768
Metal box	1	8 x 8 x 8	512	N/A
Metal box	50	4 x 5 x 7	140	N/A
Metal box	10	5 x 5 x 7	175	N/A
Metal box	1	5 x 10 x 13	650	H-2-72153
Metal box	1	5 x 5 x 5	125	N/A
Metal box	1	7 x 10 x 16	1120	N/A
Metal box	1	--	1,250 ft^3	N/A
Metal box	4	4 x 4 x 20	320	N/A
Metal box	11	2 x 4 x 8	64	N/A
Metal box	2	2 x 2 x 6	24	H-2-26526
Metal box	23	2 x 3 x 4	24	N/A
Metal box	77	4 x 4 x 6	96	H-1-72013
Metal box	14	4 x 4 x 5	80	N/A
Metal box	17	4 x 5 x 9	180	N/A
Metal box	5	5 x 6.5 x 9	292.5	N/A
Metal box	42	4 x 5 x 8	160	N/A
Metal box	151	4 x 5 x 6	120	N/A

Table 6-5. Specific Container Information for Metal Boxes. (3 sheets)

Container description	Number in R-SWIMS	Dimensions (ft)	Volume (ft^3)	Drawing number(s)
Metal box	6	5 x 5 x 11	275	N/A
Metal box	8	3 x 3 x 4	36	H-2-38030
Metal box	2	3 x 5 x 8	120	N/A
Metal box	1	5 x 7 x 17	595	N/A
Metal box	3	4 x 6 x 16.5	396	N/A
Metal box	11	4 x 4 x 4	64	N/A
Metal box	1	3.5 x 6 x 8	168	N/A
Metal box	1	3.17 x 4.5 x 6.67	95.14	N/A
Metal box	2	4.5 x 6 x 10	270	H-2-72560
Metal box	52	2 x 2 x 3	12	H-2-27069
Metal box	3	--	108 ft^3	N/A
Metal box	93	4 x 4 x 8	128	H-3-39711
Metal box	2	--	269 ft^3	N/A
Metal box	2	--	149 ft^3	N/A
Metal box	3	--	197 ft^3	N/A
Metal box	15	--	252 ft^3	N/A
Metal box	43	2.5 x 2.5 x 4	25	N/A
Metal box	1	3 x 4 x 7	84	N/A
Metal box	1	4 x 5.5 x 16	352	H-2-35001
Metal box	128	4.08 x 4.17 x 7.83	133.21	H-1-42998
Metal box	3	--	156 ft^3	N/A
Metal box	3	--	115 ft^3	N/A
Metal box	19	--	80.8 ft^3	N/A
Metal box	5	3 x 4 x 10	120	H-2-26525
Metal box	12	4 x 6 x 10	240	H-2-72118 H-2-72188 H-2-26525
Metal box	2	--	216 ft^3	N/A
Metal box	1	--	840 ft^3	N/A

R-SWIMS = Richland - Solid Waste Information Management System.
ft = 0.3 m.
ft^3 = 0.03 m^3.

6.2.14 Metal Cylinders and Casks

Metal cylinders and casks constituted a small portion of the containers buried at Hanford making up less than 0.1%. The specific types of containers listed as metal cylinders and casks are compressors, pipe casks, steel casks, Hittman liners, and in-reactor experiment capsules. The majority of the cylinders were disposed of in 1992. The relative percentages of metal cylinders and casks disposed each year are shown in Figure 6-34.

The primary waste types contained in metal cylinders and casks were radioactive and MW. The majority of the waste packaged in the cylinders was nonindustrial LLW. The primary contents of the cylinders were metal, iron, galvanized, and sheet material and plastic/polyurethane material. Additional physical contents and their number of occurrences are shown in Figure 6-35.

WHC and PNL are the two main generators of metal cylinders and casks. The SWITS database lists the waste was typically buried in the 200 West Area burial grounds. About 4% of the waste was buried in the 200 East Area burial grounds.

Figure 6-34. Percentage of Metal Cylinders, Casks By Year.

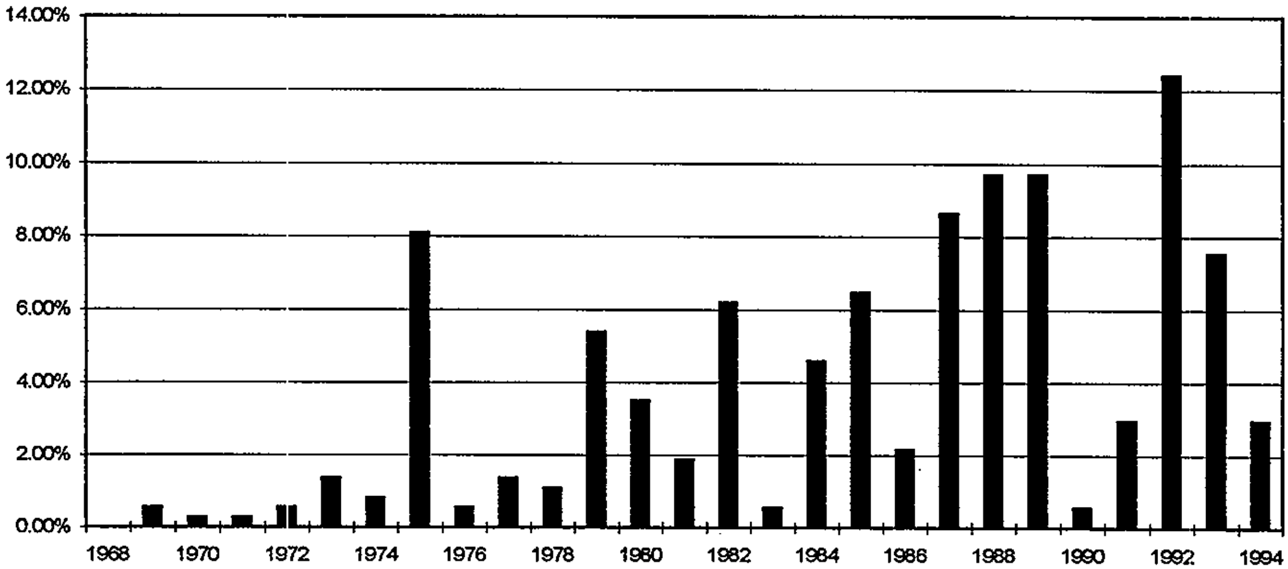
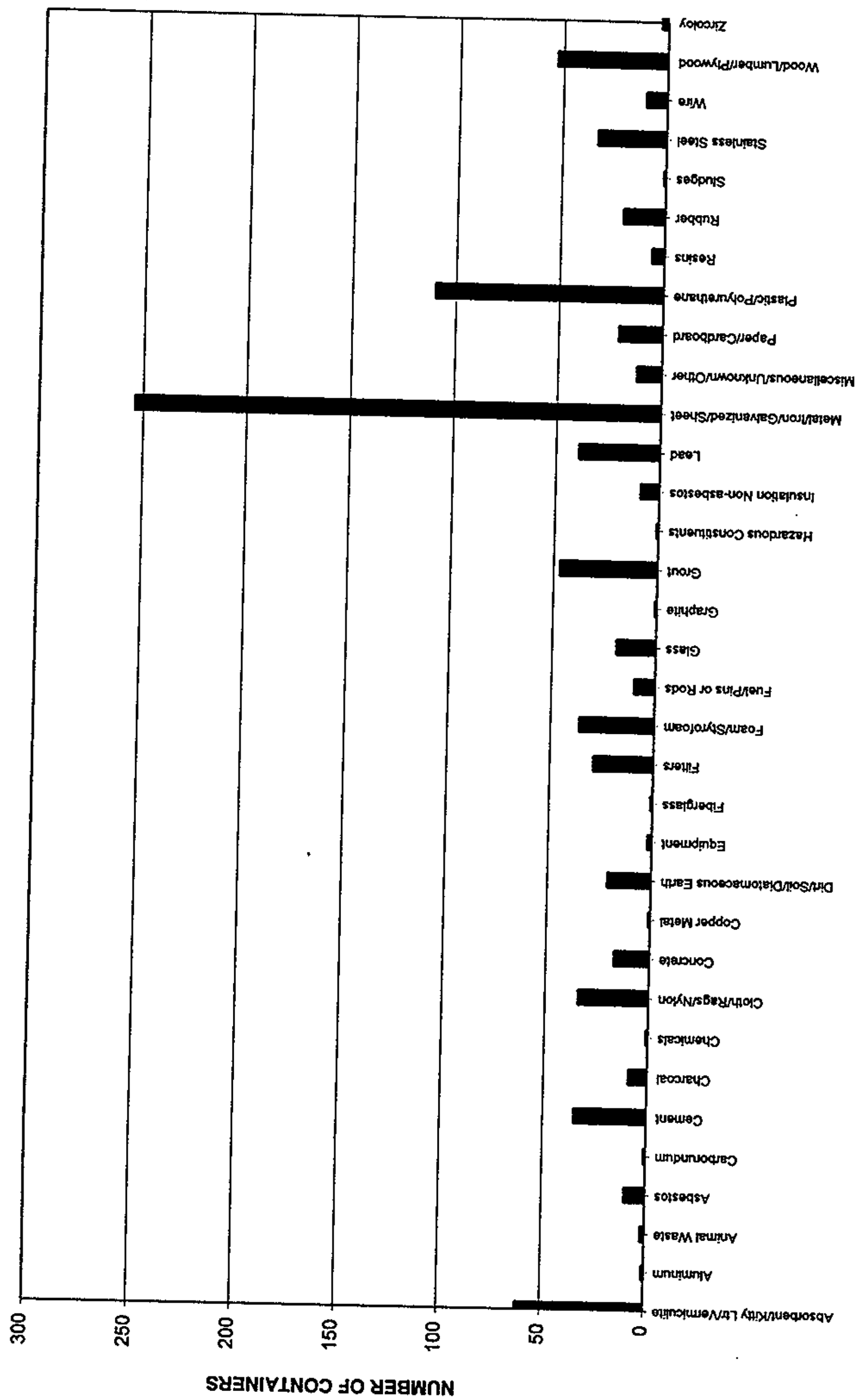


Figure 6-35. Occurrence of Physical Contents in Metal Cylinders, Casks.



6.2.15 Metal Drums, Barrels, and Kegs

Approximately 24% of all waste buried at Hanford since 1968 was packaged in metal drums, barrels, and kegs. The majority of metal drums disposed were 55-gal DOT 17-C and 17-H. A large number of drums were buried in 1987. Figure 6-36 shows the relative percentages of drums, barrels, and kegs buried by year.

The primary waste types contained in metal drums, barrels, and kegs are radioactive, radioactive containing PCBs, mixed, and mixed containing PCBs. Approximately 46,000 drums contain nonindustrial LLW. A large portion of the drums contain TRU waste, industrial LLW, and nonindustrial mixed LLW. The primary physical contents buried were metal, iron, galvanized, and sheet material and plastic/polyurethane material. An overview of all the physical contents of the drums is given in Figure 6-37.

The majority of the drums were used for packaging by WHC and PNL. Though the drums have been buried at nearly all the burial sites, most of the drums were buried in the 200 West burial grounds. There were some instances of drums being buried in the 200 East burial grounds and 300 Area burial grounds, as well as some cases of drums being stored in above-ground storage buildings.

Figure 6-36. Percentage of Metal Drums, Barrels, Kegs By Year.

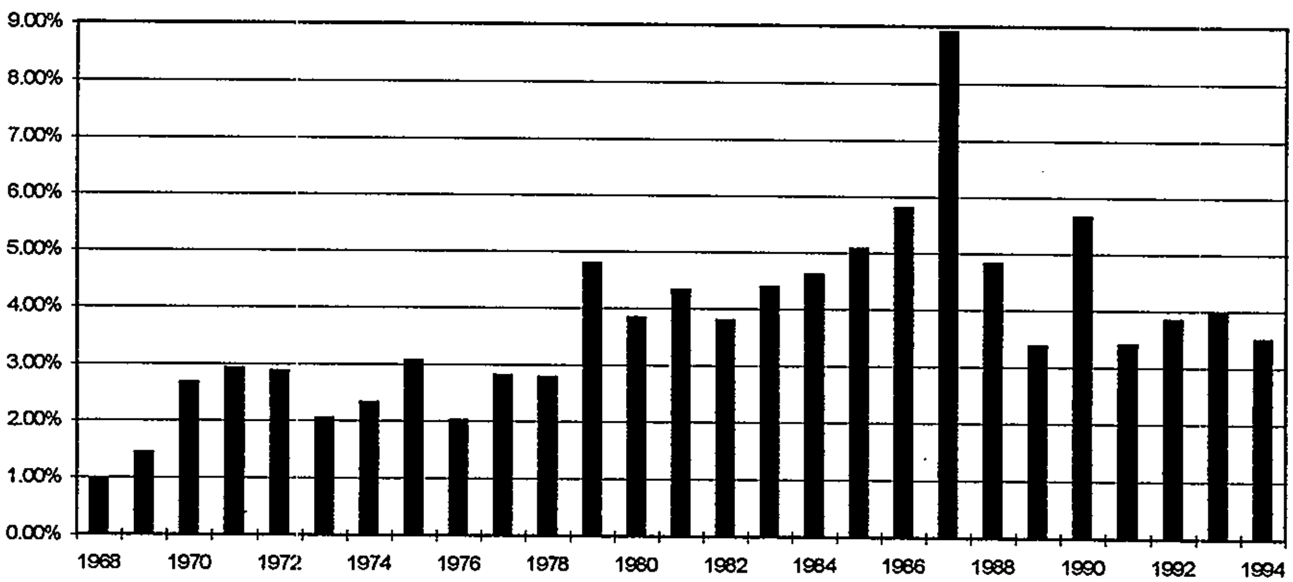
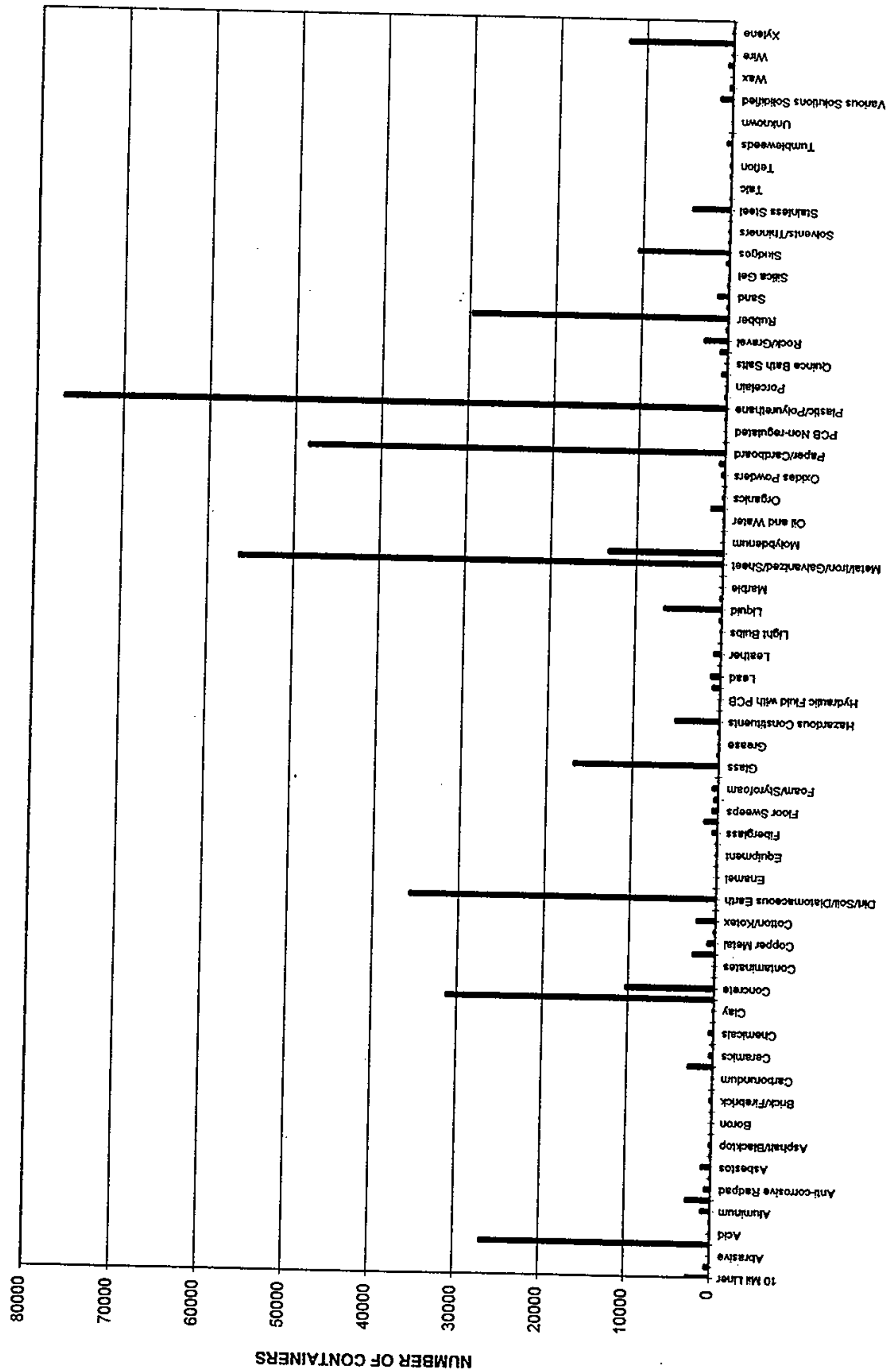


Figure 6-37. Occurrence of Physical Contents in Metal Drums, Barrels, Kegs.



Due to the high percentage of drums used for waste disposal, it is important to give a brief description of several general characteristics. The following subsections focus on 55-gal drums in general and more specifically the Specifications 17-H and 17-C.

6.2.15.1 General Description of a 55-Gallon Drum. The 55-gal waste drum was a relatively simple package with no internal or external appurtenances (e.g., valves, sample ports, etc.) which could have complicated handling or compromised packaged structural integrity. The 55-gal drum was a metal container in the shape of a right circular cylinder which served as a primary containment barrier for the waste contents. No item was to be placed inside a drum that would have prevented the lid from being installed properly or that would have caused a bulge, dent, or crack in any part of the container (Foster and Carter 1981). For a brief period during the early 1970's, reconditioned drums were used for the storage of TRU waste. After corrosion, pits, and holes were detected in the reconditioned drums, they were found to be unreliable and were no longer used.

For TRU asphalt pad storage and dry waste trench storage in 1977, individual containers were 55-gal DOT Specification 17-H drums or containers which were a minimum of 0.61 m (2 ft) in any dimension and 0.91 m (3 ft) in one dimension. For transuranic industrial and special waste trench storage, each container was a minimum of 0.76 m (2.5 ft) in any dimension (Anderson 1978).

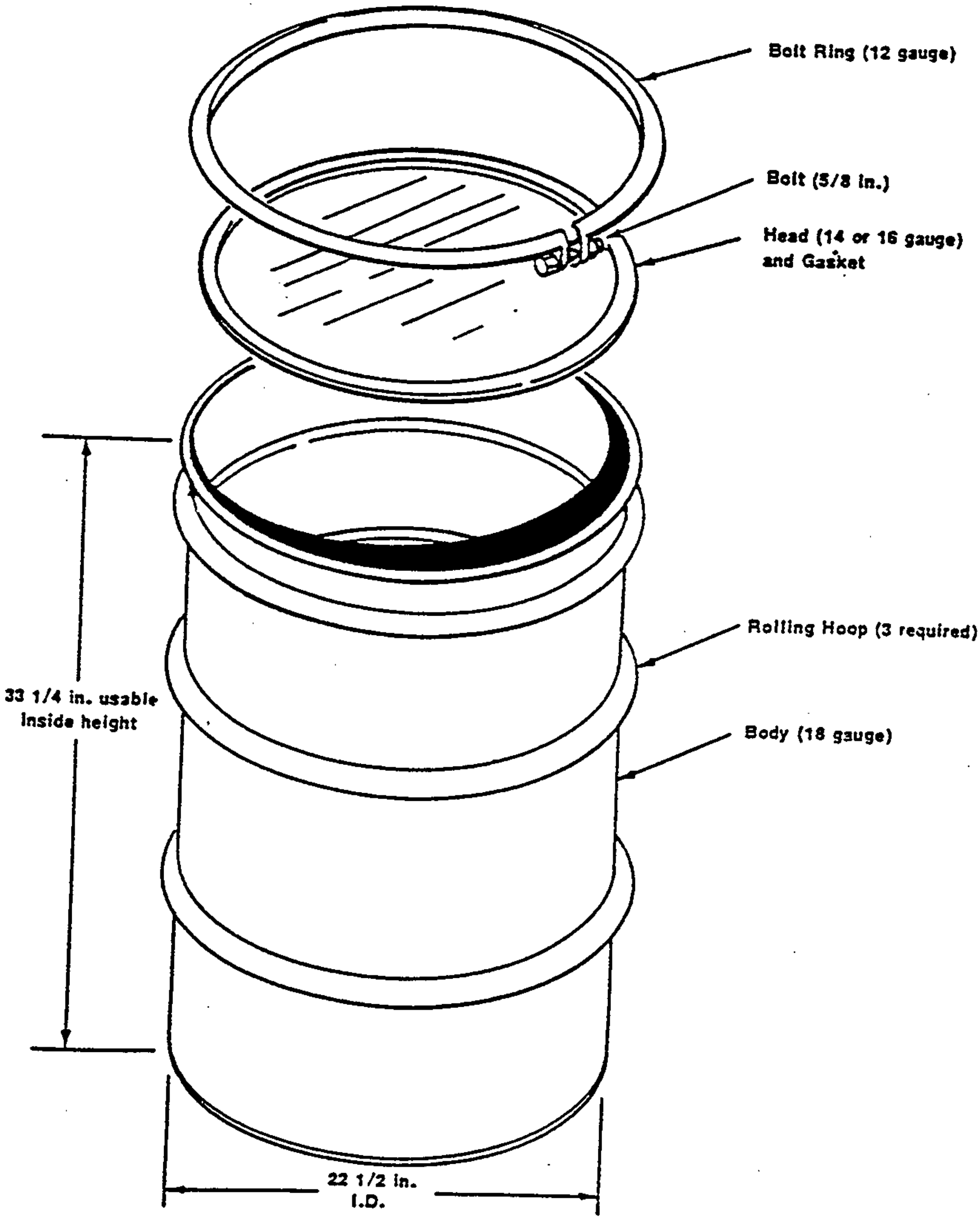
Around 1980 it was declared that the DOT 17-C 55-gal galvanized drums were the required packaging for TRU waste (McCall 1980). The 17-C and 17-H nongalvanized, drums were constructed of slightly thinner steel in the cylindrical portion and bottom end. These drums were used for non-TRU waste shipments (Foster and Carter 1981). Overall external dimensions were nominally 0.61 m (24 in.) diameter by 0.63 m (25 in.) high.

It was required by PNL that every 55-gal drum be covered with a standard lid and equipped with an approved venting device. Once the drum was filled to capacity, approximately 68 kg (150 lb) on average, the plastic containment liner was twisted and taped closed, the rubber gasket checked for integrity, and the lid sealed. A catalyst pack was put in with the waste if a vent clip was used as a venting device. The tabs of the metal sealing ring were placed in a downward position, the bolt inserted, and the nut secured for closure. The lid-locking ring was tapped into place, torqued to 54.2 N-m (40 ft-lb), and a lock nut installed. The material balance area custodian inserted a tamper-indicating device through the bolt (PNL 1993).

6.2.15.2 Specification 17-H. The basic containers used in 1971 were 55-gal steel drums which met the requirements of the DOT Specifications 17-H, shown in Figure 6-38. The drums were adequate for protected above-ground storage for five years. They also met preliminary salt mine acceptance criteria if they were not contaminated on the outside and did not contain in excess of 25 g of plutonium (Kennedy 1971a). The 17-H utilized 18-gauge (1.21 mm) (0.05 in.) carbon steel on the cylindrical portion and on the bottom end. The drums also had a fully removable head made of 14 gauge (1.88 mm) (0.075 in.) or 16 gauge (1.5 mm) (0.06 in.) carbon steel. The dimensions of the drum are as follows (Manning 1979):

Overall height, cover on	88.4 ± 0.32 cm (34.8125 ± 0.125 in.)
Height, with cover off	87.3 ± 0.32 cm (34.375 ± 0.125 in.)
Inside diameter	57.2 ± 0.32 cm (22.5 ± 0.125 in.)

Figure 6-38. DOT Specification 17-H Burial Drum.



The drums had a fully removable bolted type locking ring. The locking ring was 12 gauge (2.66 mm [0.1046 in.]) with drop forged lugs and a 1.59 cm (0.625 in.) bolt and nut. The gasket was either a neoprene tubular O-ring with a durometer shore reading of 65-75, 9.5 mm (0.375 in.) outside diameter of 2.4 mm (0.9375 in.) wall, sized to fit the drum cover recess; or a synthetic flowed-in type gasket such as DAREX Cover Compound Number 730 with an expected minimum 20 year life. The locking ring bolt was torqued to 54 N-m (40 ft-lb) when the drum was sealed (Foster and Carter 1981). Container closures were gasketed, threaded, or welded to assure tightness under all loads imposed during handling, transporting, and until all burial backfilling was initiated (McCall 1981).

6.2.15.3 Specification 17-C. The 17-C drums were constructed of 16 gauge carbon steel with three rolled or swedged-in hoops, shown in Figure 6-39. Starting in 1979, the PFP Specification 17-C drums were equipped with a carbon-filter vented lid. Those drums not equipped with the vented lid required that a vent clip and a hydrogen-oxygen recombinant catalyst pack be added to the drum to prevent pressurization resulting from radiolytic decomposition and/or chemical interaction of drum constituents (organics) that may have been present (Duncan et al. 1993). In 1986, the dimensions of the drum, including tolerances were (Kibbe 1986):

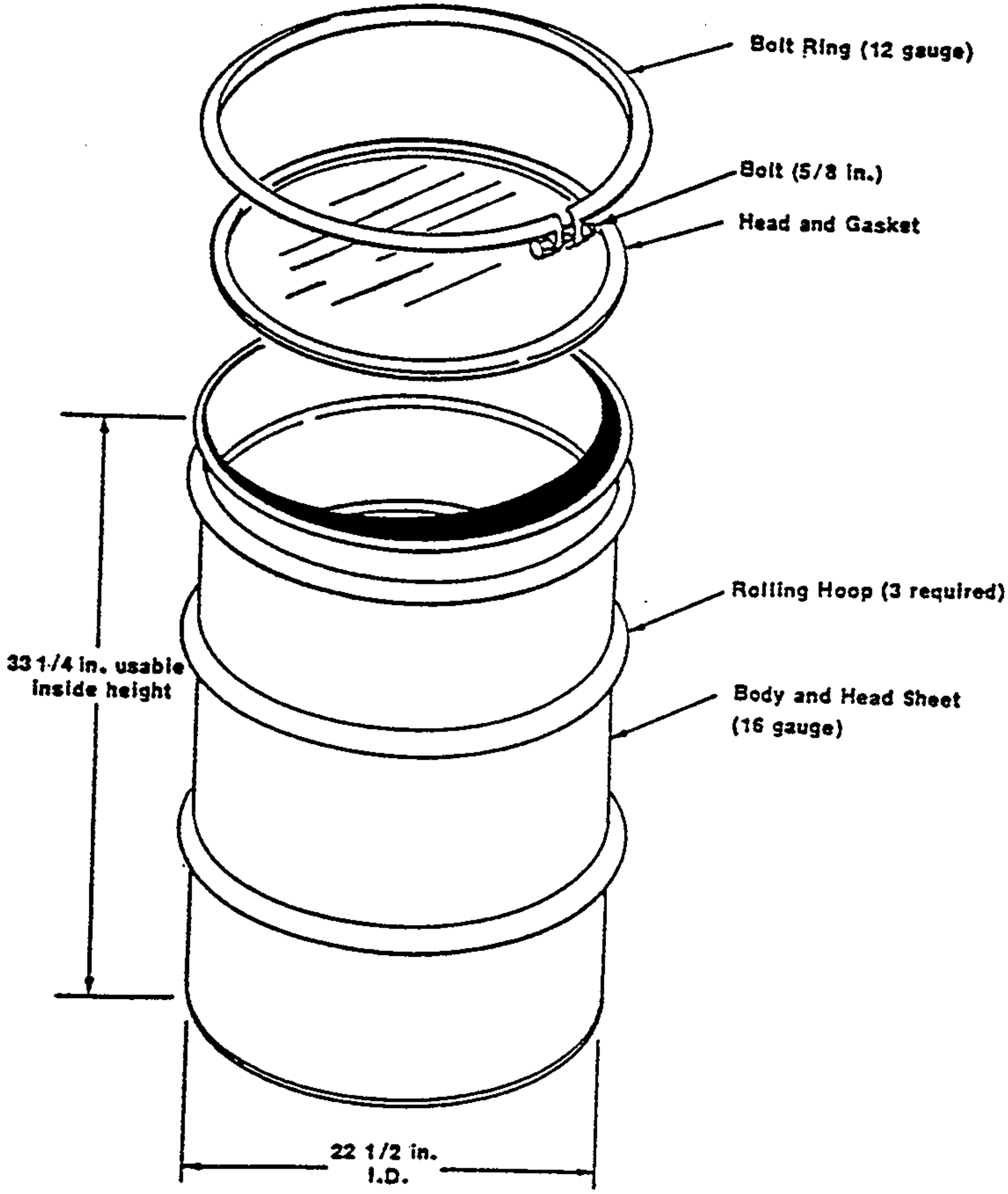
Overall height, cover on	88.4 ± 0.32 cm (34.8 ± 0.12 in.)
Height, cover off	87.3 ± 0.32 cm (34.375 ± 0.12 in.)
Inside diameter	57.2 ± 0.32 cm (22.5 ± 0.12 in.)

Around 1986 the requirements for galvanized drums were clarified. The drums and lids were coated inside and outside with zinc to meet the requirements of ASTM A 153-82, Class B-2, after all welding was completed. A hole used for dipping the lid into the galvanizing bath was allowed. The hole had a maximum diameter of 0.32 cm (0.125 in.), and was located a maximum of 0.32 cm (0.125 in.) from the edge of the lid. The lid may have been made from mill-galvanized sheet steel, providing that the finished product met the same requirements for sheet material, thickness, and zinc coating weight as the hot-dipped zinc-coated drum. The zinc coating was also applied to all surfaces of the rings and lugs after all welding was completed. When assembled on the closed drum, the ring was to have a minimum gap of 4.76 mm (0.1875 in.) after hammer tapping, with the bolt torqued to 54 ± 5.4 N-m (40 ± 4 ft-lb) (Kibbe 1986).

As of 1993, the 55-gal galvanized drum and the WIPP standard waste box were the only two approved TRU waste packages. Liners were to be a minimum of 5-mils as dictated by the TRUPACT-II SARP (Willis 1993).

Each drum was quality control inspected and approved before use and provided with a trace number. Each drum contained 3 L (0.79 gal) of diatomaceous earth absorbent in the bottom of the drum, a minimum of 4-mil polyethylene liner, and 3 L (0.79 gal) of diatomaceous earth in the bottom of the liner (Duncan et al. 1993).

Figure 6-39. DOT Specification 17-C Burial Drum.



6.2.16 Miscellaneous Scrap

Miscellaneous scrap consists of less than 0.1% of all burial containers since 1968. Waste classified as miscellaneous scrap consists of the following:

- Pipe - plastic or metal
- Concrete plugs
- Vent pipes
- Metal scrap
- Metal - fence poles/steel rails
- Paddlewheel
- Wood/posts/TT ties
- Concrete and steel support posts
- Shelves, etc.
- Machining trays and tray racks
- Concrete scrap
- Pallets
- Electrical parts/scrap
- Fuel elements.

The largest percentage of miscellaneous scrap was disposed of in the late 1970's and early 1980's. A complete timeline showing the relative percentage of containers disposed each year is given in Figure 6-40. The primary waste contained in the packages was nonindustrial LLW. Metal, iron, galvanized, and sheet material, and plastic/polyurethane material comprised the majority of the containers' physical content. Figure 6-41 provides the number of occurrences of all physical content types categorized as miscellaneous scrap.

The two main generators of miscellaneous scrap were WHC and PNL. The scrap was most often buried in the 200 Area burial grounds. Approximately 35% of the waste was placed in 218-E-12B and 48% was placed in 218-W-3A.

Figure 6-40. Percentage of Miscellaneous Scrap By Year.

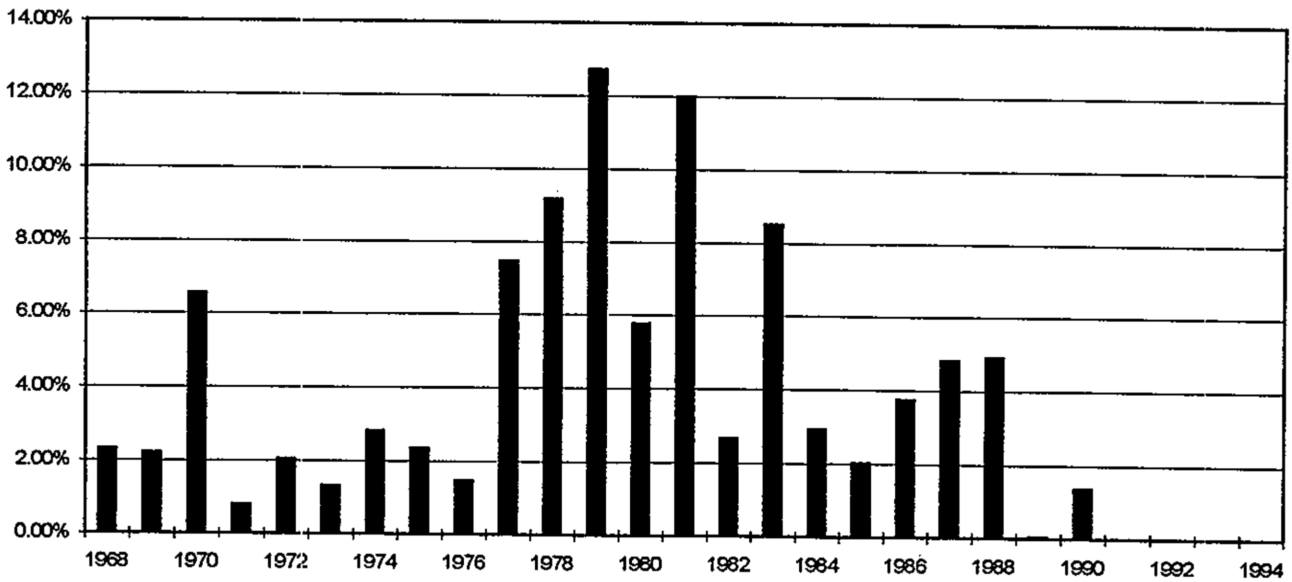
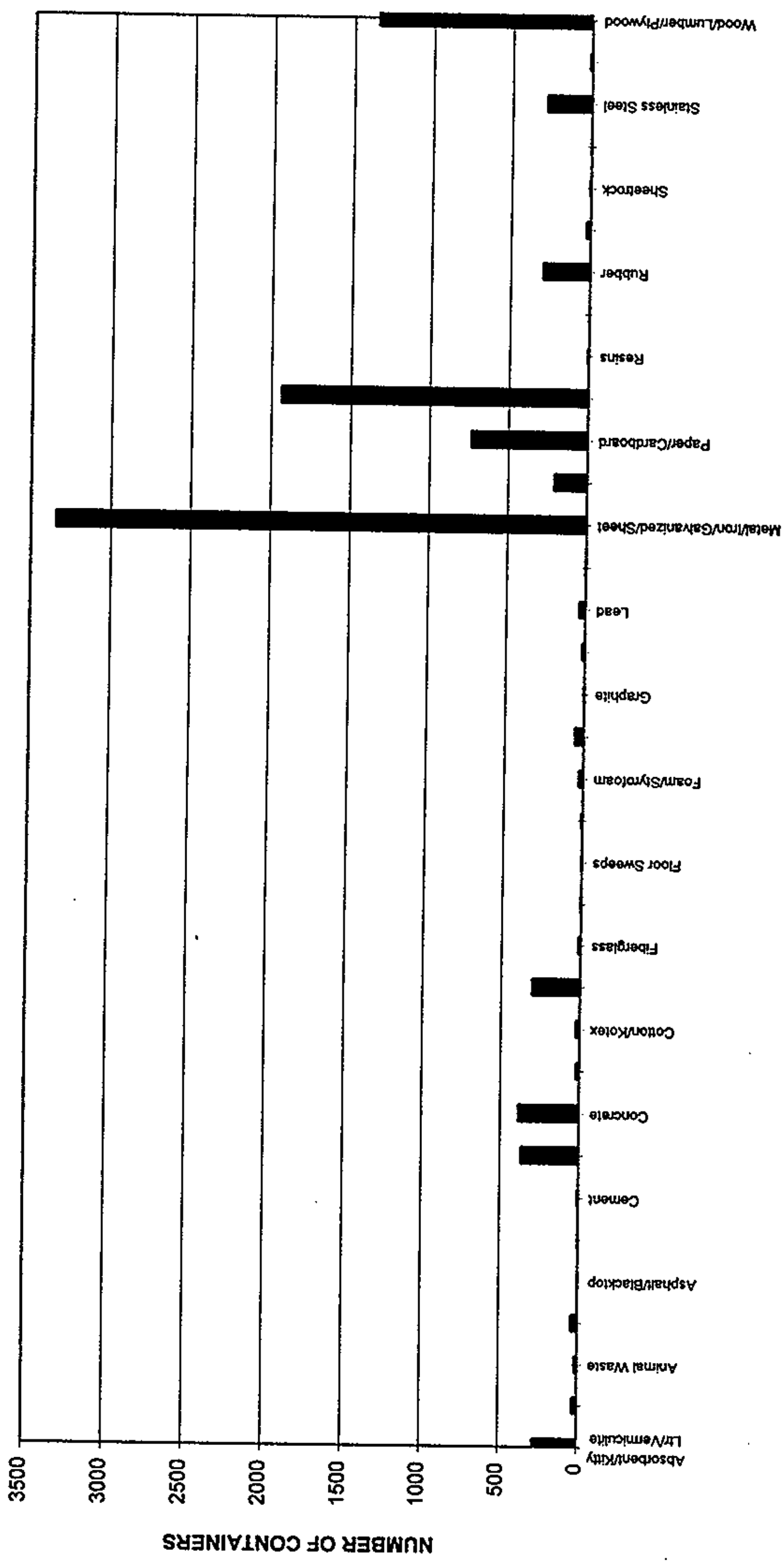


Figure 6-41. Occurrence of Physical Contents in Miscellaneous Scrap.



6.2.17 Naval Core Barrels

There have been approximately 60 naval core barrels buried at the Hanford Site since 1968. The barrels were buried between 1978 and 1987 with over half of the barrels being buried in 1978. The relative percentage of barrels disposed each year are provided in a timeline of burial practices shown in Figure 6-42.

The barrels consisted primarily of nonindustrial, classified, mixed LLW. The majority of the barrels contained metal, iron, galvanized, and sheet material. Figure 6-43 provides a complete breakdown of the barrels' physical contents.

All of the naval core barrels came from Bettis Naval and were buried in 218-W-4C.

Figure 6-42. Percentage of Naval Core Barrels By Year.

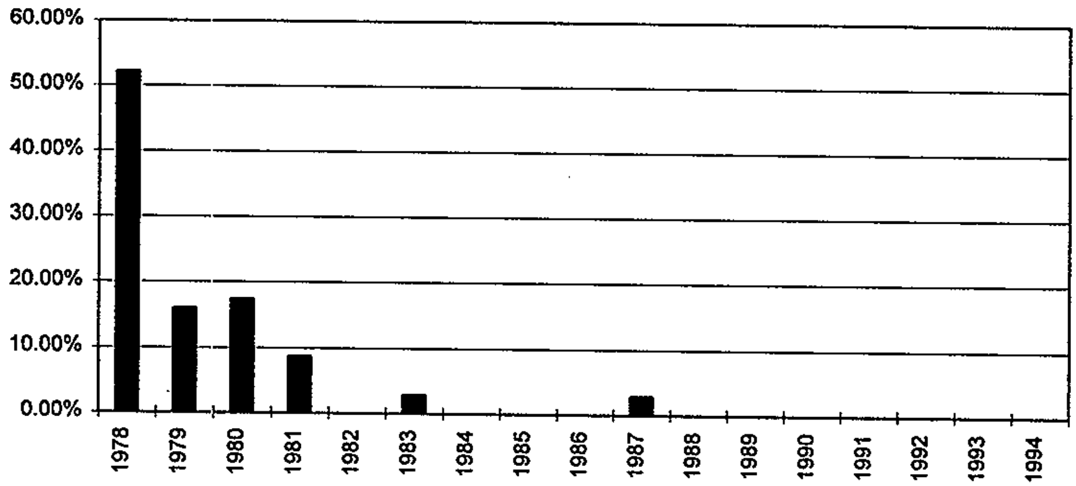
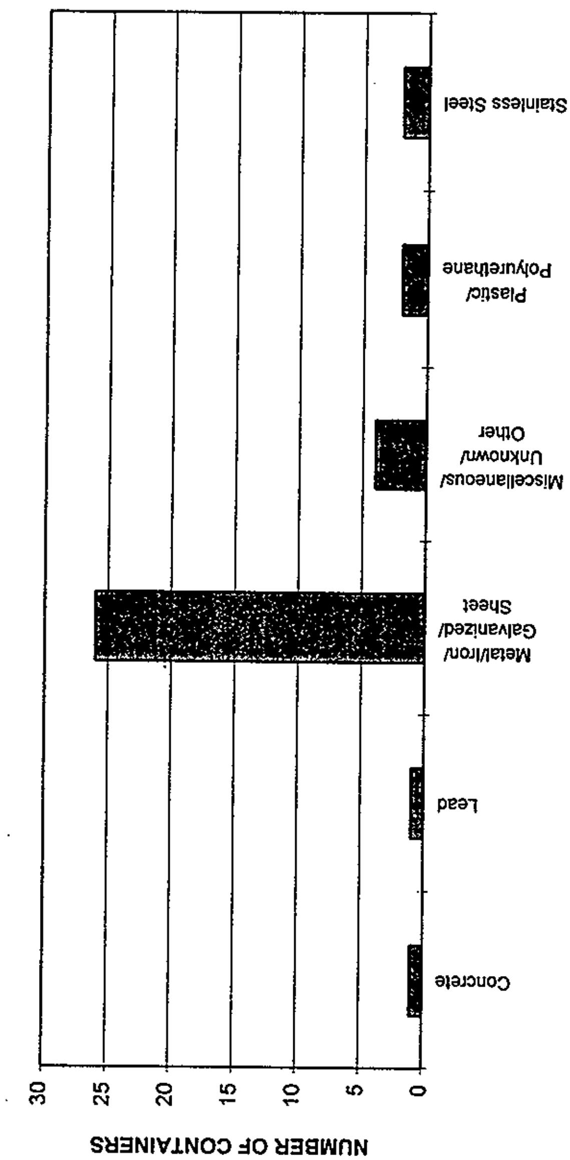


Figure 6-43. Occurrence of Physical Contents in Naval Core Barrels.



6.2.18 Self-Contained Equipment

Self-contained equipment contributes about 1% of the waste containers used at Hanford since 1968. Self-contained equipment consists of the following specific container types:

- Building instrument shack
- Jumpers
- Motors-fans
- Pumps
- Bull hooks and cables
- Panel boards
- Heat exchanger
- Truck beds
- Poppy/hand counters
- Miscellaneous equipment
- ISV glass
- Bird cages - A
- Steam generators.

The largest percentage of self-contained equipment was disposed in 1974, 1981m and 1982. Figure 6-44 provides the relative percentages of self-contained equipment disposed each year.

The largest percentage of self-contained equipment was nonindustrial LLW. The physical contents consisted of metal, iron, galvanized, and sheet material, and plastic/polyurethane material. A complete overview of the physical contents categorized as self-contained equipment is shown in Figure 6-45.

The SWITS database lists WHC as the main generator of self-contained equipment. The majority of the waste was buried in the 200 West Area burial grounds, and approximately 20% of the packages were disposed of in the 200 East Area burial grounds.

Figure 6-44. Percentage of Self-Contained Equipment By Year.

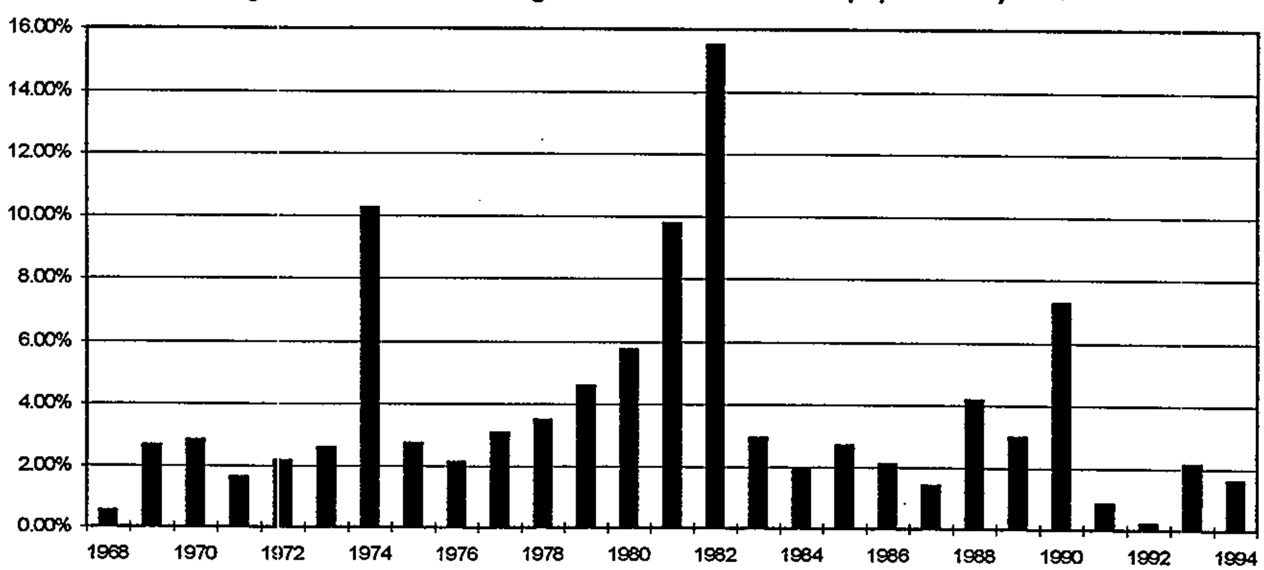
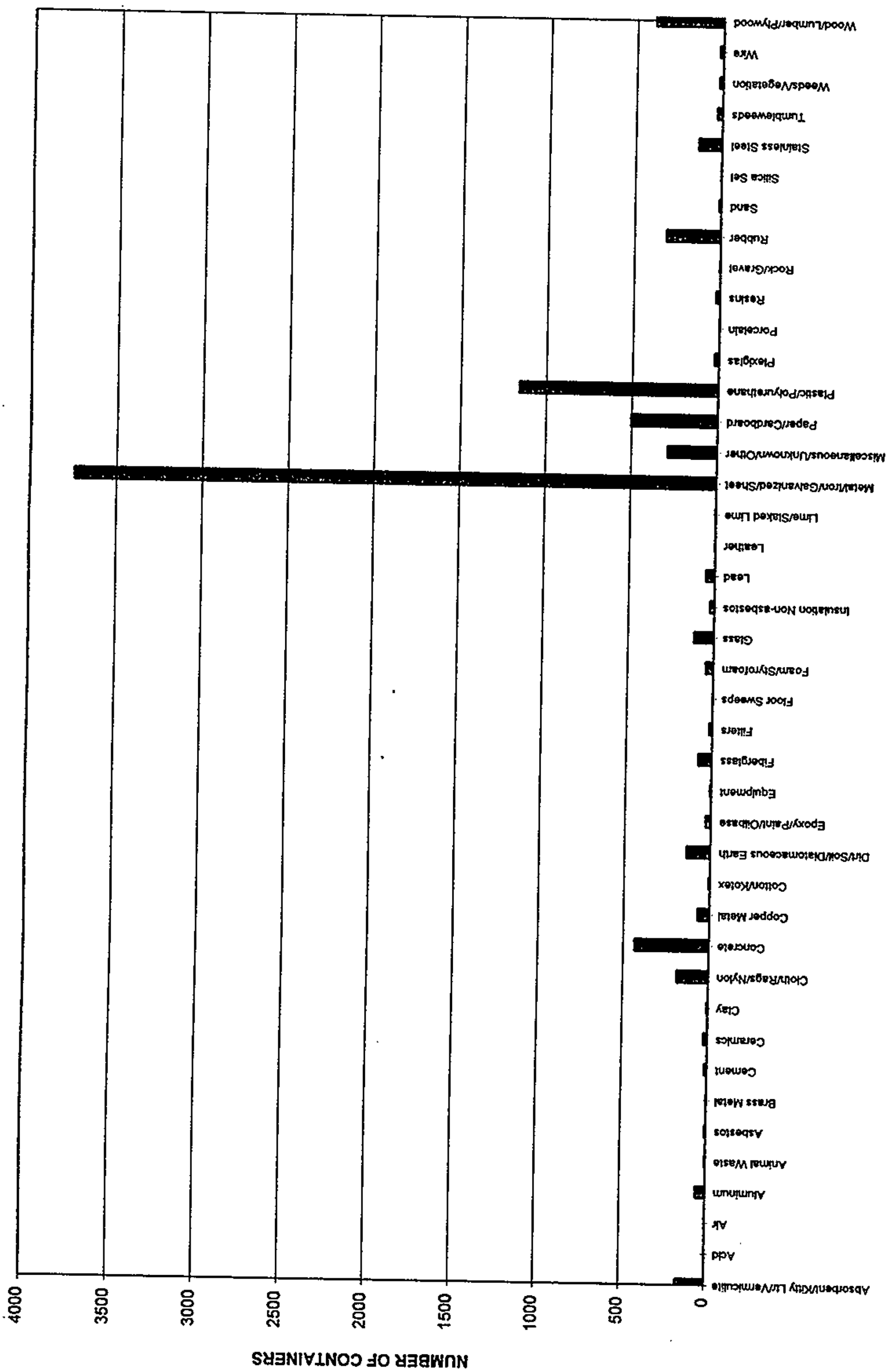


Figure 6-45. Occurrence of Physical Contents in Self-Contained Equipment.

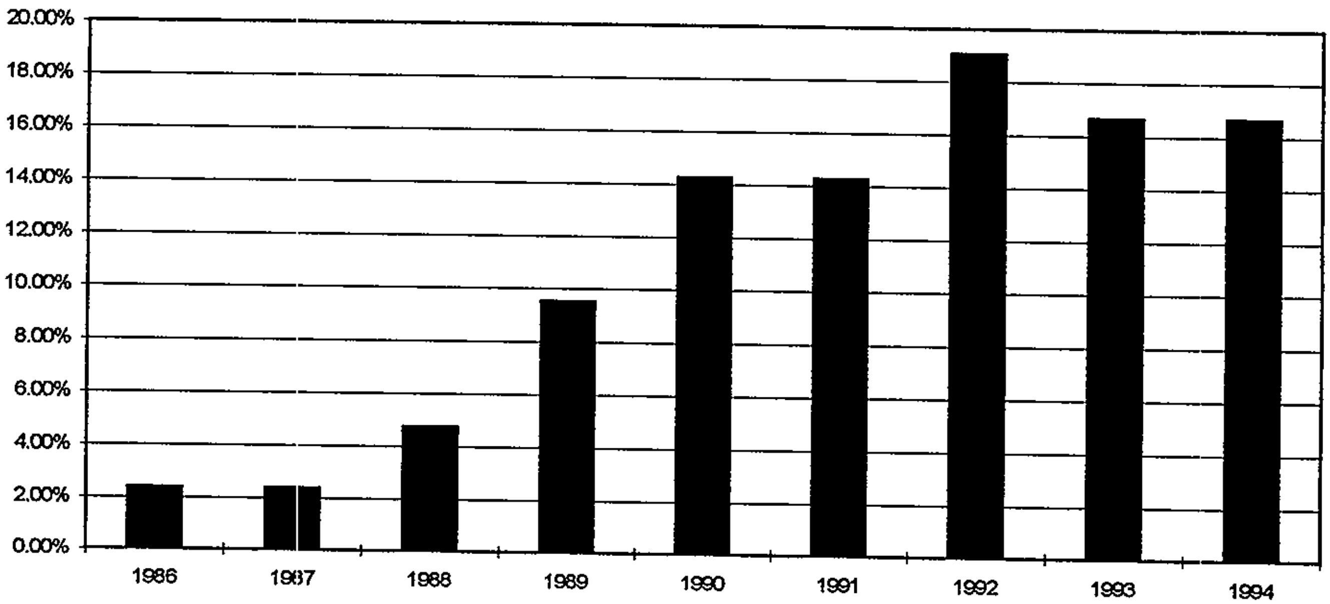


6.2.19 Submarine Reactor Compartments

There have been 42 submarine reactor compartments disposed of at Hanford since 1968. The majority of the compartments have been disposed of since 1990. A complete timeline of disposal practices is given in Figure 6-46. The primary waste types contained in the compartments are radioactive and MW contaminated with PCBs. Almost 84% of the compartments were classified as industrial mixed LLW. The reactors specifically contained large amounts of lead shielding and metal, iron, galvanized, and sheet material.

The majority of the reactors came from Puget Sound Navy. All of the compartments are buried in 218-E-12B.

Figure 6-46. Percentage of Submarine Reactor Compartments By Year.



6.2.20 Portable Tanks

Portable tanks constitute less than 0.1% of all waste buried at Hanford since 1968. Almost 17% of these tanks were disposed of in 1984. A complete timeline showing the relative percentage of tanks disposed each year is given in Figure 6-47. The tanks contained radioactive and MW with the primary waste type being nonindustrial LLW. Metal, iron, galvanized, and sheet material, and plastic/polyurethane material comprised the majority of the tanks' physical contents. There were a few cases of asbestos being disposed of in the tanks. A complete overview of the contents of the portable tanks is given in Figure 6-48.

The SWITS database lists WHC as the main generator of portable tanks. The majority of the waste was buried in the 200 West burial grounds. A small portion, about 3%, was buried in the 200 East burial grounds.

Figure 6-47. Percentage of Portable Tanks By Year.

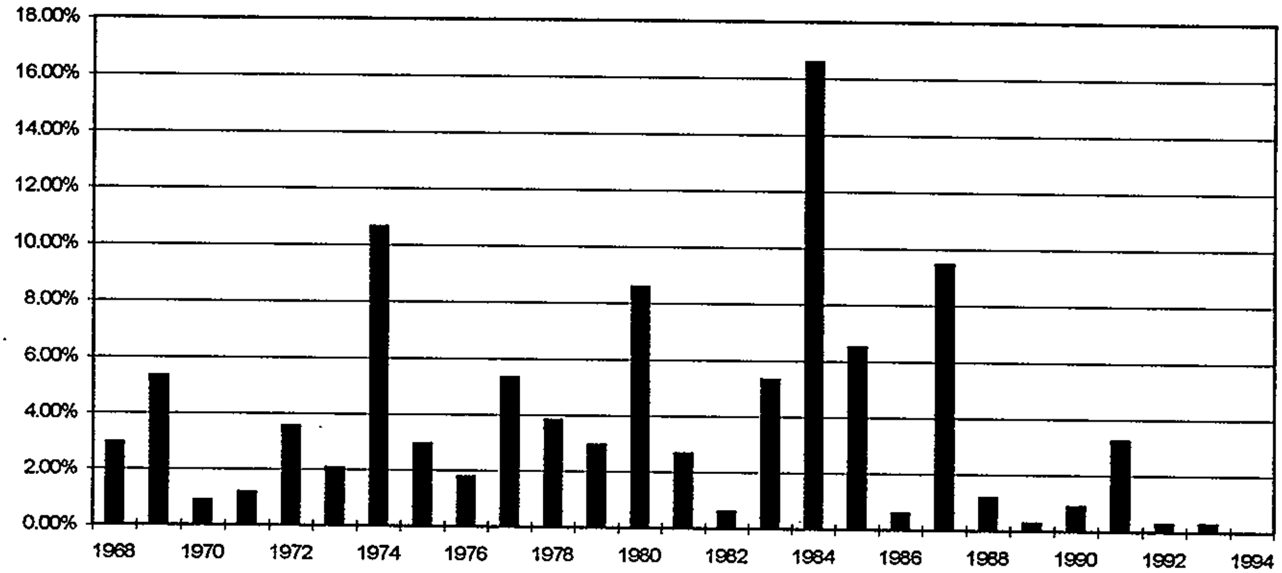
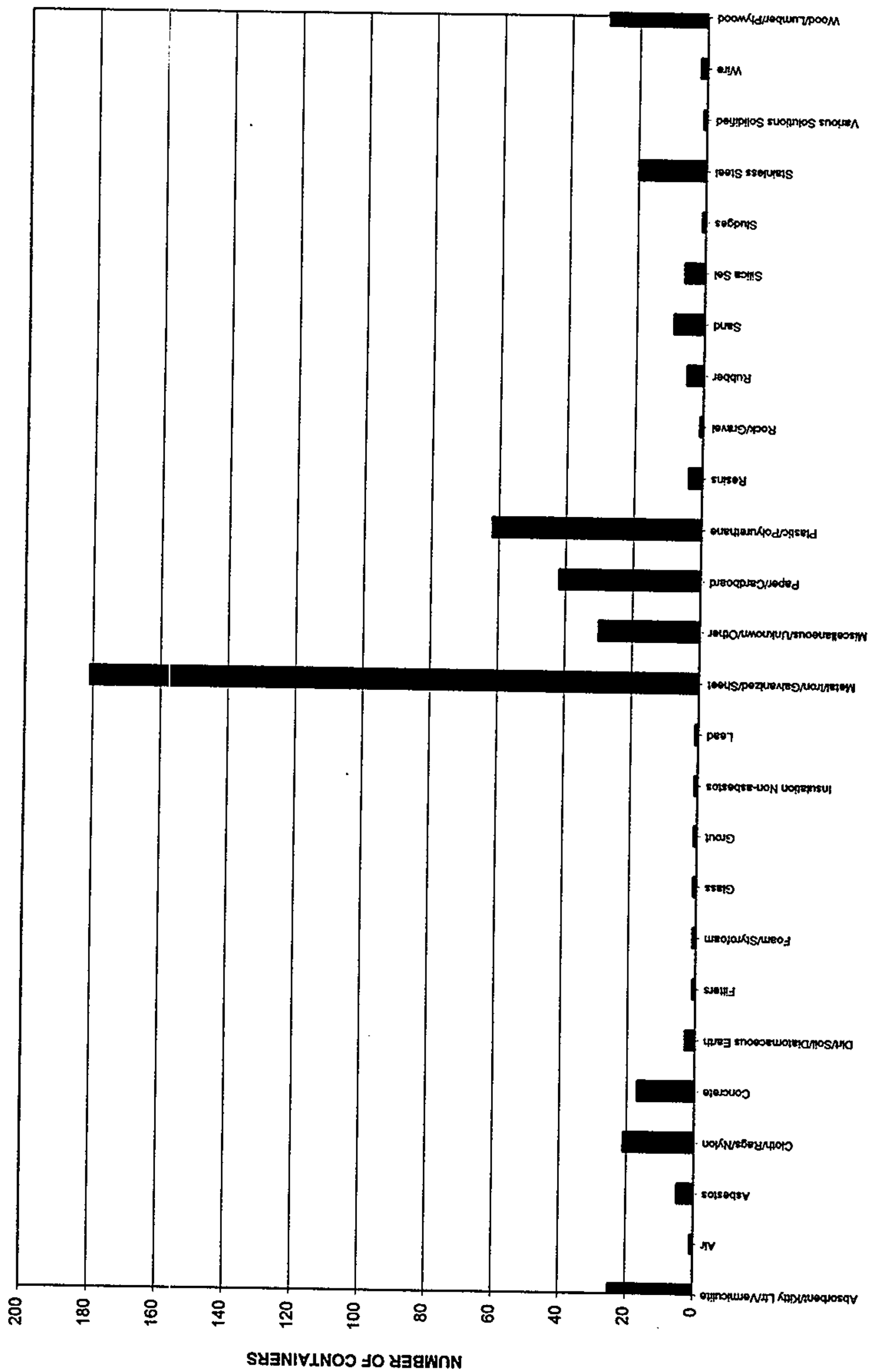


Figure 6-48. Occurrence of Physical Contents in Portable Tanks.



6.2.21 Trucks, Flatbeds, Compactor, Loadluggers

Waste classified as trucks, flatbeds, compactors, and loadluggers (hereafter known as truck waste) makes up slightly more than 1% of the containers buried at Hanford since 1968. Approximately 25% of the truck waste was disposed of in 1986. Very little waste was disposed of in the early 1990's. A complete breakdown of the relative percentages of truck waste disposed each year is given in Figure 6-49.

The primary waste type associated with truck waste is nonindustrial, radioactive LLW. The most common physical contents packaged were dirt, metal, plastic, and wood. A detailed overview of the truck waste contents is shown in Figure 6-50. The three main facilities that generated truck waste are WHC, PNL, and J.A. Jones. The waste was disposed of in both the 200 West and 200 East burial grounds.

Figure 6-49. Percentage of Trucks, Flatbeds, Compactors, Loadluggers By Year.

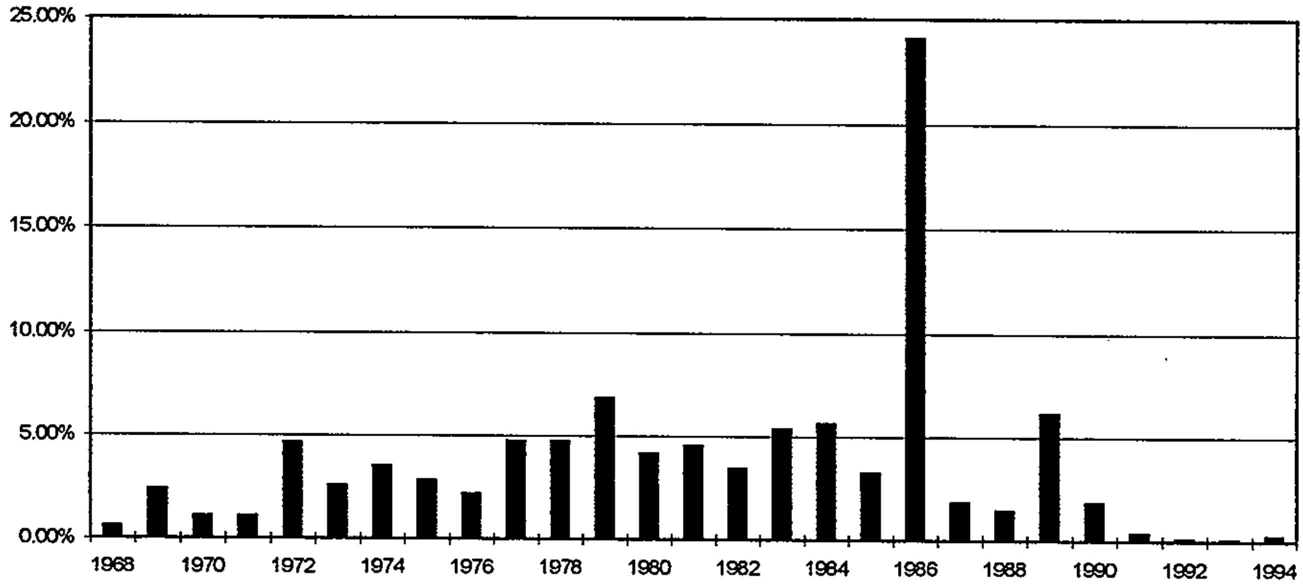
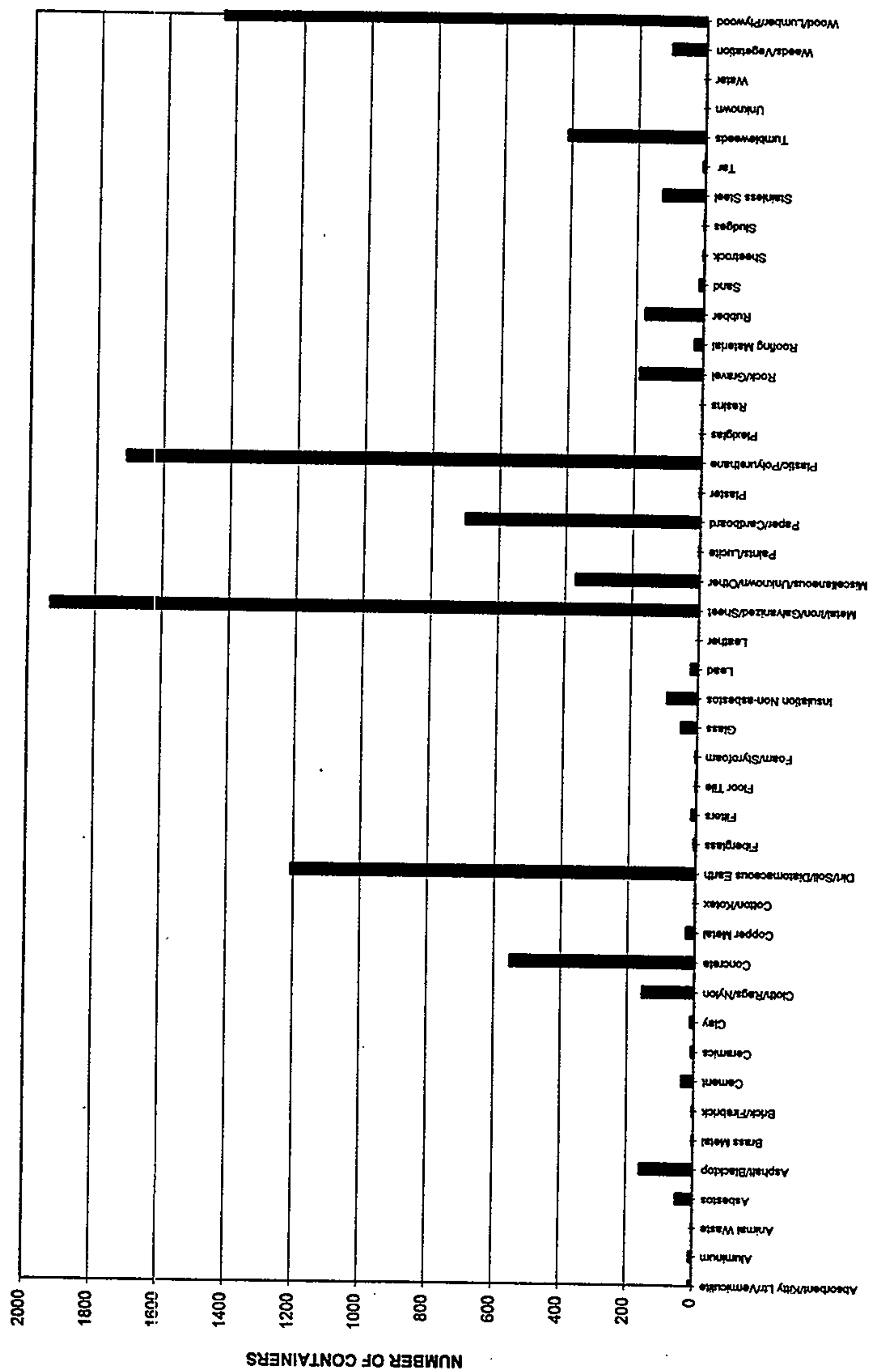


Figure 6-50. Occurrence of Physical Contents in Trucks, Flatbeds, Compactor, Loadluggers.



6.2.22 Wooden Boxes, Cartons, and Cases

A little less than 2% of the packages used to contain waste at Hanford were wooden boxes, cartons, and cases. The use of the containers have increased since 1968. Approximately 11% of all wooden containers were used in 1986. A complete timeline of disposal is given in Figure 6-51.

The primary types of waste are radioactive, mixed, and mixed containing PCBs with the majority being industrial LLW. Most of the physical contents were metal, iron, galvanized, and sheet material; paper/cardboard; plastic/polyurethane; and wood/lumber/plywood materials. A complete overview of the physical contents is given in Figure 6-52.

The main generators of waste in wooden boxes, cartons, and cases were PNL and WHC. The waste was primarily disposed of in the 200 West and East burial grounds with almost 87% of the waste was disposed of in the 200 West burial grounds.

Figure 6-51. Percentage of Wooden Boxes, Cartons, Cases By Year.

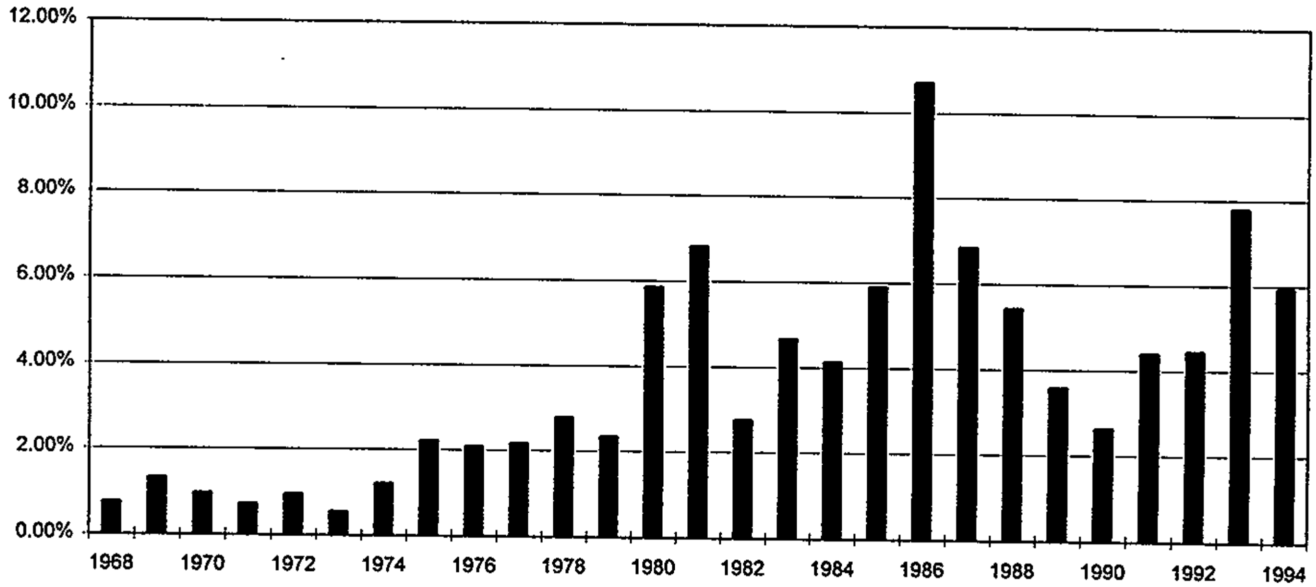
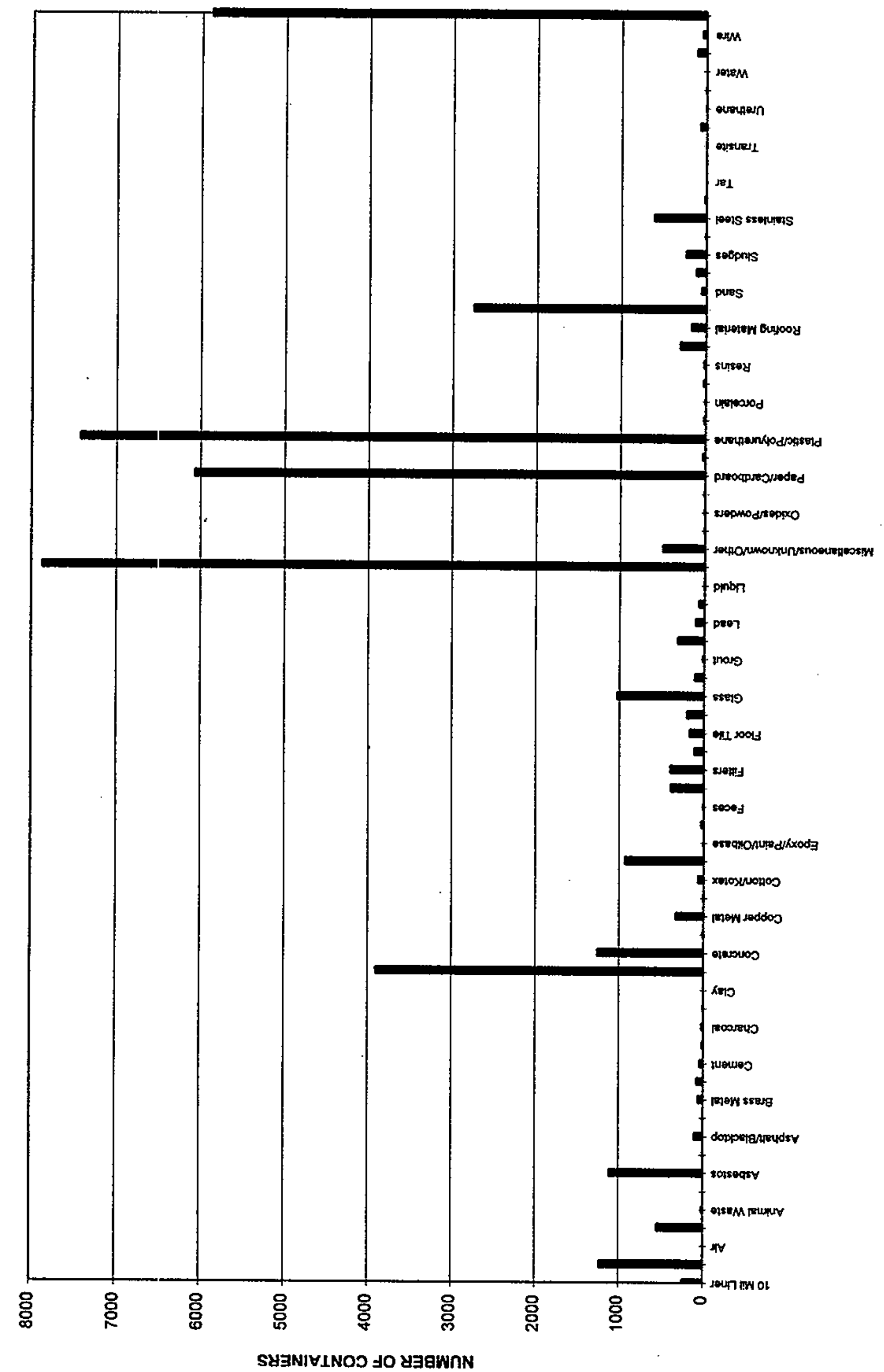


Figure 6-52. Occurrence of Physical Contents in Wooden Boxes, Cartons, Cases.



7.0 SOLID WASTE STORAGE AND DISPOSAL FACILITIES

Hanford waste storage and disposal facilities were constructed as early as 1943. Since there was an abundance of land and the burial of solid radioactive waste provided additional shielding, virtually all solid wastes were disposed by ground burial. After 1970, attention was focused on designing retrievable storage facilities. This section describes burial ground opening and planning practices, above ground storage facilities, below ground storage facilities, burial ground locations and contents, and burial ground deactivation of the Hanford Reservation over time. It should be noted that if resources were inconsistent, an effort was made to verify information by personal communications. If questions still remained, the data referenced most often was assumed to be correct.

7.1 BURIAL GROUND OPENING AND PLANNING PROCEDURES

The waste disposal sites at Hanford are located on a dry, sandy plateau 60 to 70 m above the water table, 50 km from the nearest town, and 11 to 16 km from the Columbia River. Minimum travel time of ground water from the plateau region to the Columbia river varies from 7 to 20 years. There is no evidence of significant faulting and the Hanford Site does not lie in a persistently active seismic zone. Wind and water erosion are minimal. These favorable geological and climatic conditions make the remote plateau within the Hanford Site ideal for the safe ground disposal of large volumes of slightly radioactive waste (Beard and Godfrey 1967).

New waste disposal sites were considered only when it was not feasible to use any of the existing sites. The contractor responsible for disposing of the waste determined and justified the need and initiated the proposal, which was subject to approval by the contract administrator. Each proposal contained a detailed explanation for rejecting existing sites and the justification used in selection of the new site. Justifications included topological and geological considerations, proximity to paved roads, railroad lines, power or telephone lines, projected or past conflicting uses of the site, and associated hazards. Once built, storage/disposal facilities were to be maintained as a regulated entry area by the contractor in accordance with Radiation Zone procedures until termination (Masa 1983a).

Site selection processes were required to comply with DOE Manual Chapter 6202. A Site Development Plan was prepared for each site to assure effective utilization and orderly future site development. Site layouts were developed in accordance with criteria for site development planning contained in DOE Manual Chapter 6203. For each new site, specifications were developed for maintenance efforts on structures, grounds systems, and equipment relative to reliability, maintainability, and availability. The level of attention given to each specification was based on the importance of the function provided by the structure or system in providing isolation for the specified time (Shord 1979).

For each site opened after 1978, a Land Management Plan was developed. This plan was written to facilitate burial site operations and outline the maintenance, conservation, and improvement programs for the grounds in order to increase the value of the land, prevent the waste and destruction of natural resources, protect property, and provide for the welfare of personnel. The plan was required to be consistent with the Site Development Plan and included the establishment of priorities for all ground development and improvement work (Shord 1979).

During the operation of waste disposal sites, continuing surveillance has been conducted. When plants became radioactive, the ground was sterilized (Tomlinson 1969). Routine surface surveillance has included measurement of surface radiation levels, sampling plant growth for radionuclide uptake, and visual inspection for subsidence, animal burrows, and wind erosion. Deficiencies were corrected as necessary (Albaugh et al. 1985).

7.1.1 Space Utilization

In the 1970's, many methods were developed and researched to use space as efficiently as possible at the Hanford Site. One method of saving space for transuranic waste trenches involved backfilling the trench only after it was filled, rather than backfilling nightly. This provided a continuous cross section of drums along the bottom of the trench and made for an efficient burial of material. Since heavy shielding for personnel and protection from the wind were usually not essential for the sealed transuranic waste, it was possible to wait to cover the drums until the trench was filled to within 1.2 m (4 ft) of the top (Strand 1972).

Research conducted in 1973 to compare the types of trenches used for beta-gamma waste showed great variation in the volume of burial space available per square foot of ground surface area. This variation was due to the type of trench geometry used. This study concluded that an improvement of nearly 3 to 1 could be made by changing the dimensions from the standard 12.2 m (40 ft) width x 4.9 m (16 ft) depth with 2.4 m (8 ft) of earth cover to a 18.3 m (60 ft) width x 7.6 m (25 ft) depth. A pit-type operation with dimensions of 36.6 m (120 ft) width by 12.2 m (40 ft) depth over the standard trench could provide a potential 20 to 1 improvement. Confining burials to certain locations in the pit would bring the space saving advantage of the pit down to 10 to 1, but this was still seen as a significant improvement (Heald 1974). Analysis also indicated that the added depth in the 18.3 m (60 ft) trench and in the pit-type burial provided additional compaction of the waste creating an even more positive burial ratio.

Another method of saving space was with the Prototype V-Trench. It had 90 degree concrete slab sides. Filled with drums and enclosed with a galvanized steel roof and covered with 1.2 m (4 ft) of earth and gravel, this trench was 30 m (100 ft) long and stored 1,400 drums. The disadvantage of this trench design was its tremendous cost (Strand 1972).

Incineration was also used for volume reduction. DUN minimized both the number and extent of burial sites by using a furnace above the trench in the "open pit" incinerator at 100-K Area, and ARHCO used an incinerator in the 200 West Area (Hill et al. 1970).

In 1979, the *Commercial Waste and Spent Fuel Packaging Program Package Acceptance Criteria* listed some guidelines for conserving burial site space (RHO 1979b). The guidelines included the following:

- Optimize the module or facility depth per unit area.
- Maximize the number of containers per unit volume space.
- Provide incentives for waste generators to minimize waste volume and radiation levels.
- Minimize the distance between burial or storage facilities. (Exceptions include constraints imposed by criticality limits and constraints based on location of radionuclide migration fronts.)
- Develop policy for assaying various classes of waste to minimize area needs.

7.1.2 Safety and Environmental Protection

The policy at Hanford has always been that waste materials released to the environment are controlled to assure the long-term safety of the human population and to preserve offsite plant and animal resources in the environment. In response to increasing national demand for pollution abatement, Hanford began the development of a long-range waste management program for increased long-term safety to human population in 1957 (Warren 1969). Precautions were taken so that the disposal of radioactive materials onto or into the ground could not result in their future appearance in potable water supplies beyond the boundary of the Hanford Project in concentrations exceeding the limits specified under Annex Table II, column 2, in AEC Manual Chapter 0524 (Tomlinson 1963).

From 1967 to 1977, ARHCO set specifications and standards to assure that all site generated solid wastes were packaged and disposed in accordance with waste management program objectives and with *Radiation Protection Standards* (ARHCO 1976). Specifications set forth limits required to protect the environs, operating facilities, and personnel. Changes in specification could be made only with the written approval of the Manager of ARHCO, Research and Engineering Department, and acceptance by the Manager of ARHCO, Waste Management Section. Standards set forth operating limits designed for efficient and safe operation of the waste disposal sites. Generators were required to notify ARHCO of expected waste composition changes and/or proposed packaging changes so that facilities for the handling and disposal of such wastes would be available when needed. ARHCO periodically reviewed and modified these specifications and standards to ensure conformance with Hanford waste management goals (ARHCO 1976).

The TRU waste category was created in 1970. A lower limit for TRU radionuclide content was initially not set; in 1973 a lower limit was chosen of 10 nCi/g (3.7×10^5 Bq/g) for individual packages. Waste with TRU content greater than that was stored as TRU waste. In 1982, the limit was raised to the present value of 100 nCi/g (3.7×10^6). Currently a portion of the waste stored between 1970 and 1985 would no longer be classified as TRU waste.

7.2 STORAGE FACILITIES

Before the segregation of TRU waste, storage facilities were primarily used as a temporary holding place for waste prior to disposal or burial. After 1970, retrievable storage requirements for TRU waste mandated interim and long-term storage facilities.

Changes in the management of dangerous or hazardous waste have also affected the make-up of Hanford waste storage facilities. After 1985, nonradioactive hazardous waste was not accepted for burial in the central landfill. This waste was temporarily stored awaiting shipment offsite for treatment and final disposal. Starting in 1987, LLW containing hazardous constituents was segregated and temporarily stored awaiting future treatment before final onsite disposal (Carlson et al. 1994).

Present storage facilities provide both interim and long term storage capabilities. Current storage facilities and projects under the Solid Waste Program include the Transuranic Storage and Assay Facility (224-T) and the Radioactive and Mixed Waste Storage Facilities at the Hanford Central Waste Complex (Carlson et al. 1994).

The following sections provide a general description of the storage facilities that have operated onsite. It should be noted that these storage facilities do not include waste staging areas.

7.2.1 Transuranic Storage and Assay Facility

The 224-T Building (Figure 7-1) is located in the 200 West Area and measures approximately 60.0 m (197 ft) long and 20 m (60 ft) wide. A floor plan of the three gallery levels is shown in Figure 7-2. The modified building is constructed of reinforced concrete walls, floor, and ceiling. Originally, the 224-T Building's function was to purify plutonium nitrate by the lanthanum fluoride process. The plant remained inactive following phase-out of the bismuth phosphate plant until the early 1970's. At the time, the building was modified for storage of plutonium scrap in liquid and solid forms (Pines 1987).

In 1984, the 224-T Building was targeted to house the TRU waste storage and assay operation that was under the jurisdiction of the Burial Grounds Operation (Pines 1987). In 1985, the removal of plutonium scrap from 224-T was completed, and the building was officially designated as the Transuranic Storage and Assay Facility (TRUSAF). During 1985, a thorough readiness review of the operation and the facility was completed and it was authorized for start up (Pines 1987). The TRUSAF operation consists of nondestructive analysis of TRU waste. The analysis is used to verify general compliance with the WIPP-WAC of sealed, certified, CH, TRU solid-waste packages. Those containers meeting the WIPP-WAC are stored at 224-T and maintained to retain their certification pending shipment of the WIPP.

Figure 7-1. 224-T Complex (Pines 1987).

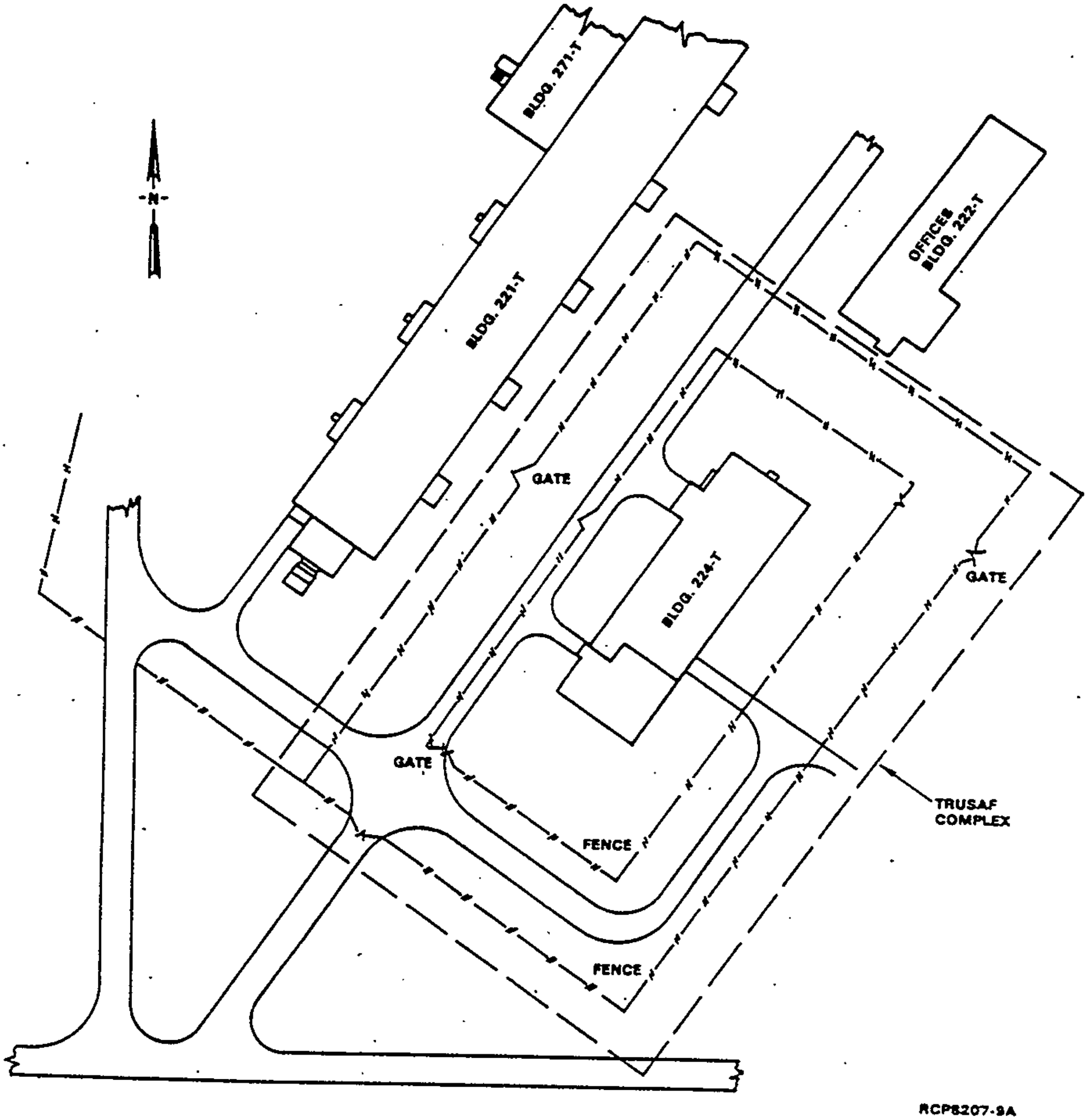
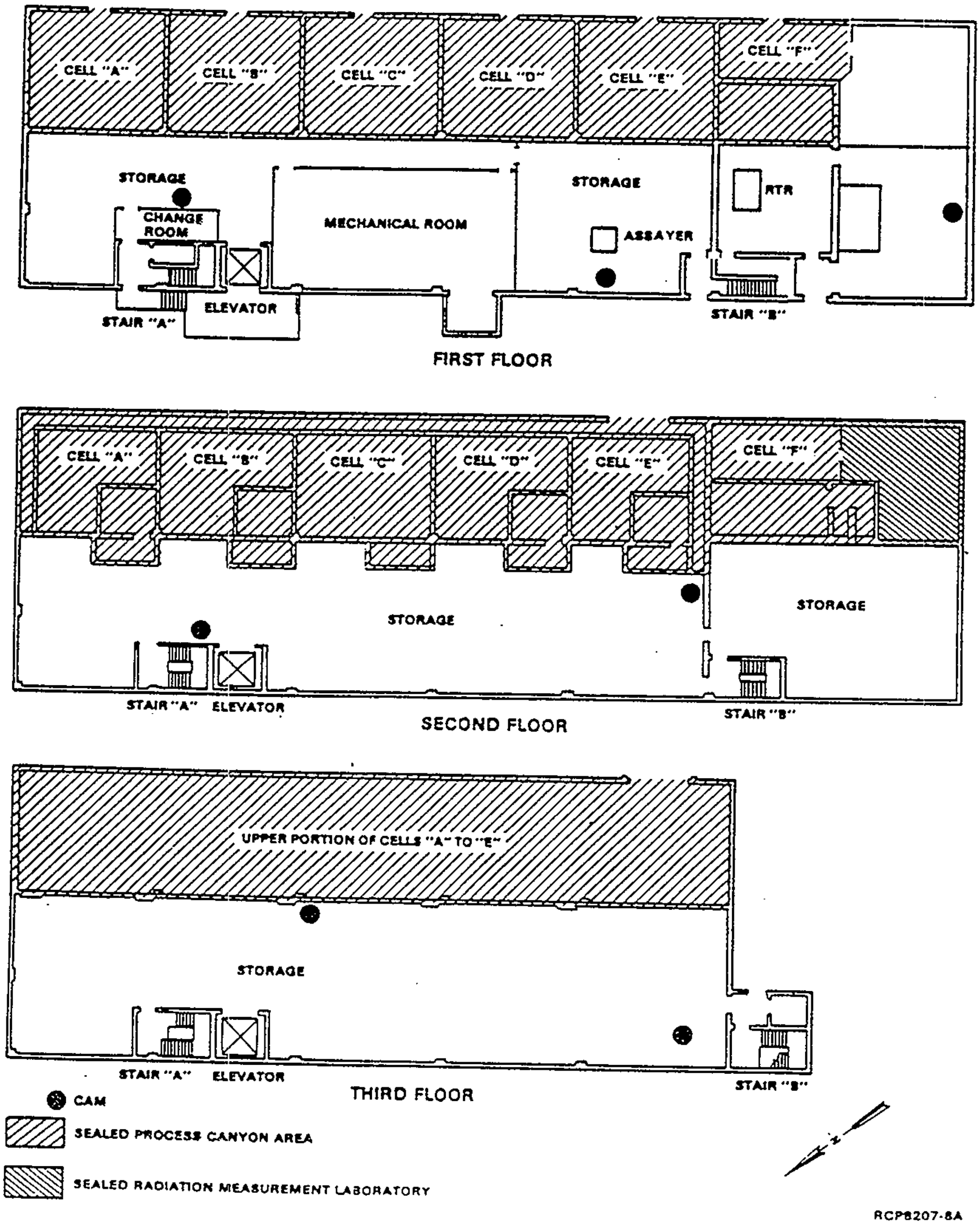


Figure 7-2. Floor Plan of 224-T (Pines 1987).



Incoming drums are assayed to determine TRU activity. Based on the assay and real time radiography results, the drums are segregated based on the following criteria (Pines 1987):

- Plant Certification Waste (waste from a plant that has an approved certification plan).

- Z Plant Room Waste or "Suspect" TRU.

  NOTE: The above areas are initial storage locations for drums to be processed.

- Certified for TRUSAF Storage (drums to be moved to the interim storage areas on the upper floors).

- Noncertifiable WIPP (drums that are not certifiable and are to be sent to the TRU retrievable storage).

- LLW (drums which assay less than 100 nCi/g (3.7×10^6 Bq/g) TRU activity and are to be relabeled and buried as LLW; all existing TRU labels are destroyed to avoid any confusion).

- Hold (drums that have one or more hold points checked on the Traveler form and are being held for further analysis).

- Return to Generator (drums that have been designated to be returned by the TRUSAF manager).

All TRU waste packages that successfully meet the requirements for WIPP certification are placed in interim storage pending shipment to WIPP. Interim storage areas are located on the second and third floors. Drums that require no overview are also planned to be received at the TRUSAF. They will be received as certified waste containers that are sent to TRUSAF for storage only. These containers will be from offsite WIPP WAC certified generators and will be sent directly to the interim storage area.

The certified drums are expected to remain in storage until shipment to WIPP (Pines 1987). Certified TRU waste will be shipped to WIPP through 2018. Any TRU waste at Hanford after 2018 will be disposed in a DOE complex-wide disposal facility, but not necessarily WIPP (Carlson et al. 1994). For a more detailed description of the TRUSAF facility and operations, see *TRUSAF Hazards Identification and Evaluation*, WHC-SD-WM-SAR-025 (Pines 1987).

7.2.2 Central Waste Complex

The Central Waste Complex (CWC) is a multi-structure complex used for the storage of CH radioactive and mixed solid wastes. This includes storage of CH TRU, LLW, and MW that will be processed in Waste Receiving and Packaging Facility (WRAP) 1 and in future treatment facilities. The storage facilities are operated in conformance with the requirements identified in the *Central Waste Complex Final Safety Analysis Report - FSAD Upgrade* (WHC 1992).

The CWC is comprised of 17 storage buildings plus low-flashpoint storage modules, alkali metal storage modules, two receiving pads and support facilities. The CWC provides storage space for over 100,000 55-gal drums or equivalent waste containers. the storage is operated to maintain appropriate separation between incompatible wastes (Olson 1994).

The storage buildings include the Plutonium/Polychlorinated Biphenyl Storage Facility (Building 2401-W), 12 MW storage building (2402-W, 2402-WB, 2402-WC, 2402-WD, 2402-WE, 2402-WF, 2402-WG, 2402-WH, 2402-WI, 2402-WJ, 2402-WK, and 2402-WL), each 3,200 m² (4,000 ft²) in area, and four larger MW storage buildings (2403-WA, 2403-WB, 2403-WC, and 2403-WD). Building 2403-WB is 5140 m² (55,250 ft²) and the other 2403 series buildings are each 34,000 ft² in area. Each building is a steel supported, sheet metal covered structure (Olson 1994).

Adjacent to the buildings are two open air pads: a waste receiving and staging area and a MW storage pad. The Waste Receiving and Staging Area is an asphalt pad ≈61 m long and 46 m wide (200 ft long and 150 ft wide). The pad is used for handling and staging the containers of radioactive contaminated waste destined for the various storage facilities. The pad includes an access for loaded trucks and other vehicles. The MW storage pad is a 15 cm (6 in.) thick curbed 840-m² (9,000 ft²) concrete pad with an access ramp. The pad has a rainwater collection and removal system (Olson 1994).

The low flashpoint MW storage modules are designed to meet the storage requirements for hazardous and radioactive wastes. The storage modules are small pre-engineered structures with a floor space ranging from 12 m² (135 ft²) to 27 m² (297 ft²). Waste storage is limited by the radionuclide content in each container and the total in each module (Olson 1994).

The alkali metal waste storage modules are designed to meet the requirements for low level radioactive alkali metal MW storage. The alkali metal waste storage modules are similar in construction to the pre-engineering low flashpoint mixed waste modules (Olson 1994).

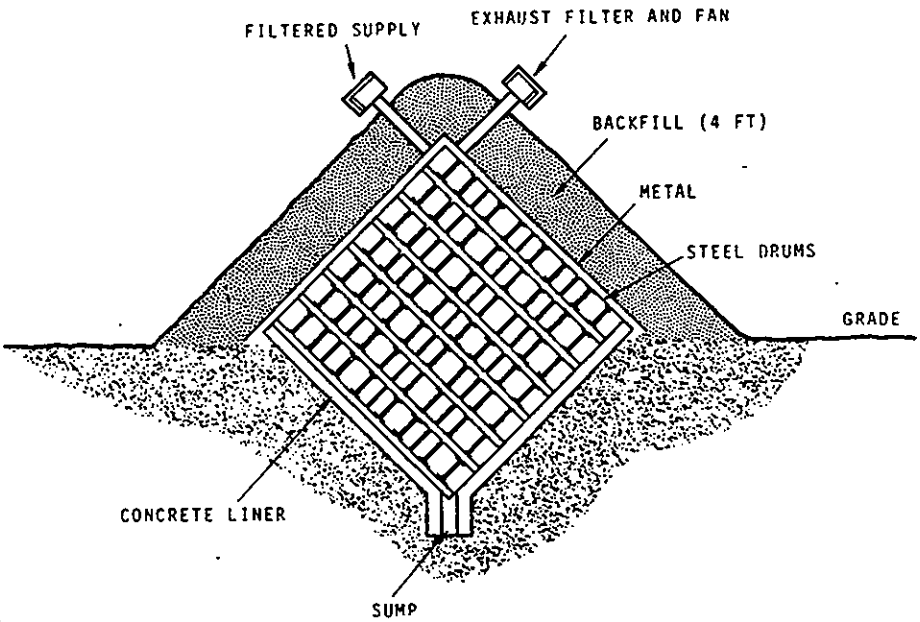
7.2.3 Trench Storage

In 1970 the storage of TRU waste in below ground trenches in the Hanford Site 200 Areas was begun, to implement the new TRU waste management requirements from the AEC. This storage was implemented in several physical configurations, differing with time.

7.2.3.1 Horizontal Stacking. The first storage configuration, used from 1970 to 1972, consisted of several layers of containers stacked horizontally in a gravel bottom "V" trench. The containers were covered directly with at least 1.2 m (4 ft) of soil.

7.2.3.2 Concrete V-Trench. In June 1972, a prototype V-trench became operational for the interim storage of 55-gal drums containing TRU waste (see Figure 7-3). This trench was constructed as a 90 degree V-shaped concrete slab. The cross section is essentially square but oriented with corners at the bottom and top. When filled with drums, it was enclosed with a galvanized steel roof and covered with 1.2 m (4 ft) of earth and gravel.

Figure 7-3. Concrete Lined V-Trench Used for Retrievable Transuranic Waste Storage (ERDA 1975).



In this design, the drums were separated from soil and moisture to reduce corrosion during storage. The structure was designed to contain possible leakage from the drums within the structure (Strand 1972).

The V-trench is 30 m (100 ft) long and has a storage capacity of about 1,400 drums, divided into four compartments. The portable metal cover was provided to cover the compartment being filled to exclude sand, moisture, and debris that would be blown in around the drums. The concrete structure provided a base for the pile of drums to isolate them from the ground. The slope of the decking was designed to drain any moisture away form the trench (Heald 1974).

Based on a distance of 12 m (40 ft) between centers of the V-trench, the burial utilization ratio was high at approximately 1.3 m^2/m^3 (0.40 ft^2/ft^3). All the volume designed into the structure had to be used. In earthen trenches, partial backfilling of the trench and improper stacking of waste could cause the operation land usage to be as much as four times the theoretical land usage (Strand 1972). In this design each drum was placed in a certain position in the trench before being covered. Also, it provided a facility that protected the drums during burial in a manner comparable to building storage without the need for facilities for fire protection.

One significant problem encountered during construction was the high cost of pouring the concrete side wall of the trench on a 45 degree slope. The soil, which is sand and gravel, would not stabilize at a slope much steeper than 30 degrees. Therefore, it was recommended that future trenches be made with a 30 degree slope on the sides and top, even though this would reduce the ground utilization ratio to 0.82 m^2/m^3 (0.25 ft^2/ft^3) (Heald 1974).

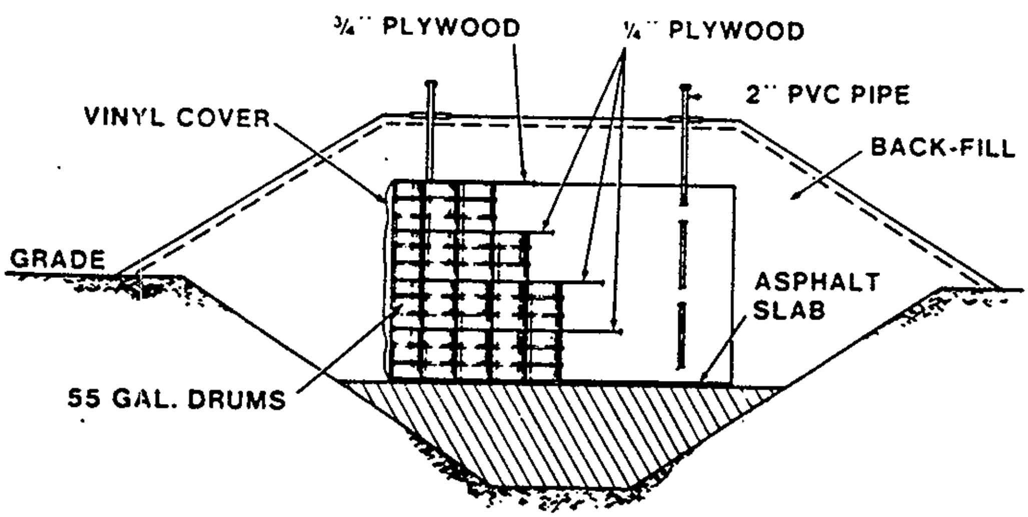
7.2.3.3 Plywood Base. The third configuration consisted of wide bottom and V-trench. In both cases the trench floor was covered with plywood and drums were stacked vertically. Fire-retardant plywood was placed between layers of drums and on top of the drums. Drum stacks were separated into modules, each module a 12 by 12 array 4 to 5 drums high. Each module was completely covered by a plastic tarp, and separated from the next module by several feet of earth. Vent pipes of 5 cm (2 in.) polyvinyl chloride piping were placed in the middle of each module from the trench bottom to 1 to 2 m (3.3 to 6.6 ft) above the soil surface in an attempt to reduce humidity. This storage configuration was used in the 200 West burial grounds 218-W-3A and 218-W-4B from 1974 until 1988.

7.2.3.4 Asphalt Base. This configuration, shown in Figure 7-4, consists of wide-bottom trenches, and is similar to the third with the exception of asphalt base rather than plywood. This was used in 218-W-4B Trench 7 from 1974 until 1980 and in burial ground 218-W-4C from 1978 until 1988.

7.2.4 Caissons

The typical caisson, after 1970, was designed to support retrievability (Albaugh et al. 1985). It consisted of a reinforced concrete tank (corrugated cylinders with concrete slabs on both ends), 3 m (10 ft) tall and 2.4 m (8 ft) in diameter, placed vertically in the ground. The bottom of the caisson is approximately 7.5 m (25 ft) below grade. The 0.9 m (36 in.) diameter helical fill pipe extends from grade level, at a point outside the caisson cover, approximately 4.5 m (15 ft) below grade. The earth cover and the configuration of the fill pipe minimize radiation exposure to personnel. Each caisson also has an air-exhaust system consisting of a 0.3 m (12 in.) vent pipe, HEPA filters, exhausters, an air sampler and a short stack. The exhaust system is normally operated only during discharge of waste to the caisson to prevent backflow of potentially contaminated air to the environs from the caisson via the fill pipe (Roeker 1978). Figure 7-5 shows three different caisson designs.

Figure 7-4. The Transuranic Asphalt Slab (ERDA 1975).



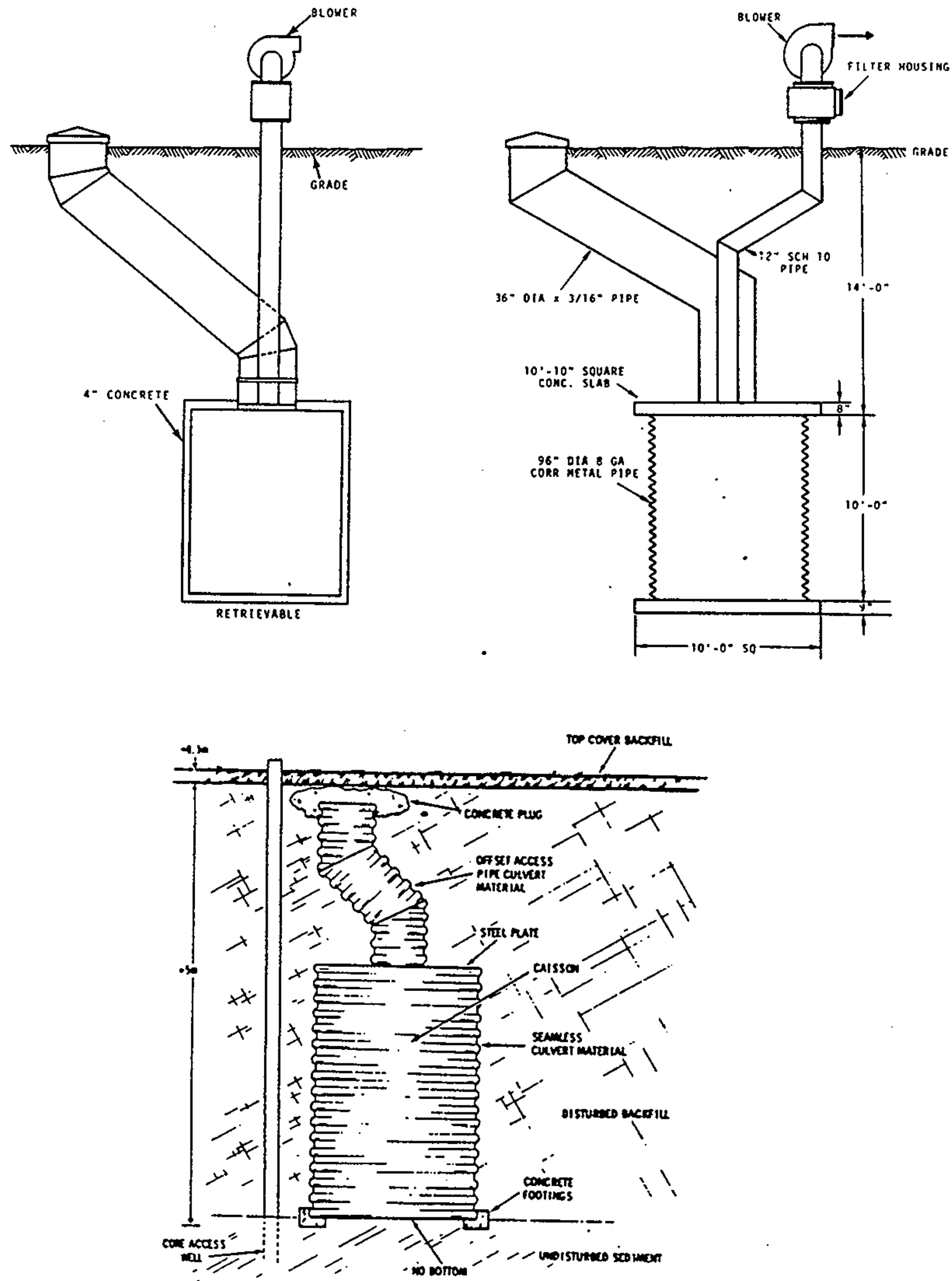


Figure 7-5. Solid Waste Burial Caissons (ERDA 1975 and Gerber 1992b).

7.2.5 PUREX Tunnels

Located south of the 202A Building, the PUREX tunnels are used for interim storage of failed or obsolete process equipment that was too radioactive or bulky for removal to other waste management facilities. Equipment selected for storage in the tunnels was loaded onto old railroad cars, which serve both as a transport and storage platform while the equipment is in storage. A remote-controlled, battery-powered locomotive (Little Toot) was used to position the rail car in the tunnel. Since the equipment is stored on a single, dead end, rail spur in each tunnel, equipment can only be removed in the reverse order of emplacement (i.e., first in, last out) (Pottmeyer et al. 1993c).

Both tunnels are built on a 0.1% grade, sloping downward to prevent movement of the railroad cars toward the tunnel entry. The entry is blocked by water-filled doors that serve as radiation shields. These doors can be drained and raised to allow access to the tunnels. The maximum capacity of burial tunnels 1 and 2 is 8 to 40 railcars, respectively. Only Tunnel 2 is currently in use; Tunnel 1 was filled to capacity in 1964 and was closed at that time. A more detailed description of the equipment stored in the PUREX Tunnels is contained in the *PUREX Storage Tunnels Disposal Alternatives Engineering Study* (Henckel 1991).

Figure 7-6 shows the two PUREX tunnels and their locations relative to the PUREX building.

7.2.5.1 Tunnel 1. The 218-E-14 Tunnel, more commonly referred to as Tunnel 1, extends southward from the east end of the 202-A Building. This tunnel, constructed in 1956, is made of creosote-treated Douglas fir timbers placed side by side and is 150 m (500 ft) long by 5.8 m (19 ft) wide by 6.7 m (22 ft) high. The entire tunnel is covered with mineral roofing, a layer of tar, and 2.4 m (8 ft) of fill dirt. Figure 7-7 shows the plan, section, and elevation views of Tunnel 1. An analysis of the structural integrity of the timbers was performed in 1980. This study concluded that the strength of the beams was within the standards for new wood (RHO 1980).

A 1973 study looked at the potential for an explosion or fire in Tunnel 1. This study concluded that no danger of explosion existing and that the possibility of a fire was remote (DOI 1973). Despite this finding, an effort was made to create an inert atmosphere by isolating the tunnel and filling it with carbon dioxide. Diffusion of the carbon dioxide through the gravel bed rendered this effort unsuccessful. The duct for Burial Tunnel 1 is blanked, and the door to this tunnel has been sealed so that air in the tunnel is stagnant.

Construction of Tunnel 1 was completed in 1956 as part of the PUREX construction project. The first failed equipment item to be placed in the storage tunnel was an ion exchange column, which was approximately 12.5 m (41 ft) long. Due to its length, two rail cars coupled together were required as a transporter. This column, along with a box of miscellaneous pipe jumpers, were placed in Tunnel 1 in June, 1960. The remaining six positions (total capacity eight rail cars) were filled between June, 1960 and January, 1965, at which time the water-fillable entry door sealed closed and door opening hoists were deactivated electrically, as was the tunnel exhaust system (Pottmeyer et al. 1993c).

Figure 7-6. Location of PUREX Tunnels (Pottmeyer et al. 1993c).

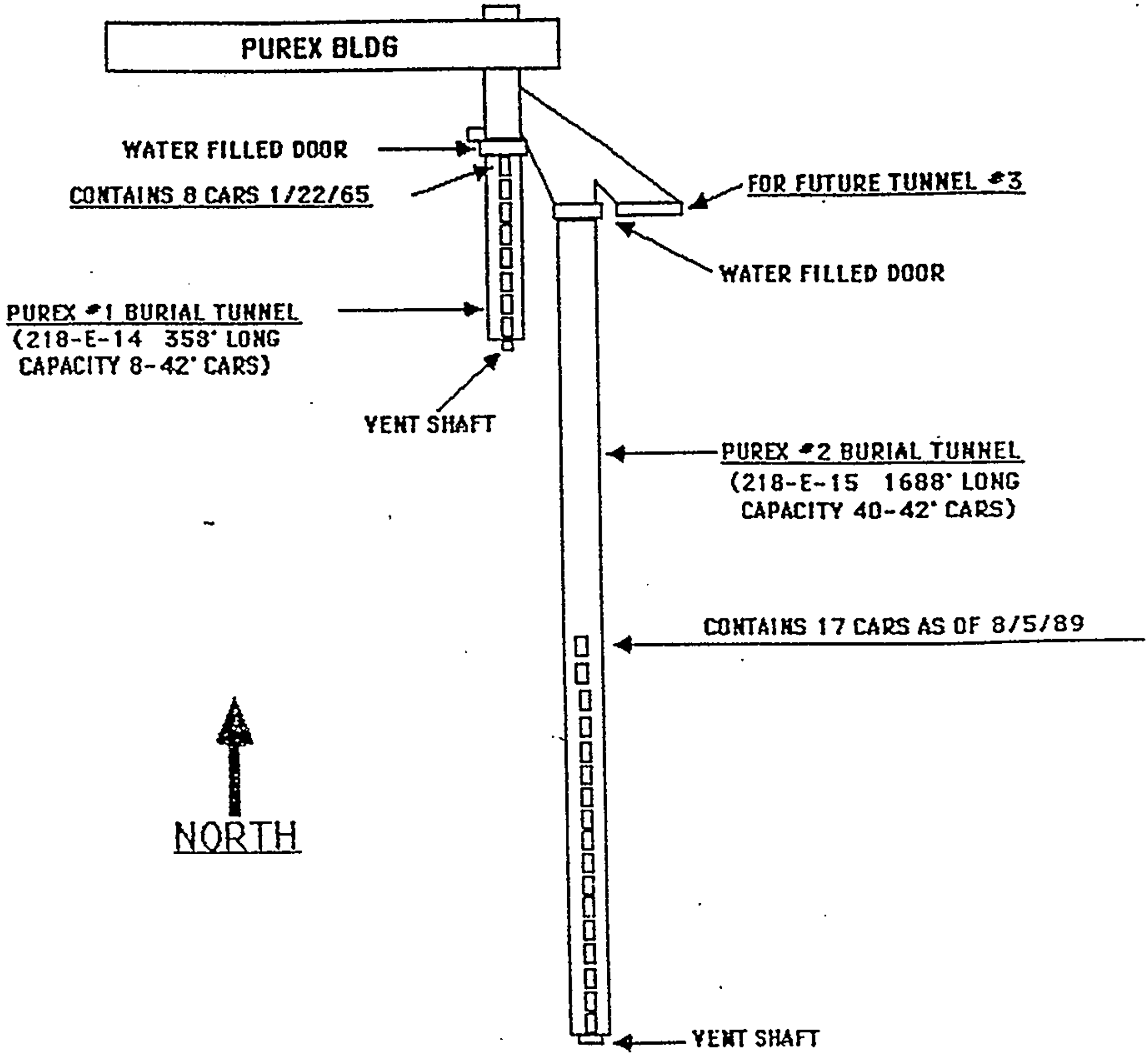
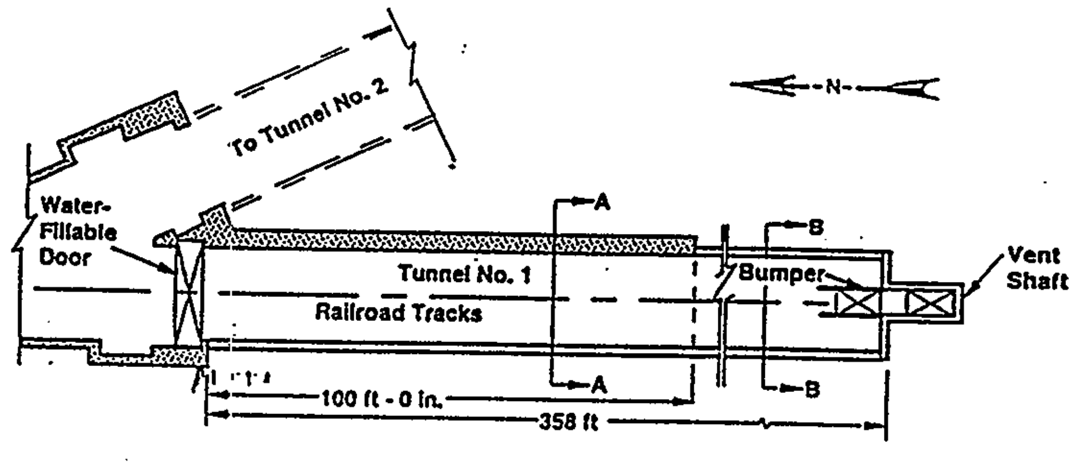
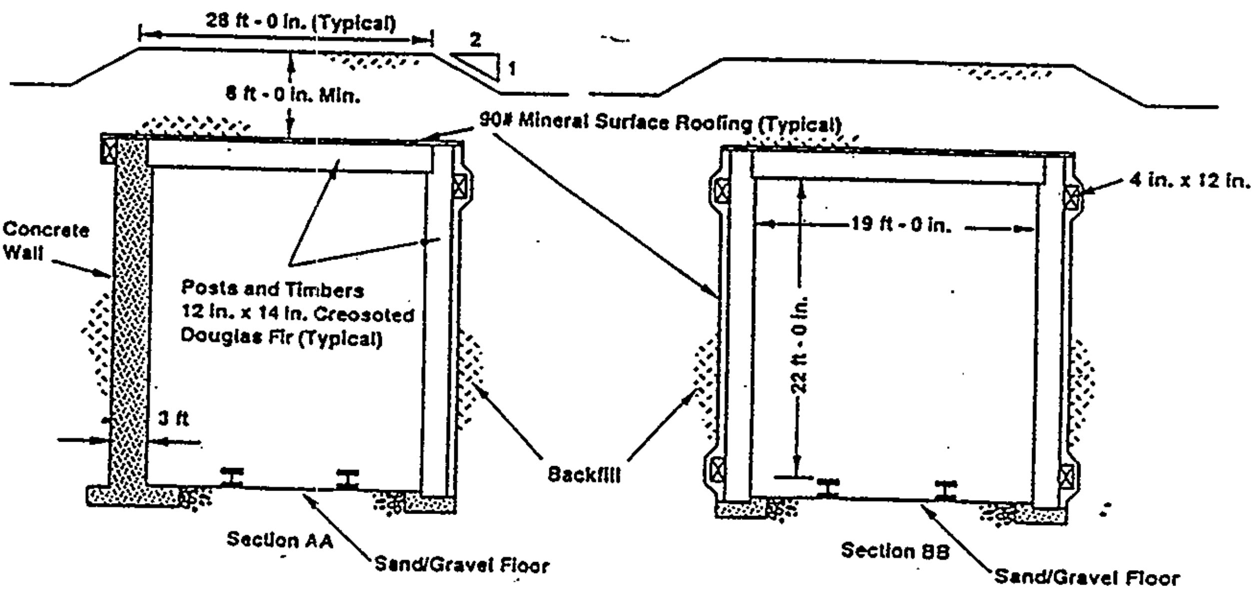


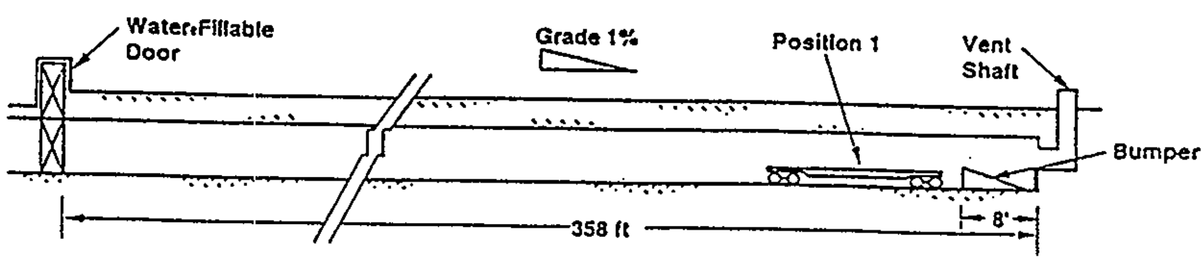
Figure 7-7. PUREX Tunnel 1 Details (218-E-14) (Pottmeyer et al. 1993c).



Tunnel No. 1 - Plan View



PUREX Tunnel No. 1 - Section Views



PUREX Tunnel No. 1 - Elevation View

78910032.2

7.2.5.2 Tunnel 2. Tunnel 218-E-15, more commonly referred to as Tunnel 2, was constructed in 1964. The tunnel is 514.5 m (1,688 ft) long by 10.4 m (34 ft) wide by 6.7 m (22 ft) high. the roof is made of corrugated steel, and cement arches are placed at regular intervals along the tunnel roof to add strength. There is an overburden of 2.4 m (8 ft) of fill dirt covering the tunnel roof (Pottmeyer et al. 1993c). Plan, section, and elevation views of PUREX Tunnel 2 are shown in Figure 7-8.

The capacity of Tunnel 2 is 40 rail cars. The first storage position was filled in December, 1967; the most recent waste emplacement occupied in August, 1989. At the present time a total of 17 rail cars have been placed in the tunnel (Pottmeyer et al. 1993c).

7.2.6 Other Storage Facilities

Since its shutdown in 1958, 221-U has been used to store deactivated equipment from other plants. After final placement of the cell cover blocks, any deactivated equipment received was stored on the canyon deck (Duncan et al. 1994a). The contents of each cell in U Plant are estimated and described in the *Characterization of Decontamination and Decommissioning Wastes Expected form the Major Processing Facilities in the 200 Areas*, WHC-EP-0787 (Duncan et al. 1994a).

In addition to the Radioactive Mixed Waste Storage facilities, the CWC will also include an enhanced radioactive and MW storage, Phase V facility (Project W-112). Phase V storage will provide the appropriate mitigating features to permit safe storage of the following waste streams and WRAP facility process support storage requirements.

- Category 3 low-level mixed-waste storage
- Greater Than Category 3 LLW storage
- Recovered Suspect Transuranic waste storage
- Newly generated TRU and TRU Mixed waste storage
- WRAP Facility process support storage.

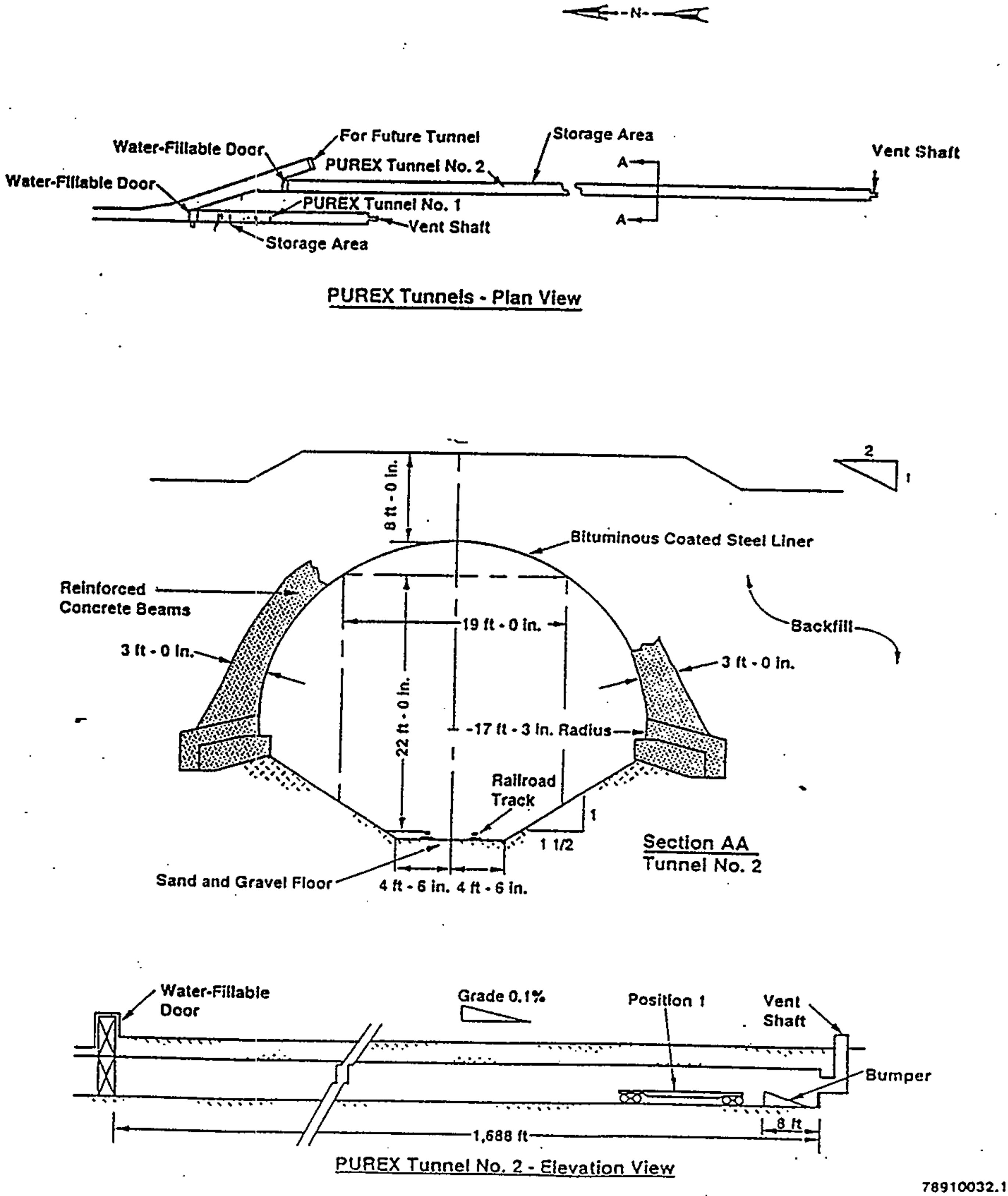
7.3 DISPOSAL FACILITIES

7.3.1 Trenches

Since operations began, burial trenches have been the primary destination for radioactive solid waste at Hanford; after 1970, trenches for TRU waste were designed for interim or retrievable storage.

Cranes, front loaders, and bulldozers were used for digging trenches, unloading shipments of solid waste, and backfilling the trenches. Usually, unloading was performed by a crane or a fork truck. Cranes with capacities of 5.4 to 136 metric tons (6 to 150 English tons) and fork trucks with capacities of 756 to 605 kg (2,000 to 16,000 lb) were typical. Occasionally, waste was unloaded by hand or dumped directly into the trench (Masa 1983a).

Figure 7-8. Burial Tunnel 2 (218-E-15) (Pottmeyer et al. 1993c).



After its placement in the open dirt foundation trenches, solid waste was normally covered with 3 to 6 m (10 to 20 ft) of earth to prevent uptake of radionuclides by plant life or disturbance by burrowing animals. However, when the wastes were contained in concrete boxes or small drums, as most were, the dirt cover was reduced to a minimum of 1.3 m (4.3 ft), provided that radiation levels at grade were less than 1 mrem/hour (Kennedy 1972). A container with hazardous materials which could react with the contents of another container was isolated by a minimum of 1.2 m (4 ft) of dirt (Anderson 1977b). Waste trenches were backfilled whenever the dose rate at the edge of the trench reached 100 mrem/hour (ARHCO 1967), or at the end of the day if containment of radioactive material was in doubt, or when waste susceptible to wind scattering was placed into the trench (McCall 1987).

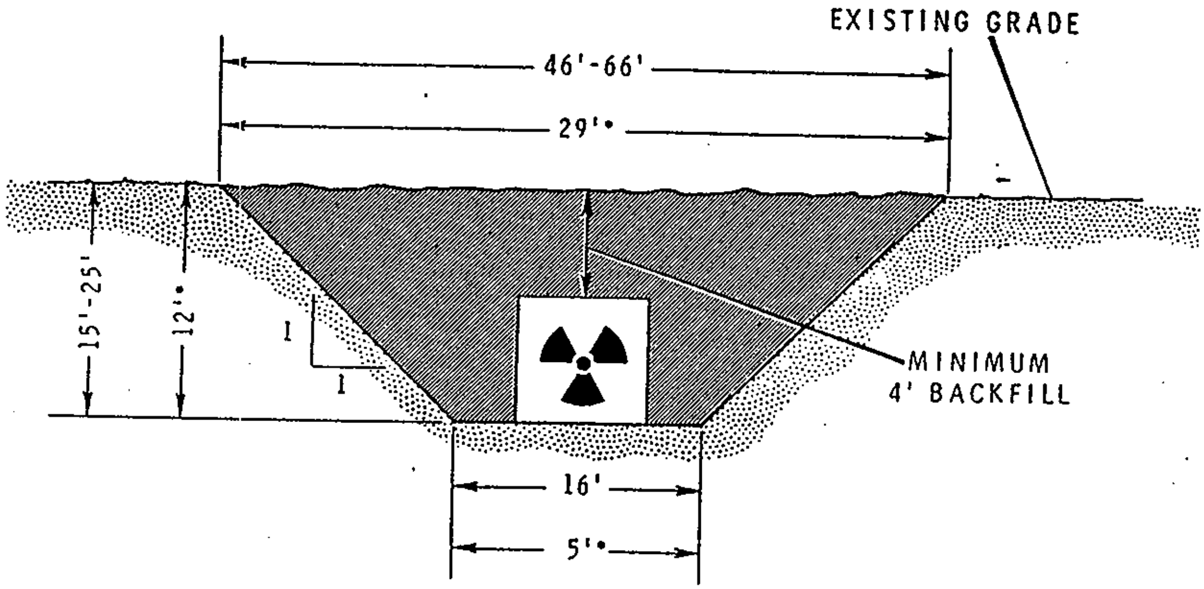
This section describes the types of trenches used for solid waste storage.

7.3.1.1 Burial Trenches. Burial trenches have been used for unsegregated and non-TRU waste since the 1940's. Waste meeting TRU criteria, but disposed prior to 1970, is now termed "buried TRU" waste. Trenches were referred to as "industrial trenches" when used for disposal of physically large contaminated items (usually failed plant equipment) and "dry waste trenches" when used for other, smaller contaminated materials. Typical dimensions of an industrial waste trench were a width of 4.9 m (16 ft) at the base, 14 to 20 m (46 to 66 ft) at grade level, and a depth of 4.6 to 7.6 m (15 to 25 ft). Dimensions of a dry waste trench were a width of 1.5 m (5 ft) at the base, 8.8 m (29 ft) at grade level, and a height of 3.7 m (12 ft) (RHO 1985). A cross section of a typical non-TRU burial trench is illustrated in Figure 7-9.

The most common method of depositing wastes in dry waste trenches was simply to dump boxes of solid waste into the burial trenches (Barnes 1964). Once the boxes were dumped into the trench, bulldozers backfilled the trench with soil. The weight of soil covering the boxes crushed them, compacting the waste (Beard and Godfrey 1964). Little consideration was given to retrieval, since once buried this waste was considered permanently disposed (Tomlinson 1969).

The large size, great weight, and high radioactivity presented difficult problems in the disposal of industrial wastes into waste trenches. The wastes were buried with operating personnel being required to maintain a distance of 30 m (100 ft) or more from the burial boxes to reduce their exposure to permissible limits. The filled burial boxes were transported to the burial site by railroad car and dragged into the earthen trench by bulldozers with long cables. Individual boxes were positioned in the burial trench so that a minimum of 0.9 m (3 ft) of edge to edge spacing was assured for all boxes containing greater than 250 g (0.6 lb) total plutonium, ^{233}U, and ^{233}Pa, singly or in combination (ARHCO 1967). Additionally, the distance between burial boxes was limited by the backfilling of previously disposed boxes to provide radiation shielding and also the provision of a ramp for the dozers to exit the trench. During trench backfilling the bulldozer operator maintained an earth shield between himself and the box (Beard and Godfrey 1967).

Figure 7-9. Solid Waste "Industrial and Dry Waste" Trench (Tomlinson 1969).



* Dimensions for typical "Dry Waste" Trench (larger dimesions are for contaminated "Industrial" Solid Waste Trench).

The trenches were linearly oriented excavations used for a variety of wastes including, but not limited to, LLW in sealed fiberboard boxed, 55-gal drums, specially fabricated wood, metal, and reinforced-concrete containers, and both packaged and direct-buried failed equipment. Land use per unit volume of wastes was usually relatively high in these trenches for three reasons: (1) trench sides were sloped at approximately 45 degrees, the natural angle of repose of the Hanford Site, (2) most wastes were not compacted before burial, but were compressed in place by the weight of the earth cover and the earth-moving equipment, and (3) the practice of covering waste before nightfall (to control airborne contamination and suppress fires) resulted in wasting a considerable volume of otherwise available space in the trench (Christenson et al. 1984).

One source indicated that bulldozers weighing approximately 25 metric tons (27 English tons) were driven over the TRU waste trenches during backfilling (Hammond 1977). It is not known if this practice was widely used as all other sources only noted the use of bulldozers "within" the trenches during backfilling.

The waste was packaged inside the trench in one of two ways:

1. Encased in containers (usually 55-gal drums) and stacked in modules. A module was a group of drums with the width of the trench (usually 12 drums) and, usually, a length of 12 drums. Each layer of drums within a module was separated by a sheet of flame-retardant, 0.63 cm (0.25 in.) plywood. A completed module was covered with 28 g (1 oz) polyvinyl chloride (PVC) laminated nylon sheet, sheets of 1.9 cm (0.75 in.) flame-

retardant plywood, and an overburden of soil and gravel. When TRU waste was placed on an asphalt pad, two 5 cm (2 in.) diameter pipes extend from 0.9 m (3 ft) above the soil to the lower portion of each module to permit sampling of air inside. Container stacking was done so that no stack exceeded 5 drums or a height of 6.1 m (20 ft). A single asphalt pad might consist of many modules or might consist of a single module. Drums of a single category (TRU combustible, TRU noncombustible) could be placed in an infinite array. When it was necessary to place several modules on the asphalt pad because of different categories or criticality concerns, the modules had to be separated by a minimum of 0.9 m (3 ft) of earth (Christenson et al. 1984).

2. Encased in wood, steel containers, concrete, or fiberglass-reinforced plywood boxes and covered with a soil and gravel overburden (Christenson et al. 1984).

7.3.2 Caissons

Underground caissons were used primarily for the storage of small packages of RH TRU waste. They began as welded 55-gal drums and have progressed to reinforced concrete caissons. Between 1954 and 1964, the caissons, sometime referred to as vaults, were known as "pipe fields." They were made of five to six open-bottomed 55-gal drums welded together and buried upright and were designed without retrievability criteria (Albaugh et al. 1985). Solid waste disposed in the early caissons was generated primarily in the 300 Area laboratories. The waste was collected in cardboard containers and stored in lead pans known as "gunk catchers." These packages were transported in shielded "load luggers" to the 300 North Burial Grounds where containers were dropped from the "load luggers" into the caissons (Hill et al. 1970). Since waste packages were allowed to fall freely into the caissons, damage and/or rupture of the packages in the caisson often resulted (Christenson et al. 1984).

Cardboard waste containers and gunk catchers were replaced by the milk pail disposal system. Radioactive wastes were collected in the operations buildings in 19- to 23-L (5- to 6-gal) aluminum milk pails. The milk pails were placed in lead shielded casks and transported to the 300 North Burial Grounds, and after 1962 to the Wye Burial Ground. The cask was positioned over the caisson, the cover removed, and the cask bottom opened to discharge the wastes into the caisson by gravity (Masa 1983b). A portable concrete collar and plug were provided as a temporary top closure until the caisson was full of waste. When full, a concrete cap was poured and the drums were permanently isolated (Beard and Godfrey 1967).

The 300 North and Wye Burial Grounds also received 0.9-L (1-qt) "grape juice cans" that held used highly radioactive charcoal filters from the operating buildings. Grape juice cans were transported in cylindrical, shielded casks known as "Gatling Gun Casks" (Gerber 1992b).

Around 1966 and 1967, the milk pail system was replaced by the paint can system. Radioactive wastes from operations buildings were collected in 4-L (1.1-gal) paint cans with metal lids fastened on by two set of clips. Eight paint cans were loaded into a lead shielded cylindrical cask. Since the cask was more securely sealed and heavily shielded, solid wastes traveled to the Wye Burial Grounds, and after 1970, to the 200 Area Burial Grounds. The casks were not disposed, but reused many times. On occasion, a cask was accidently lost into the caisson. The paint can system continued in use for many years and is still used today to some extent. Recently 50 lb lard cans have been used to contain the waste. These 10-gal cans are used for high-activity waste from the 300 Areas (Gerber 1992b).

During the 1970's, reinforced-concrete alpha caissons and high activity non-TRU caissons were used. The reinforces-concrete alpha caissons, buried below grade, received transuranic hot cell waste from the PNL facilities for interim storage. Transuranic waste caisson storage started in the early 1970's and continued until mid 1988 when this practice was terminated. These facilities have always been considered to be retrievable storage (Dukelow 1989).

The active LLW (i.e., non-TRU) caissons, sometimes referred to as silos, received high activity LLW from PNL hot cell activities. These caissons were also started in the 1970's, and were designed to receive low-level waste which consisted of fission products and mixed activation products. They were constructed of vertical 8-ft diameter corrugated cylinders with concrete slabs on both ends. These facilities were designed for the final disposal of the waste with the capability for grouting the waste contained in the caisson (Dukelow 1989).

7.3.3 Other Disposal Facilities

Other types of specialized disposal facilities have been used for specific purposes. These specialized facilities include the following:

- Crib pits, 2.7 m^2 (approximately 30 ft^2), constructed of railroad ties, and used for small reactor hardware
- Vertical steel pipes and culverts, of various diameters, used for small parts
- Pipe storage units, made by welding together five 55-gal drums (also referred to as 15-ft-depth dry wells)
- Buried vaults, constructed of vertical cylindrical concrete culvert section, used for laboratory wastes.

7.4 BURIAL GROUND LOCATIONS AND CONTENTS

Currently, there are 75 burial grounds located throughout the site. There are 28 burial grounds in the 100 Areas, and 34 in the 200 Areas. The remaining 13 are in the 300 and 600 Areas (Carlson et al. 1994). These burial grounds have received radioactive solid wastes from all the various missions at the Hanford Site over its fifty year history.

The burial grounds also have received radioactive solid waste from offsite generators (Carlson et al. 1994). Appendix C also contains a list of burial facilities and corresponding drawing numbers.

From 1944 to 1952, solid wastes were buried near the operating areas as depicted in Figure 7-10 (Kiser and Witt 1992; Miller and Wahlen 1987). Figure 7-11 indicates the flow from 1953 to 1964 when reactors began to shut down and the PUREX tunnels were used for storage (Kiser and Witt 1992; Masa 1992; Miller and Wahlen 1987; Parks 1966). The flow of radioactive solid waste from generators from 1965 to 1968 is shown in Figure 7-12 (Hill et al. 1970). After 1968, wastes generated by the 300 Area operations were sent to the 200 Area burial grounds. Wastes from the reactor operations in the 100 Area have been sent to the 200 Area for burial since 1973. The 200 Area burial grounds were managed by ARHCO from 1967 to 1977, Rockwell Hanford Company from 1977 to 1987, and have been managed by WHC since 1987.

As part of the dangerous waste regulations, the Hanford Reservation was required to submit permits for operation of those burial grounds that would remain active. The burial grounds for which permits were submitted are: 218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, and 218-W-6 (future site). All other burial grounds at the Hanford Site are considered inactive and will be remediated under CERCLA as part of the Environmental Restoration Program mission (Carlson et al. 1994).

7.4.1 100 Areas

Direct land burial was used in the Hanford 100 Area to dispose of low-level, solid radioactive waste associated with reactor operations from 1944 through 1973. A total of 28 locations within the 100 Areas have been identified as inactive radioactive solid waste burial grounds. The majority of waste generated from plutonium production reactor operations was placed in seven primary burial grounds. The seven primary burial ground sites are identified as follows:

- 118-B-1 (105-B Reactor)
- 118-C-1 (105-C Reactor)
- 118-D-2 (105-D Reactor)
- 118-D-3 (105-DR Reactor)
- 118-F-1 (105-F Reactor)
- 118-H-1 (105-H Reactor)
- 118-K-1 (105-KE and KW Reactors)

The remaining burial grounds were associated with special programs such as retention basin repair and effluent line modifications, thimble removal, and special irradiations. For the most part, the contaminated waste in these "special" burial grounds contained very low levels of radioactivity (Miller and Wahlen 1987).

The 100 Area burial grounds are near the Columbia River and are relatively close to the water table; soils beneath some of these burial trenches have little ion adsorption capacity. Radioactive materials placed in the 100 Areas trenches were normally well fixed, of short half life, or of little biological significance. Once materials were disposed in the burial grounds, radiological effects on the environs are believed to be minimal. Because of this, the materials buried in the 100 Area present no severe radiation or contamination hazards, and they could be dug up with little problem. Burials generally involved the disposal of equipment type waste (Backman et al. 1963). Table 7-1 summarizes information about the burial grounds in the 100 Area and Figure 7-13 contains a timeline of active operation for all of the 100 Area burial grounds. Diagrams of the four quadrants of the 100 Area Burial Grounds are shown in Figures 7-14 through 7-18.

7.4.2 200 Area

The 200 Area is well above the water table, with soil columns that have good ion exchange capabilities. Precipitation does not leach through the soil to the ground water but is taken up by plants and returned to the atmosphere or is transported to the surface via capillary action and evaporated to the atmosphere. Therefore, a mechanism for transporting radioactive materials from the burial ground to the ground water does not exist, and materials properly disposed to these burial grounds do not present significant radiological problems regardless of half-life, physical or chemical nature, or biological significance. Reasonably large quantities of long-lived materials were deposited in these burial grounds. The first burial grounds in the 200 Area, which contained chemical processing plants, opened in 1944 (Backman et al. 1963).

In 1966, the release of unused Hanford reservation grounds was considered. At that time, 404,000 m^2 (100 acres) within the 200 Area boundaries had been contaminated from solid waste burials. Such areas grossly contaminated by radioactive nuclides of relatively long half-life and biological significance will probably never be decontaminated for economic reasons, thus there are were considered nonreleasable. Excavation of 200 Area burial sites were judged to present hazard from the standpoint of contamination spread alone (Parks 1966).

By 1967, there were 15 burial gardens in the 200 Areas; by 1985, there were 31. They fall into three categories: dry waste, industrial waste, and construction waste. Dry waste included low level cardboard cartons, miscellaneous wastes from contaminated dirt, paper, gloveboxes containing multigram quantities of plutonium, and offsite wastes. Industrial waste includes large wooden or concrete boxes, large pieces of failed or obsolete equipment from the chemical separations plants, and gross quantities of fission products. Construction waste is found only in two of the 200 East Area burial gardens. Both contain low activity wastes from construction work on existing facilities. In addition, small waste vaults near the 222-T, 222-B, and 222-S Analytical laboratories were used for small quantities of high level solid wastes with mixed fission products and traces of plutonium (Sloat 1967). Most of the wastes buried in the 200 Area were dry wastes, including soiled clothing, laboratory supplies, and tools. Relatively small trenches were used for dry wastes, larger trenches were used for the burial of industrial wastes (Tomlinson 1969).

Before 1965, all waste buried in the 200 Areas was generated by fuel reprocessing operations. After 1965, a good share of 300 Area waste was shipped to the 200 Area for burial. After 2973, waste from reactor operations in the 100 area was also brought in and buried. All plutonium wastes initiated at the Hanford Site were buried in the 200 Areas. Additionally, offsite wastes were stored in the 200 West burial grounds (Hill et al. 1970).

Figure 7-10. Waste Flow 1944 - 1952 (Kiser and Witt 1992; Miller and Wahlen 1987).

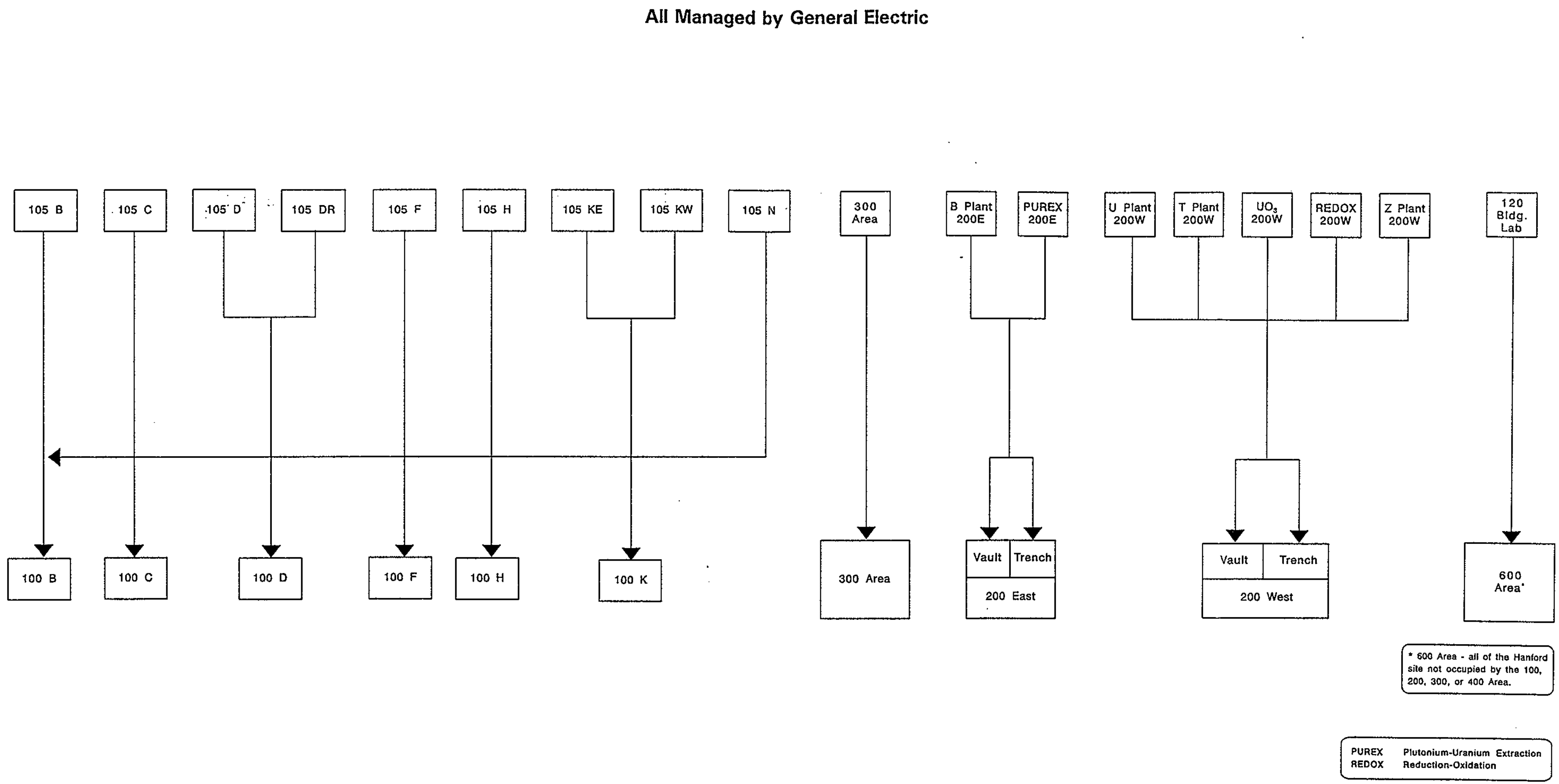
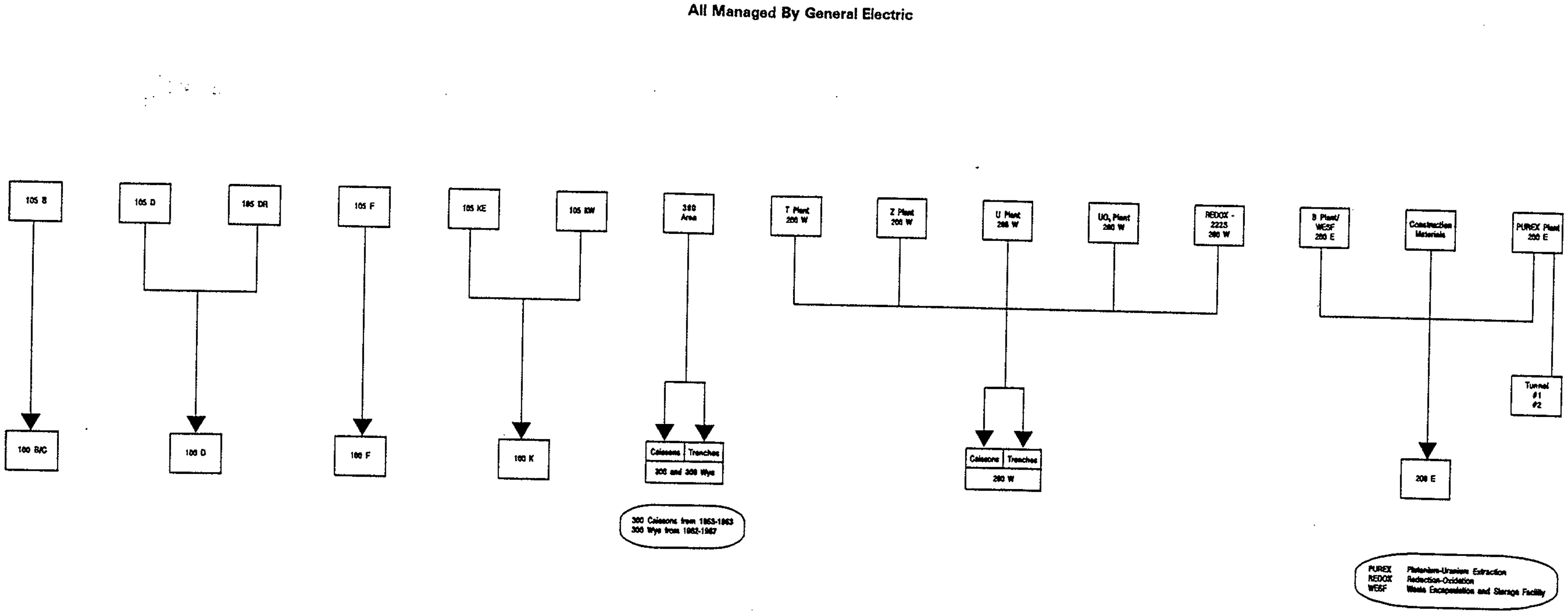
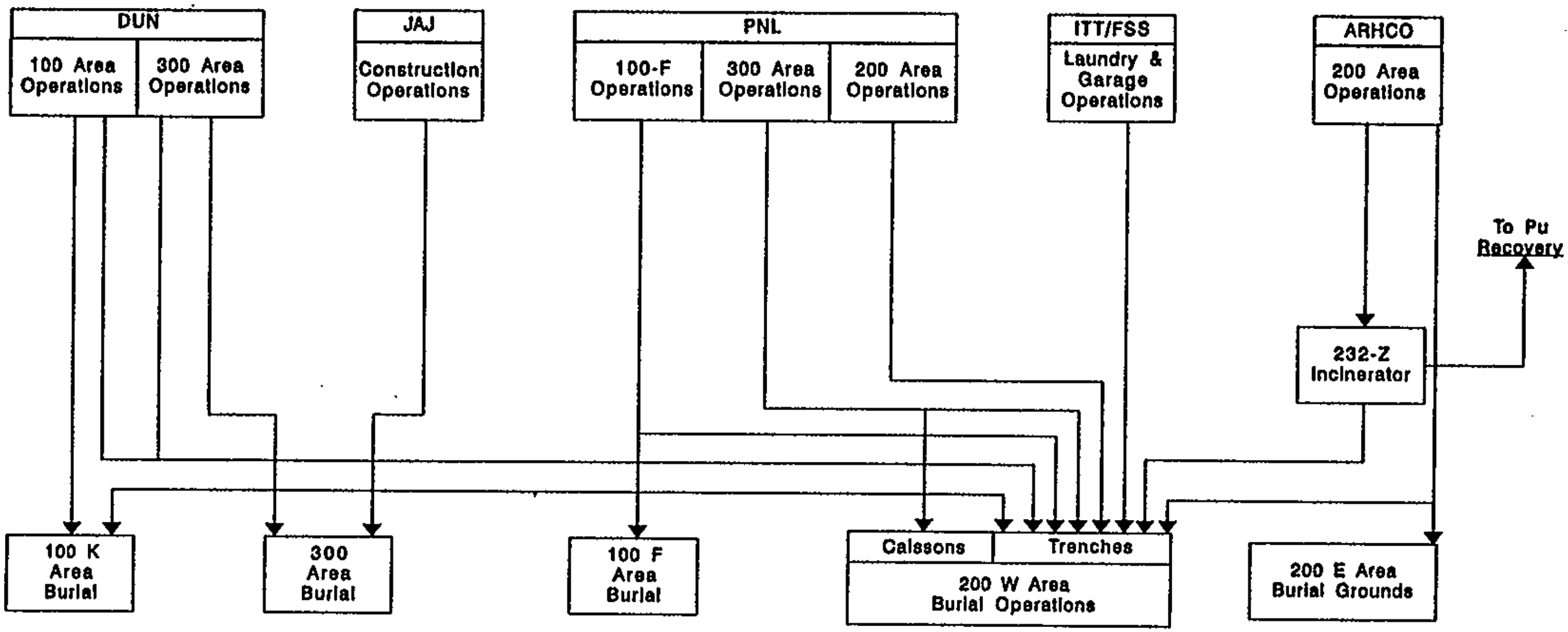


Figure 7-11. Waste Flow 1953 - 1992). (Parks 1966; Masa 1992; Miller and Wahlen 1987; Kiser and Witt 1992).





ITT/FSS Transports Wastes Between Areas.

DUN	Douglas United Nuclear
JAJ	J. A. Jones
PNL	Pacific Northwest Laboratory
ITT/FSS	ITT/Federal Support Services
ARHCO	Atlantic Richfield Hanford Company

Figure 7-12. Waste Flow 1965 - 1968 (Hill et al. 1970).

Table 7-1. 100 Area Burial Grounds. (3 sheets)

Facility number	Previous facility designators	Years of operation	Description
118-B-1	105-B Burial Ground	1944 - 1974	Located 335 m (1,100 ft) west of 182-C, the reservoir, and the pump house. Contains miscellaneous radioactive solid waste from the 100 N Area (ERDA 1975) and was the primary burial ground for 105-B Reactor. It also received waste from the tritium separation program glass line (Miller and Wahlen 1987).
118-B-2	Construction Burial Ground No. 1	1954 - 1956	Located 107 m (350 ft) directly east of the 105-B Building. Used as a construction burial grounds and contains dry waste from 107-B basin repairs and for waste from 115-B alterations (ERDA 1975).
118-B-3	Construction Burial Ground No. 2	1956 - 1960	Located east of 118-B-2 (ERDA 1975). Used as a construction burial ground and contains waste from effluent line modifications. The bulk of the waste was 1.4 m (54 in.) cold-rolled steel pipe with low-level contamination (Miller and Wahlen 1987).
118-B-4	105-B Space Burial Ground	1956 - 1968	Located approximately 61 m (200 ft) east of 103-B. Contains six storage tanks installed below ground for fuel spacer disposal (ERDA 1975).
118-B-5	Ball 3X Burial Ground	1953	Located 46 m (150 ft) east of 115-B. Referred to as Ball 3X Burial Ground and contains irradiated material such as thimbles and step plugs removed from the reactor during the ball 3X work.
118-B-6	108-B Solid Waste Burial Ground	1950 - 1953	Located 107 m (350 ft) NW of 105-B Reactor. Contains two concrete piped 5.5 m (8 ft) long and 1.8 m (6 ft) in diameter placed vertically in the ground for the disposal of dry tritium waste (ERDA 1975).
118-B-7	111-B Solid Waste Burial Ground	1951-1968	Contains equipment decontamination and shop waste from the 111-B Building. A small amount of waste came from the building when the building was a reactor fuel inspection station.
118-C-1	105-C Burial Ground	1953 - 1969	Contains miscellaneous radioactive solid waste from 105-C Reactor (ERDA 1975).
118-C-2	105-C Ball Storage Tank	1952-1953* Retired	A storage tank measuring 1.8 m (6 ft) in diameter and 1.5 m (5 ft) deep that contains radioactive boron steel balls (3X balls) from 105-C Reactor.
118-D-1	100-D Burial Ground No. 1	1944 - 1967	Contains irradiated dummies, thimbles, rods, gun barrels, and other contaminated solid waste from 105-D Reactor (ERDA 1975).

Table 7-1. 100 Area Burial Grounds. (3 sheets)

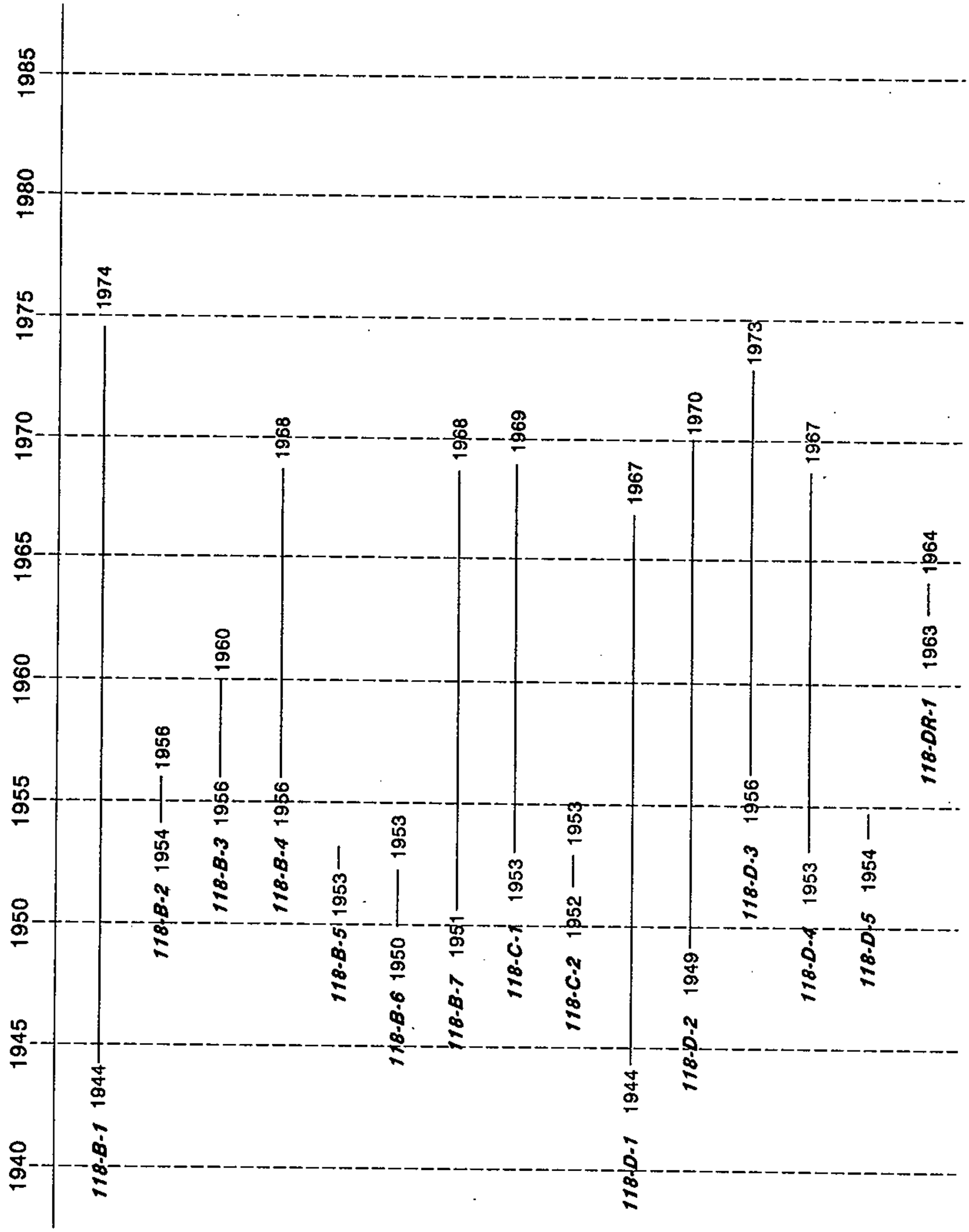
Facility number	Previous facility designators	Years of operation	Description
118-D-2	100-D Burial Ground No. 2	1949 - 1970	Contains miscellaneous solid waste and was primary burial ground for 105-D Reactor waste. Starting in 1966, 100 N Area solid waste was also disposed (ERDA 1975).
118-D-3	100-D Burial Ground No. 3	1956 - 1973	Contains miscellaneous contaminated solid wastes and irradiated dummies, splines, rods, thimbles, and gun barrels, as well as 100 N Area solid waste (ERDA 1975). Primary burial ground for 105-DR Reactor operation waste (Miller and Wahlen 1987).
118-D-4	Construction Burial Ground	1953 - 1967	Located 61 m (200 ft) east of 115-D. Used as a construction burial ground and contains contaminated material removed from the 105-D reactor building (ERDA 1975).
118-D-5	Ball 3X Burial Ground	1954	Located 30 m (100 ft) south of 105-DR. Contains thimbles removed from 105-DR Reactor during the ball 3X work (ERDA 1975).
118-DR-1	105-DR Loop Burial Ground	1963 - 1964	Located 180 m (600 ft) south of 105-DR. Referred to as Gas Loop Burial Ground and contains an irradiated metal assembly from the 105-DR Reactor gas loop (ERDA 1975). All high-level radioactive material was removed prior to closing the burial grounds (Miller and Wahlen 1987).
118-F-1	Burial Ground No. 1	1954 - 1965	Includes a solid waste burial ground and a minor construction burial ground and contains miscellaneous radioactive solid waste from 105-F Reactor (ERDA 1975).
118-F-2	Burial Ground No. 2	1945 - 1965	Received waste generated during project modifications and major maintenance to effluent system, rupture monitor detection equipment, and downcome repair. Does not contain significant quantities of radionuclides (Miller and Wahlen 1987).
118-F-3	Burial Ground No. 3	1952	Received irradiated waste such as thimbles and step-plugs removed from the 105-F pile during the ball 3X work (ERDA 1975).
118-F-4	115-F Pit	1949	Located 61 m (200 ft) south of the 115-F Building. A 3 m by 3 m (10 ft x 10 ft) pit that contains silica gel from a dryer room (ERDA 1975).
118-F-5	PNL Sawdust Repository	1954 - 1975	Contains low level activity sawdust from animal pens used for biological studies by Battelle PNL (Miller and Wahlen 1987).

Table 7-1. 100 Area Burial Grounds. (3 sheets)

Facility number	Previous facility designators	Years of operation	Description
118-F-6	PNL Solid Waste Burial Ground	1965 - 1973	Located about 0.8 km (0.5 mi) southwest of the 108-F Building this pit adjoins the south end of burial ground 118-F-1. This site received animal and laboratory wastes (ERDA 1975). The site also contains a buried steel tank with a vent (commonly referred to as the "submarine") which was formerly used to incinerate slightly contaminated animal carcasses.
118-F-7	Miscellaneous Hardware Storage Vault	1945 - 1965	This storage vault consists of a concrete box 4.9 m (16 ft) long by 2.4 m (8 ft) wide, 2.4 m (8 ft) deep with a wooden cover and contains miscellaneous used reactor parts that were slightly contaminated.
118-H-1	100-H Burial Ground No. 1	1949 - 1965	Contains dummy elements, process tubing, and miscellaneous solid waste from 105-H Reactor (ERDA 1975).
118-H-2	100-H Burial Ground No. 2	1955 - 1965	Received stainless steel tube removed from the reactor in 1955 and a small amount of contaminated pipe during the deactivation of H Plant (ERDA 1975).
118-H-3	Construction Burial Ground	1953 - 1957	A construction burial ground located approximately 240 m (800 ft) south of 105-H buildings southeast corner. Contains sections of contaminated 40 cm (16 in.) pipe used as chutes for removal of thimbles from 105-H (ERDA 1975).
118-H-4	Ball 3X Burial Ground	1953	Located 30 m (100 ft) directly west of 105-H. Contains irradiated material such as vertical safety rod thimbles and guides from 105-H (ERDA 1975). This was generated during the conversion from liquid to ball 3X safety system (Miller and Wahlen 1987).
118-H-5	105-H Thimble Pit	1953 - 1961	Located 30 m (100 ft) directly north of the 1608-H crib. Referred to as a Thimble Pit and contains a thimble assembly from the "B" experimental hole.
118-K-1	100-K Burial Ground (118-K)	1955 - 1975	Contains wastes from the K and N Reactor Operations, which included discharged zircalloy and/or aluminum process tubes, reactor fuel element spacers, equipment, small tools, and control rods (ERDA 1975).

*The actual service dates for 118-C-2 are unknown; however, since the 3X Ball work occurred during 1952 and 1953, these dates were assumed as operating years.

Figure 7-13. Timeline of the 100 Area Burial Grounds. (2 sheets)



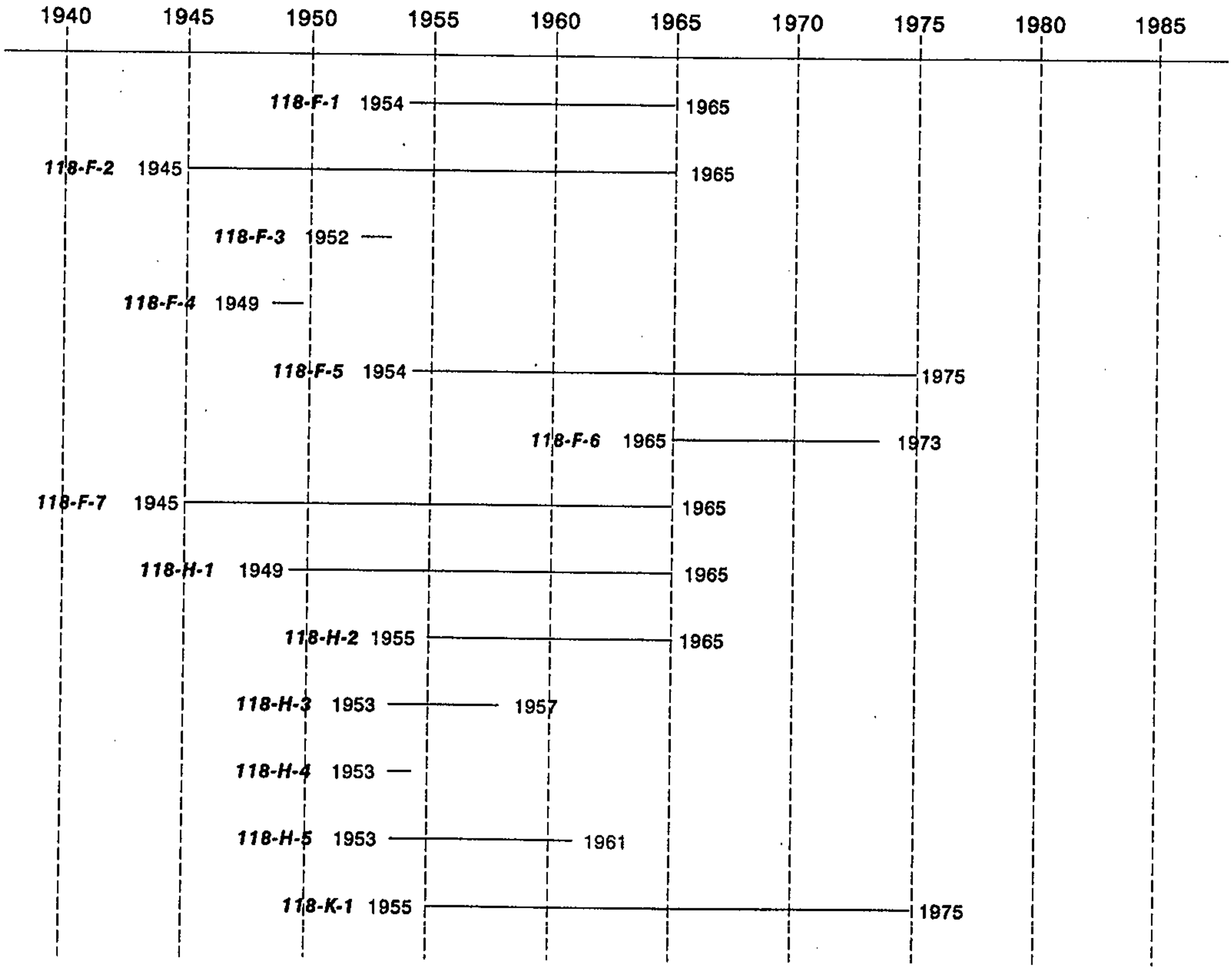


Figure 7-13. Timeline of the 100 Area Burial Grounds. (2 sheets)

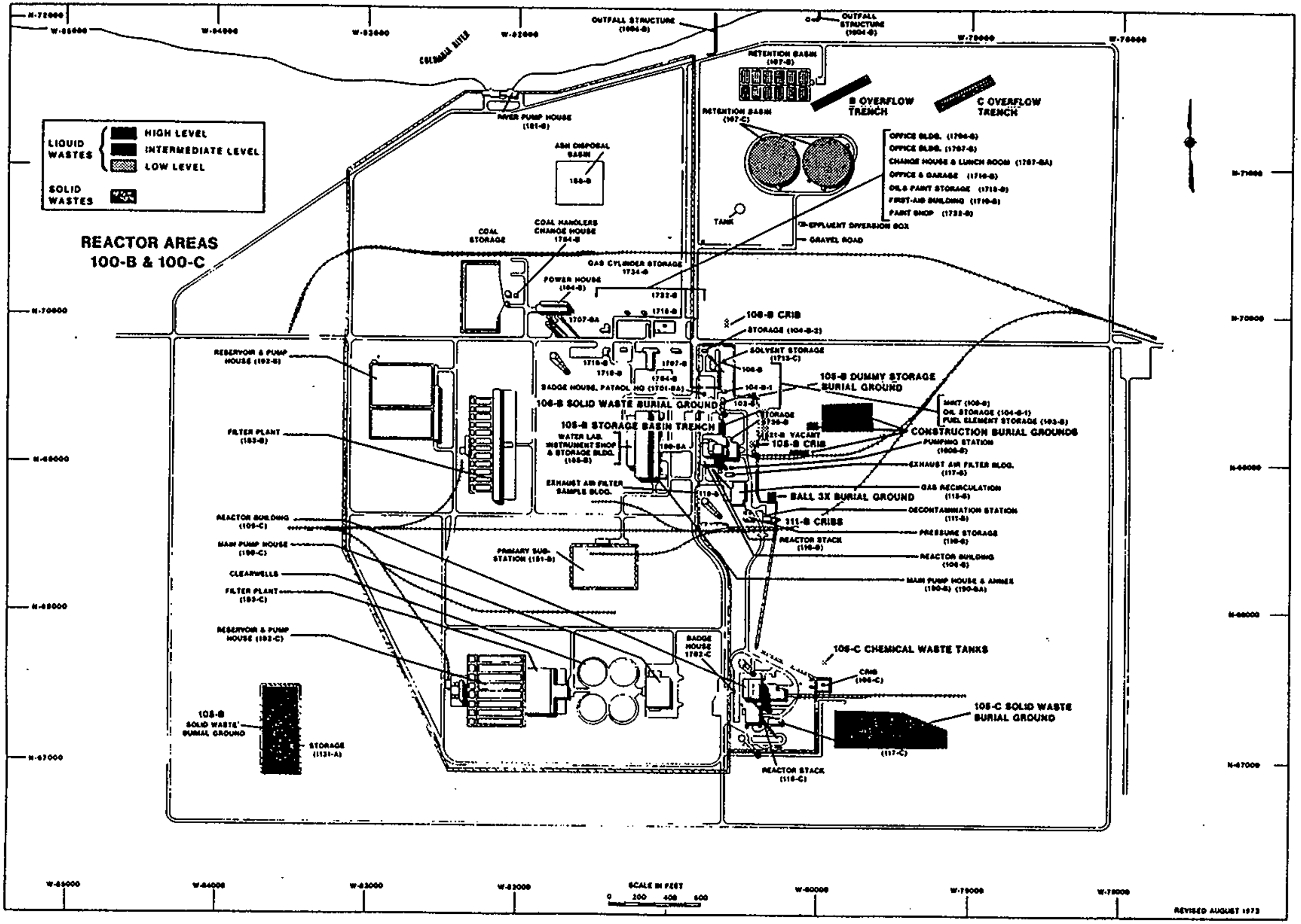


Figure 7-14. 100-B and 100-C Areas Map (ERDA 1975).

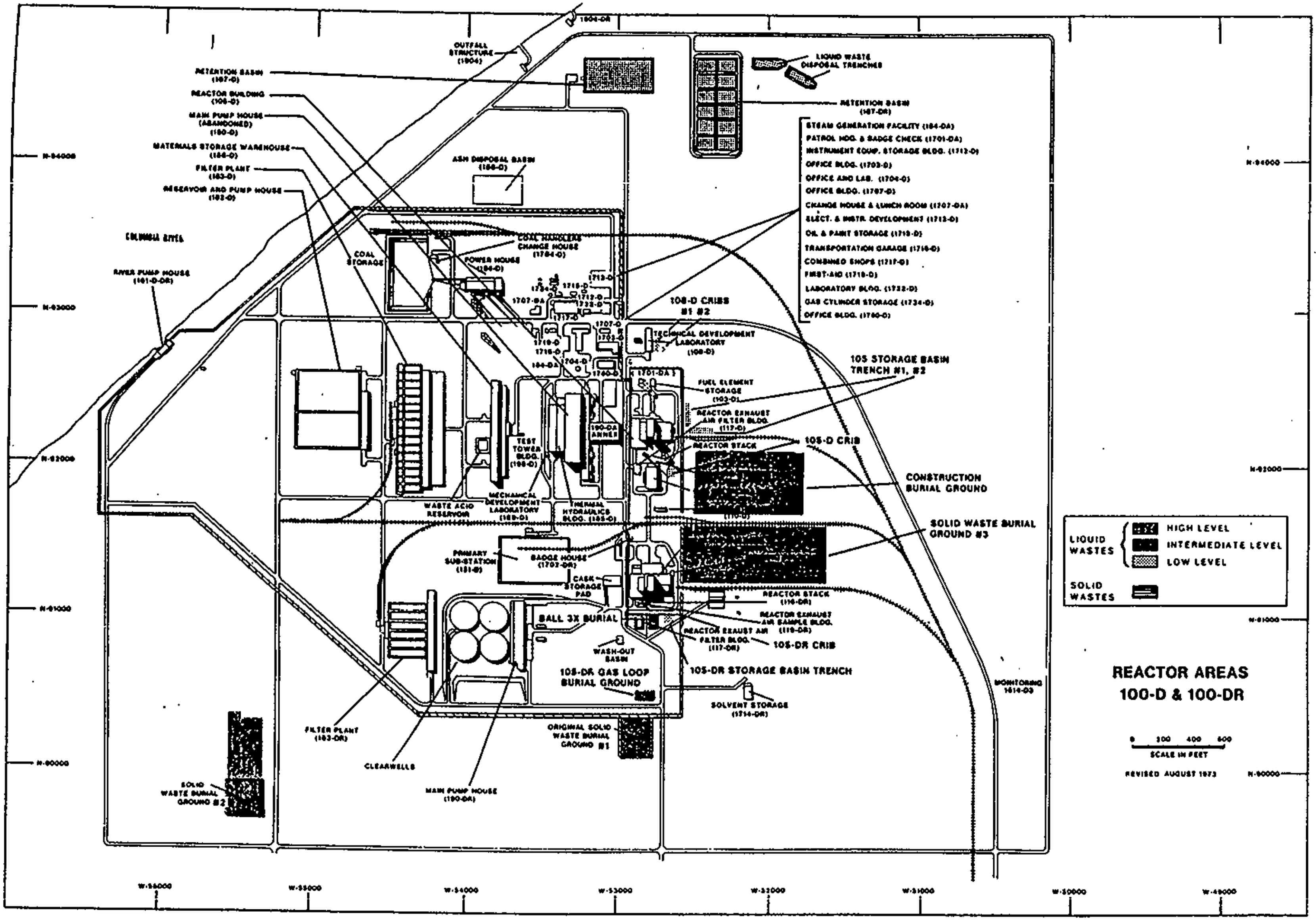


Figure 7-15. 100-D Area Map (ERDA 1975).

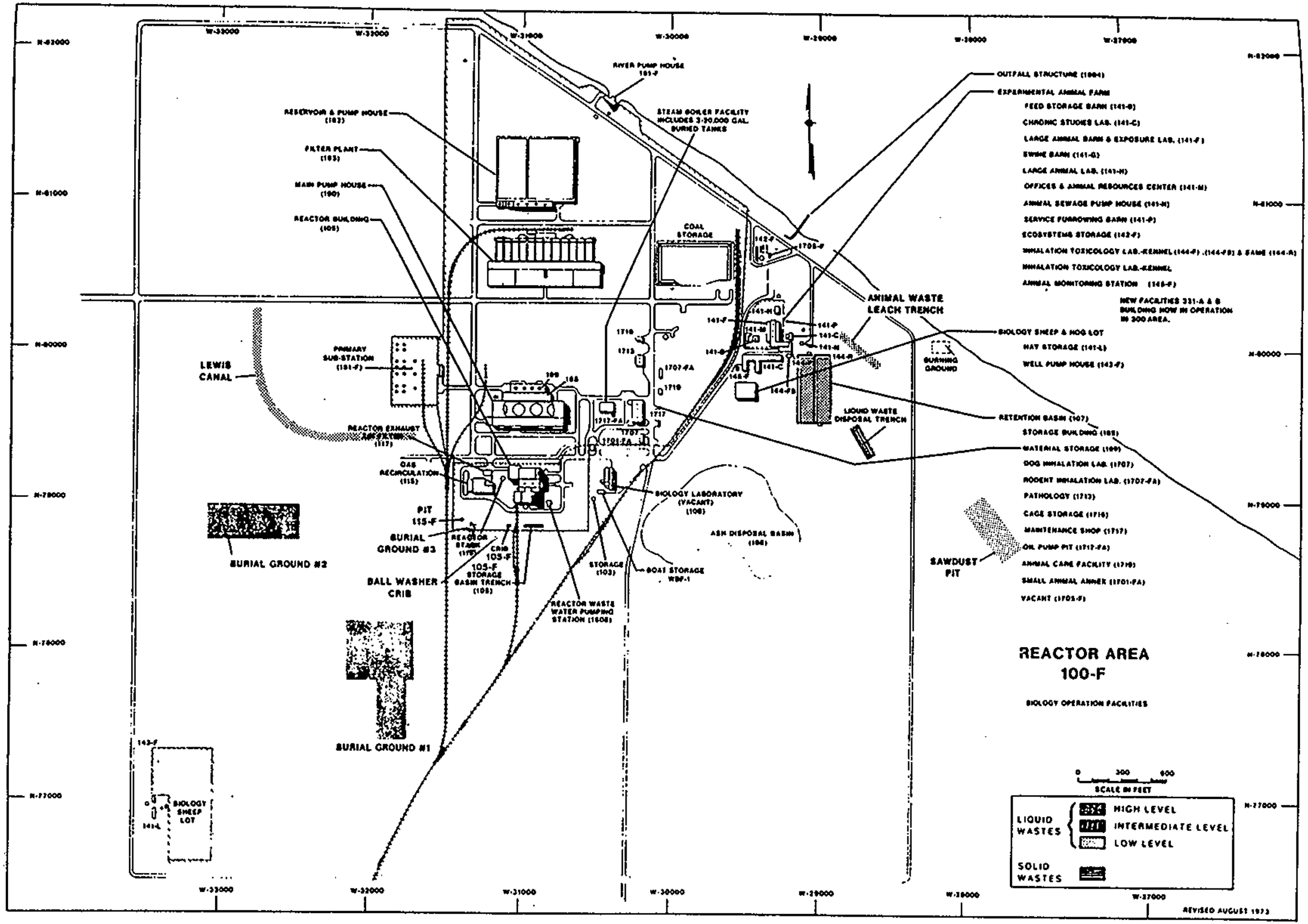


Figure 7-16. 100-F Area Map (ERDA 1975).

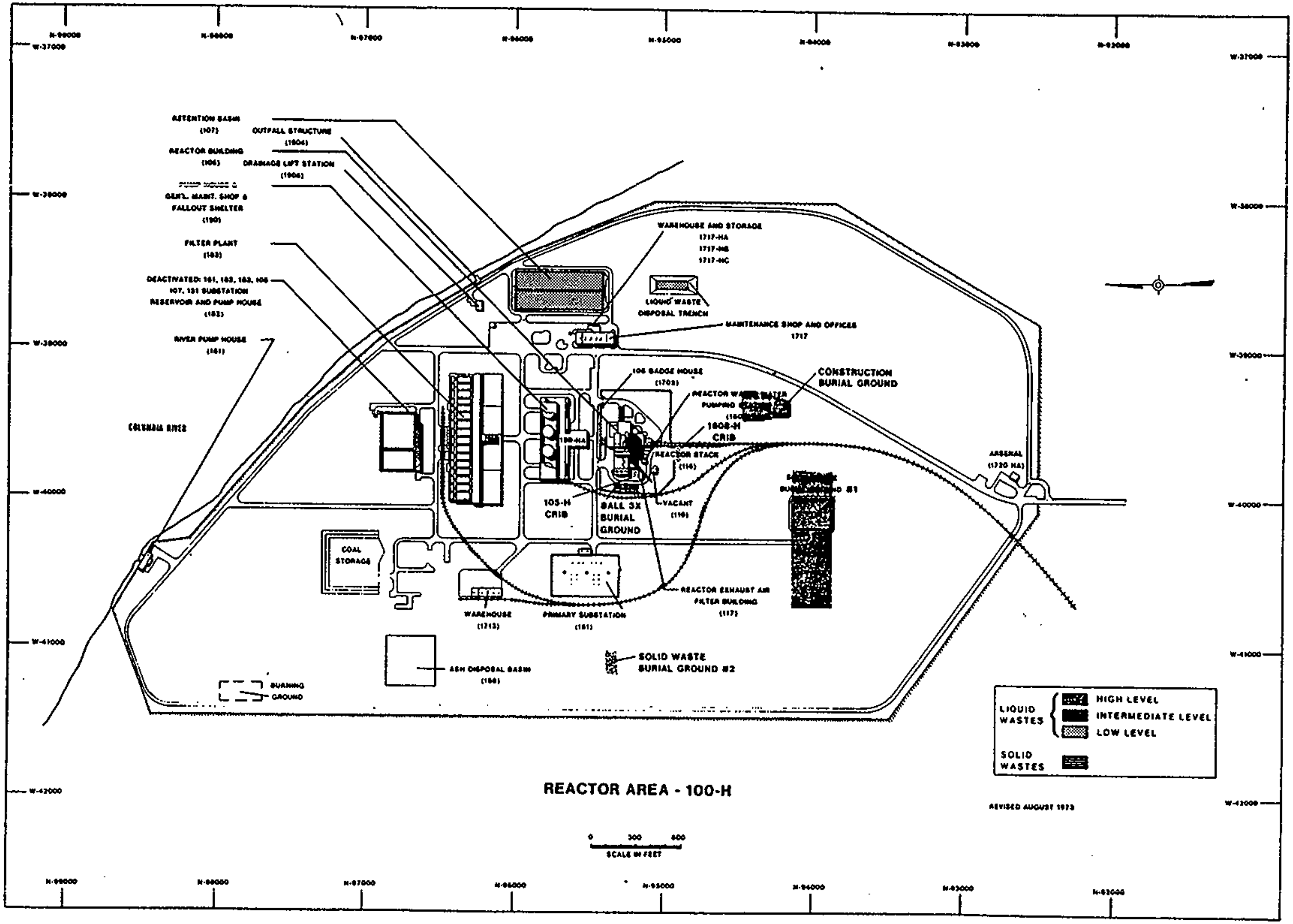
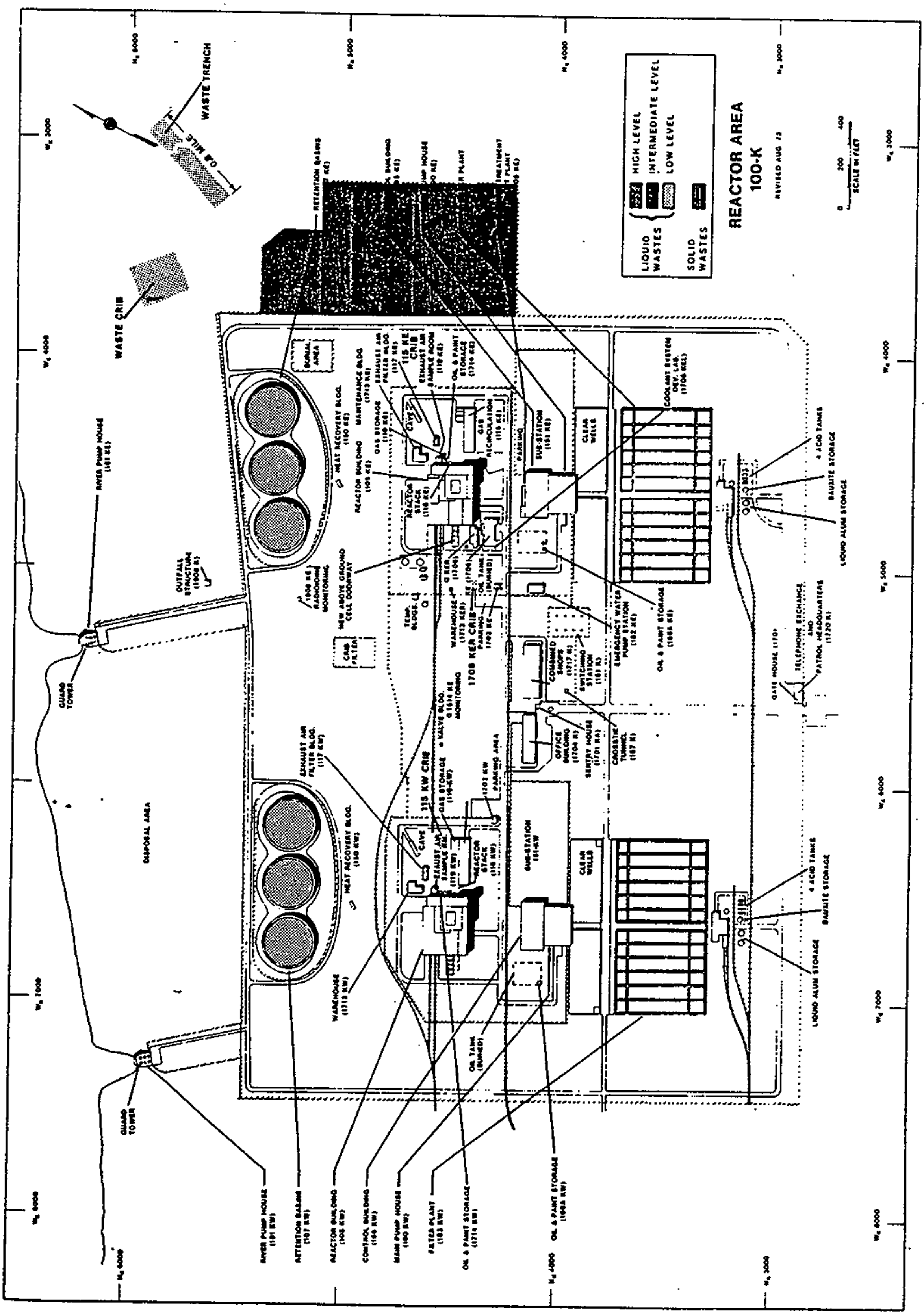


Figure 7-17. 100-H Area Map (ERDA 1975).

Figure 7-18. 100-K Area Map (ERDA 1975).



The storage and disposal facilities since startup in 1944 through calendar year 1993 in contained in a *Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1993*, WHC-EP-0125-6 (Anderson and Hagel 1994).

Waste containers were buried in different manners appropriate to their contents. TRU wastes placed in interim storage were either in underground, reinforced-concrete caissons; trenches with an asphalt pad foundation; trenches with a dirt bottom; or in buildings. Non-TRU wastes were stored in trenches with dirt bottoms, or in silos (RHO 1985).

7.4.2.1 200 East Area. The location and contents of the 200 East burial grounds are summarized in Table 7-2. Figure 7-19 shows the burial grounds in the 200 East Area. For a timeline of the years of operation of all 200 East Area Burial Grounds, see Figure 7-20 (RHO 1986).

7.4.2.2 200 West Area. A summary of the locations and contents of the 200 West burial grounds in contained in Table 7-3. For a map of the 200 West Area, see Figure 7-21. For a timeline of the years of operation of all 200 West Area Burial Grounds, see Figure 7-22 (RHO 1986).

There were also a number of sites in the 200 West Area that were contaminated by unplanned releases or unscheduled burials. Contamination from cask cars and equipment being hauled to the burial ground from the T Plant was spread to the ground along the railroad on several occasions during 1949. In the spring of 1950, the contamination was covered with about 10 in. of clean gravel. This area is within an established radiation zone (Heid 1956).

Approximately fifty empty 55-gal oil drums, contaminated as a result of the particle problem in and around REDOX in 1952, were buried about 150 m (500 ft) directly east of the northeast corner of the REDOX exclusion area fence and were covered with 1.8 m (6 ft) of clean soil. The area is not marked above ground (Baldridge 1959).

Contaminated metal scrap including the 211-S tank taken from REDOX facilities was buried in September 1954 northwest of the REDOX exclusion area. The location was designated by four corner posts marked with "Do No Excavate" signs (Baldridge 1959).

Three covered trenches used to decontaminate heavy equipment were constructed in 1951 and located approximately 180 m (600 ft) west of the "T" facility. They were last used in Spring 1954. Signs were posted warning "Underground Contamination" (Heid 1956).

Unirradiated uranium waste from test runs during the original start-up of the "T" facility was placed in a trench 90 m (300 ft) northwest of the 221-T Building. It was backfilled with 0.6 m (2 ft) of clean soil and posted with "Underground Contamination" signs (Baldridge 1959).

Table 7-2. 200 East Area Burial Grounds. (3 sheets)

Facility number	Years of operation	Description
218-E-1	1945 - 1953 Retired	Located about 110 m (350 ft) west of the PUREX Plant, this site consists of 21 trenches north-south approximately 61 m (200 ft) long with a total surface areas of approximately 10,300 m (1.11 x 10^5 ft^2) (Maxfield 1979) and contains packaged waste from the semi-works process building. Upon closure all open trenches were filled with about 0.91 m (3 ft) of clean soil, a monument was erected on the center line at the ends of all trenches, and the area was enclosed with a wire fence posted with radiation signs (Baldridge 1959).
218-E-2	1945 - 1956 Retired	An industrial waste burial ground consisting of 7 trenches is located about 610 m (2,000 ft) north of B Plant. It contains process equipment and industrial waste. After a 1978 inspection disclosed trench caving, ground surface stabilization work was undertaken (Maxfield 1979).
218-E-2A	Unknown Service Dates. Retired Prior to 1975	This was a regulated equipment storage site located 430 m (1,400 ft) north of B Plant. No records or burial inventories are available to indicate that this site was ever used as a burial ground. It is probably more properly designated as a regulated equipment above ground storage site. One burial trench runs along the north boundary of 218-E-2A, and was designated as a part of this burial ground. A number of sink holes along the center line of the trench indicate the trench was dug and used for dry waste burials. Dirt was dumped over this burial trench in 1979, and plans for 1980 included stabilization of the ground surface of this trench (Maxfield 1979).
218-E-3	Unknown Service Dates. Exhumed	This burial ground was exhumed. It was located at the corner of Akron Avenue and Route 4 South inside the fenced perimeter (Masa 1983b).
218-E-4	1955 - 1956 Retired	A minor construction burial ground-consisted of two trenches running in a north-south direction. The trenches contain wastes removed from the 221-B Building during modifications to the building in 1955. Both were covered with 2.4 to 3 m (8 to 10 ft) of clean soil, and were stabilized in 1980. This burial ground was enclosed by a fence with radiation zone signs (Baldridge 1959).
218-E-5	1954 - 1956 Retired	This industrial waste burial ground measures 40 m (130 ft) by 90 m (300 ft) and located 550 m (1,800 ft) south of 221-B on the west side of Burial Ground 218-E-2. It contains miscellaneous equipment from tank farm recovery and some PUREX equipment. It was backfilled and marked with stakes, chains, and radiation zone signs (Baldridge 1959). The ground surface was stabilized in 1979 (Maxfield 1979).
218-E-5A	1956 - 1959 Retired	An industrial waste burial garden, located 550 m (1,800 ft) south of 221-B on the west side of Burial Ground 218-E-5 measures 107 m (350 ft) by 150 m (500 ft) and contains PUREX L-Cell packages, a concentrator grossly contaminated with plutonium, and other boxes of miscellaneous equipment. In 1979, stabilization work was required, and this burial garden was marked with stakes, chains, and radiation zone signs (Baldridge 1959).

Table 7-2. 200 East Area Burial Grounds. (3 sheets)

Facility number	Years of operation	Description
218-E-6	Unknown Service Dates. Exhumed	This burial ground was exhumed prior to 1975 (ERDA 1975). The exact location was not found.
218-E-7	1945 - 1950 1945 - 1952 1954 - Retired Prior to 1975 All Retired	A collection of three vaults, containing laboratory and sample waste from 222-B; was located approximately 61 m (200 ft) south of the 222-B Building. Vault 1 Vault 2 Vault 3 Vaults 1 and 2 had 53 cm (21 in.) square, baffled chute openings over the center and both were delimited above ground by wooden fences posted with radiation signs. Vault 3 had a 0.6 m (2 ft) metal corrugated pipe opening for packaged waste disposal and was enclosed by a chain fence posted with radiation zone signs (Baldridge 1959).
218-E-8	1958 - 1959 Retired	This was a construction burial garden used to handle equipment from 293-A construction and the temporary PUREX canyon ventilation barricade used for the new crane addition. Located about 1524 m (5000 ft) north of the PUREX Plant (Maxfield 1979), it was marked with stakes, chains, and radiation zone signs, and measures 46 m (150 ft) by 150 m (500 ft) (Baldridge 1959).
218-E-9	1953 - ? Retired between 1975 and 1983	This above ground area measures 61 m (200 ft) by 107 m (350 ft) and is located 550 m (1,800 ft) south of 221-B on the east side of Burial Ground 218-E-2. It was used for the above ground storage of fission product equipment contaminated in the uranium recovery program at tank farms. The location was marked with wire fence, stakes, rope, and radiation zone signs (Baldridge 1959).
218-E-10	1961 - Present Active	This site is an industrial waste burial ground consisting of 8 trenches running north and south, approximately 120 m (Maxfield 1979). Located 610 m (2,000 ft) northwest of the 221-B Building, it contains burial boxes of tanks, columns, tube bundles, jumpers, and other miscellaneous equipment, along with mixed fission products and plutonium.

Table 7-2. 200 East Area Burial Grounds. (3 sheets)

Facility number	Years of operation	Description
218-E-12A	1953 - 1967 Retired	A dry waste burial ground (north) is located about 990 m (3,250 ft) of the PUREX Plant. The 28 dry waste burial trenches contain acid soaked waste and boxed dry waste from the operations facilities in the 200 East Area. In 1979, interim stabilization activities were initiated to eliminate the hazards of subterranean voids, reduce wind surface erosion, remove ground surface contamination, and establish deterrents against the growth of undesirable vegetation. In addition, the burial ground was chosen as a test site for interim stabilization materials and techniques (Work Procedure D0101WP0106). During the past years many of the trenches settled and created voids in the waste buried below. Fill dirt was used to bring al trench surfaces to normal ground level, and to provide soil for seed beds. A 7.7 to 10.2 cm (3 to 4 in) deep sand cushion was spread over the surface of each trench (Maxfield 1979).
218-E-12B	1967 - Present Active	A dry waste burial ground (south) is located 150 m (500 ft) north of the northwest corner of the 241-C tank farm. Received boxed waste from the PUREX plant containing both plutonium and mixed fission products. This is the only burial ground in the 200 East Area that contains TRU waste. The TRU waste was placed in retrievable storage, with the drums stacked horizontally without tarp coverage before soil coverage (Anderson 1991). This burial ground contains 29 trenches running north and south. Six of these trenches are narrow, shallow trenches that measure 290 m (960 ft) long, 0.91 (3 ft) wide, and 1.2 m (4 ft) deep. The remaining 23 are 290 m (960 ft) long, 12 m (40 ft) wide, and 4.9 m (16 ft) deep with an approximate 1.5 m (5 ft) bottom. Twenty trenches are filled and two are partially filled.
218-E-13	1966 Retired	This unplanned burial site is located approximately 110 m (350 ft) west of the PUREX exclusion area. It contains broken pieces of contaminated concrete from a pipe trench encasement that was repaired at that location (Maxfield 1979).
218-E-14	1956 - 1965 Retired	This is Burial Tunnel 1 of the PUREX Plant. See Section 7.2.3.1 for description.
218-E-15	1964 - Present Active	This is Burial Tunnel 2 of the PUREX Plant. See Section 7.2.3.2 for description.
Miscellaneo us Trench	1955 Retired	This miscellaneous trench contains contaminated forms, a shack, and other wooden items which were removed form the 291-B stack area during clean-up of the exclusion area in the fall of 1955. A trench 1.2 m (4 ft) deep was dug and contaminated items were burned with the ashes being covered. Three signs stating "Underground Contamination" were posted (Heid 1956). This trench was located near the 291-B Stack within the B Plant perimeter (Heid 1956).

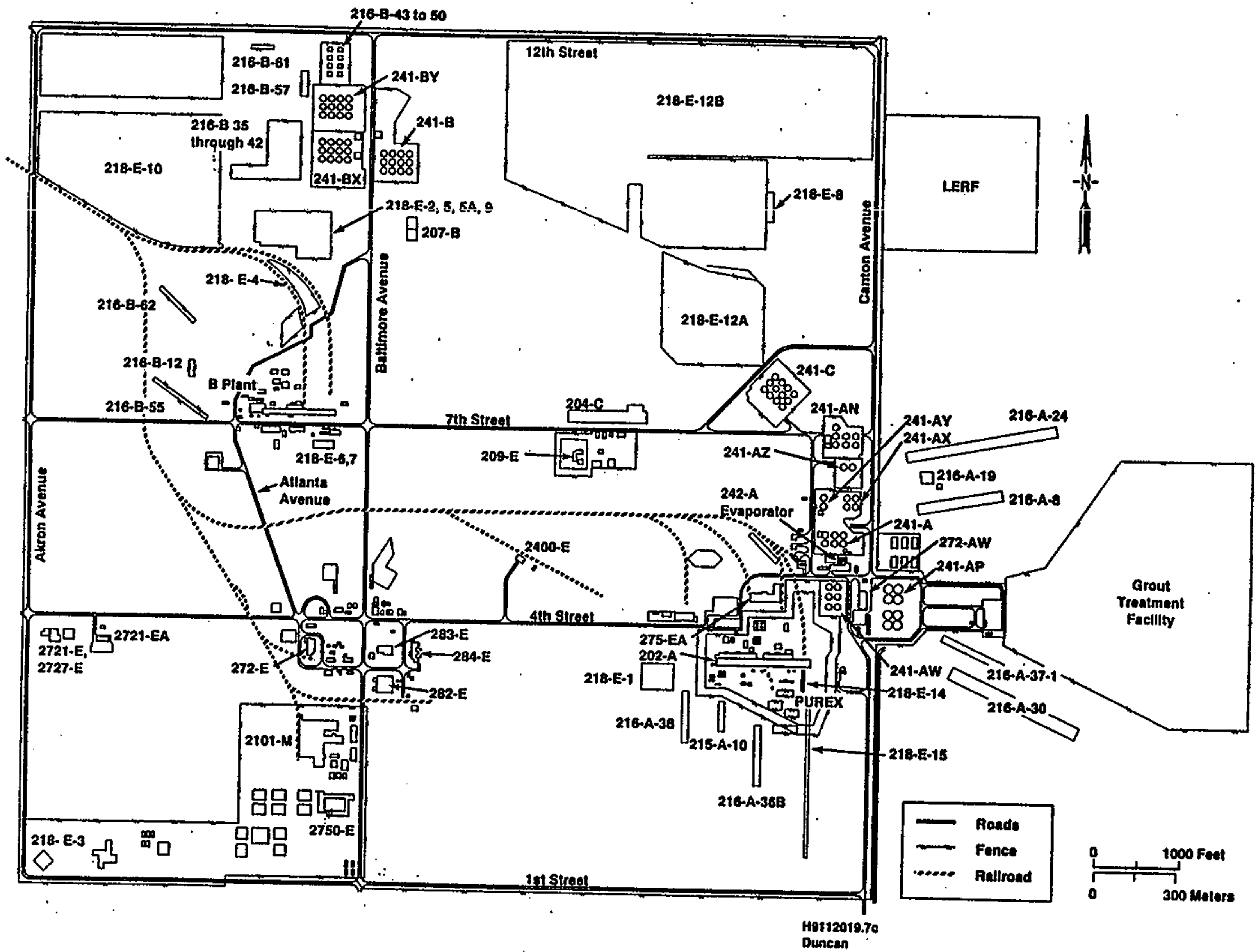


Figure 7-19. Map of the 200 East Burial Grounds.

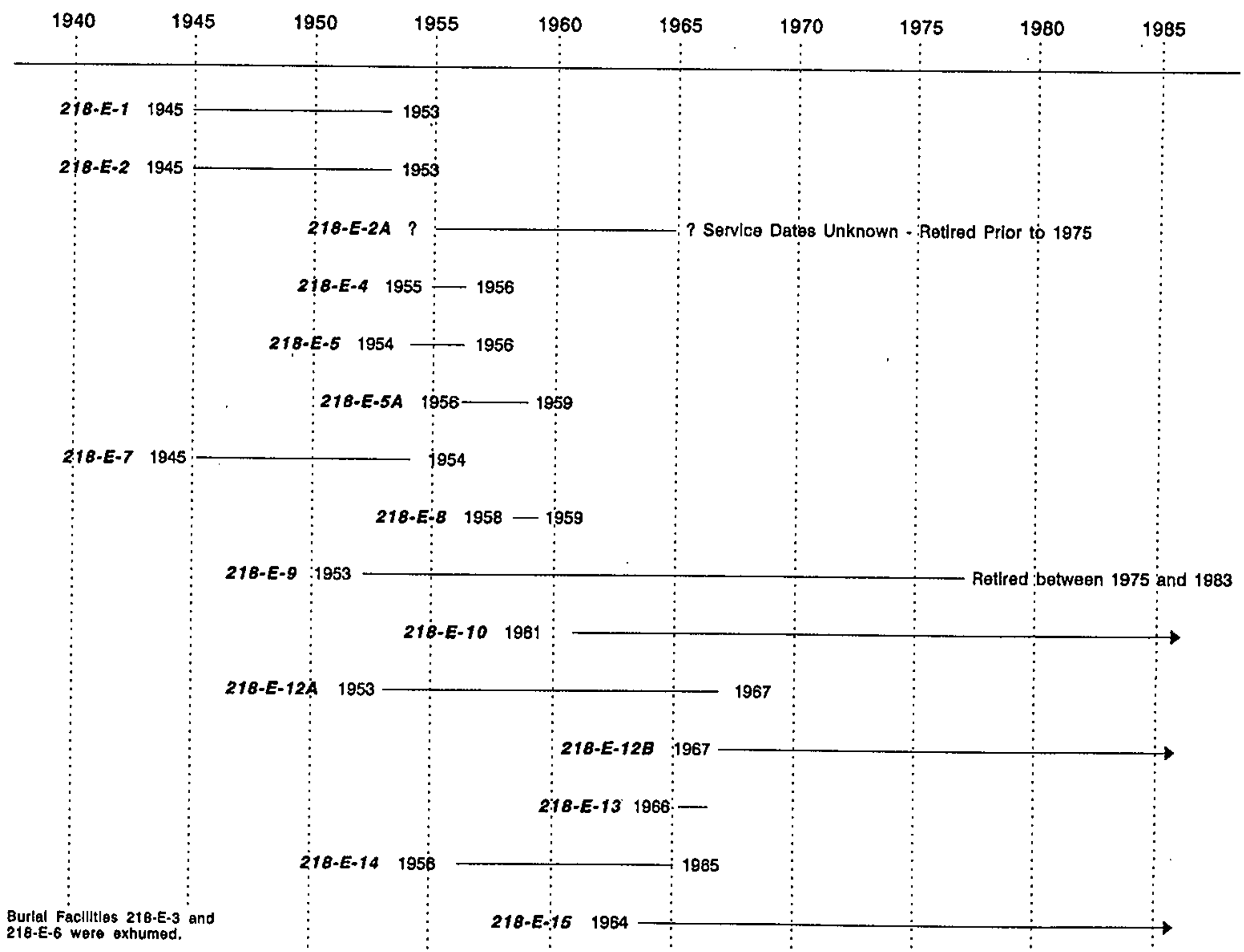


Figure 7-20. A Timeline of the 200 East Burial Ground Operations (RHO 1986).

Table 7-3. 200 West Area Burial Grounds. (3 sheets)

Facility number	Years of operation	Description
218-W-1	1944 - 1953 Retired	This dry waste burial ground located approximately 550 m (1,800 ft) northwest of 234-5 Building consists of 3 large and 12 small backfilled dry waste trenches. Some of the waste trenches in this burial ground did not receive the required 1.2 m (4 ft) overfill. In 1979 waste boxes were observed to be less than 1.2 m (4 ft) from the ground surface and contaminated weeks were found to be growing over the trenches (Maxfield 1979).
218-W-1A	1944 - 1954 Retired	This industrial waste burial ground contains failed equipment and industrial waste. It is located approximately 610 m (2,000 ft) northwest of the 221-T Building and it was the first large equipment burial site used in the 200 West Area. Most of the equipment was buried in wooden boxes which eventually rotted and caused settling of the ground surface. Most of the sink holes were filled with dirt in 1975, but there still remains a number of deep sink holes north of the railroad tracks. The ground surface is free of contamination. A large number of 1.8 m (5 ft) thick concrete cell blocks were stored above round south of the railroad tracks. Nearly all of the surface radioactive contamination that was on the blocks when they were stored in the burial ground has since decayed. In 1979 only about 1000 cpm on the underside of two of the blocks (Maxfield 1979).
218-W-2	1953 - 1956 Retired	This dry waste burial ground contains 20 dry waste burial trenches approximately 142 m (465 ft) long, running east-west. It is located approximately 550 m (1800 ft) northwest of the 234-5Z Building. Some of the waste trenches in this burial ground did not receive the required 1.2 m (4 ft) overfill. Waste boxes have been observed to be within 46 cm (18 in.) of the ground surface. Routine radiation surveys of the surface of the trenches have found contaminated Russian thistle growing mostly along the edges of the trenches. All sink holes were filled in 1974 (Maxfield 1979).
218-W-2A	1957 - 1979 Retired	The industrial waste burial ground containing 25 filled trenches and two unused trenches, is located approximately 1070 m (3500 ft) west of the 221-T Building. All of the trenches were dug with their centerline running northwest from the railroad track except for 3 short trenches in the southwest corner. Wastes buried in this ground include failed equipment and industrial waste, contaminated soil from the bottom of the 216-T-4-1 Pond, and cell cover blocks (Maxfield 1979).
218-W-3	1957 - 1961 Retired	This dry waste burial ground is located approximately 1200 m (4,000 ft) west of the 221-T Building and is composed of 20 trenches running east-west. Although the site is covered with a good growth of native grasses and rabbit brush, there is no evidence of transport of radioactivity by plant root penetration (Maxfield 1979).
218-W-3A	1970 - Present Active	Located approximately 1,200 m (4,000 ft) west of the 221-T Building, there are 50 trenches that run east-west in this burial ground. Some of the drums in this dry waste burial ground contain classified material from Rocky Flats (and other sites) and were stacked horizontally with the other waste until 1975. After 1975, the classified material was segregated from other wastes and stacked vertically in earthen-bottom trenches. These trenches also contain approximately 100 waste liners packaged in concrete containers from GE and contaminated soil from a spill of radioactive salt waste at 102-S tank in the 241-S Tank Farm. Some trenches also contain segregated TRU waste (Maxfield 1979).

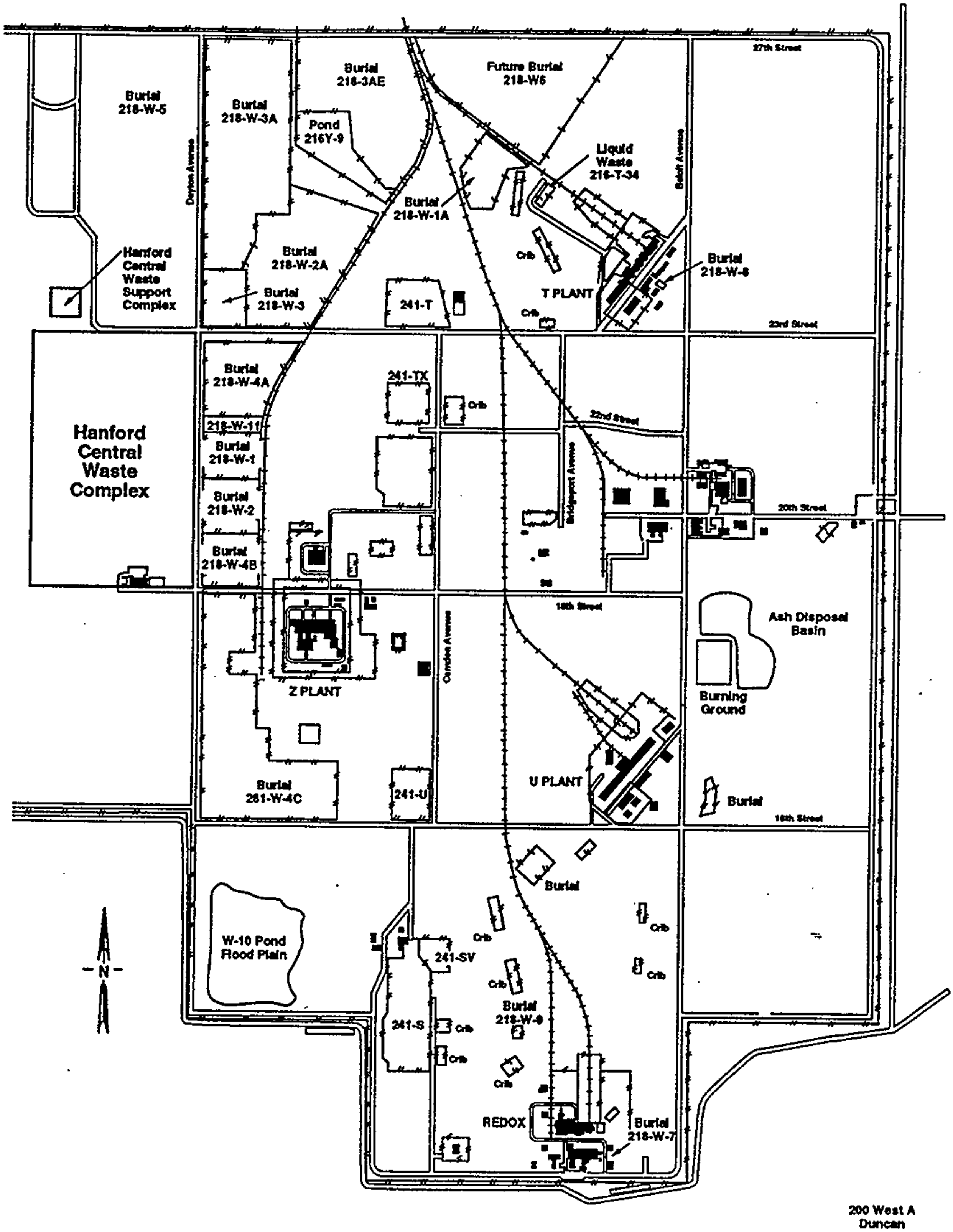
Table 7-3. 200 West Area Burial Grounds. (3 sheets)

Facility number	Years of operation	Description
218-W-3A-E	? - Present Active (activated after 1975 but prior to 1983)	This burial ground consists of 31 trenches that contain LLW and MLLW. It is located next to 218-W-5 with trenches running parallel to 27th Street (Wood et al. 1994).
218-W-4A	1961 - 1967 Retired	Located approximately 1,200 m (4,000 ft) west of the 221-T Building, this dry waste burial ground contains 21 trenches running east-west and 6 caissons. The caissons are 4.6 m (15 ft) deep dry wells that were made out of 55-gal steel drums welded together with the ends of the drums cut out except the bottom of the lower drum. The resultant wells were then placed on end in Trench #16. In 1975, gross alpha contamination and lesser amounts of beta-gamma contamination were found on contaminated waste (bottles, pipets, etc.) that had been uncovered from near the ground surface by wind erosion. The waste had obviously not been buried a minimum of 4 ft underground as required at the time of the burial. The contaminated waste was disposed of, and the affected area 15 x 15 m (50 x 50 ft), was covered with a sheet of 10 mm plastic topped with 45 cm (18 in) of san and gravel to stabilize the area. During the years form 1965 and 1974 routine radiation surveys disclosed contaminated Russian thistle to be growing in a loosely scattered pattern over many of the burial ground trenches. In 1974, all of the sunken holes were filled to ground level. No contaminated weeds appeared in 1975, 1976 or 1977. It should be noted that some waste boxes were still within 46 cm (18 in.) of the ground surface in 1979 (Maxfield 1979).
218-W-4B	1967 - Present Active	Located approximately 150 m (500 ft) northwest of the 234-5 Building, this burial ground contains 13 trenches and 10 caissons. Two of the trenches contain TRU retrievable waste, and the other 11 trenches are standard burial trenches that contain alpha-beta and gamma contaminated dry waste (Maxfield 1979).
218-W-4C	1974 - Present Active	This dry waste burial ground used for miscellaneous dry waste, is located approximately 150 m (500 ft) west of the 234-5Z Building and consists of six retrievable waste trenches running east-west. The northernmost trench is designated as the Navy Core Barrel Trench. It contains a number of core barrels from Navy submarine reactors. These are sitting at the east end of the open trench. The other trenches contain plutonium contaminated soil and drums of assorted TRU wastes. The trenches are asphalt bottom trenches that were covered with plywood and nylon tarps when full and then topped with fill dirt (Maxfield 1979). During early 1980, a heavy snowfall and rapid melting caused flooding within some 4C trenches. Drums were observed floating in trench T04 and were recovered undamaged (Anderson et al. 1991).
218-W-5	? Present Activated in mid 1980's	This burial ground contains 33 LLW trenches and is located at the corner of Dayton Avenue and 27th Street along the 200 West Area perimeter fence. These trenches are unlined and most are about 6 to 7 m deep, and of variable length up to about 500 m. The slopes of the trenches are angles at about 45°. They are typically either wide-bottomed (about 8 m [26 ft] wide) or V-shaped (about 3 m [10 ft] wide) (Wood et al. 1994).
218-W-6	Future Site	This site is planned to meet future storage space requirements (Carlson et al. 1994).

Table 7-3. 200 West Area Burial Grounds. (3 sheets)

Facility number	Years of operation	Description
218-W-7	1952 - 1960 Retired	This burial ground contains the 222-S dry waste disposal vault that was used for dry packaged waste from the 222-S laboratory. The vault is a steel tank approximately 3.6 m (12 ft) in diameter and 4.3 m (14 ft) high, buried with the top 1.8 m (6 ft) below ground level. It was marked with a chain fence and posted with radiation signs (Baldridge 1959). It is located directly east of the 222-S Building (Maxfield 1979).
218-W-8	1944 - 1975 Retired	This burial ground contains the 222-T dry waste disposal vaults used for dry packaged waste from the 222-T laboratory. The first vault was built in 1944 and the second in 1949. They were constructed of wood, with dimensions 3 m (10 ft) by 3.7 m (12 ft) by 3 m (10 ft), and covered with 1.8 m (5 ft) of soil. The third vault was built in 1950 and is approximately 3 m (10 ft) in diameter and 9 m (30 ft) deep. Constructed of concrete rings, this vault was still in use in 1959. Al three faults are on a north-south line 61 m (200 ft) east of the 222-T Building. The vaults are enclosed by a rail fence with radiation zone signs (Baldridge 1959). In 1975, fill dirt was spread over the surface of this radiation zone to fill the sink hole that had settled around the vault opening. It was recommended at that tie that the facility be capped over with a dome of concrete to preclude future cafe-ins (Maxfield 1979).
218-W-9	1954 Retired	This dry waste burial ground, located about 300 m (,1000 ft) northwest of the 202-S Building, contains contaminated metal scrap including the 211-S Tank taken from REDOX facilities. The location is designated by four corner posts marked with "Do Not Excavate" signs (Maxfield 1979).
218-W-11	1960 Retired	This solid waste burial and regulated storage is located about 610 m (2000 ft) northwest of the 234-5 Building. The burial ground was used as an aboveground storage. The one burial trench within the burial ground runs 45 m (150 ft) east-west. The trench was used for burial of low-level contaminated sluicing equipment that had been used in the uranium recovery program. Some of the equipment was later taken from the trench and used in the strontium-cesium recovery program (Maxfield 1979).

Figure 7-21. A Map of the 200 West Burial Grounds.



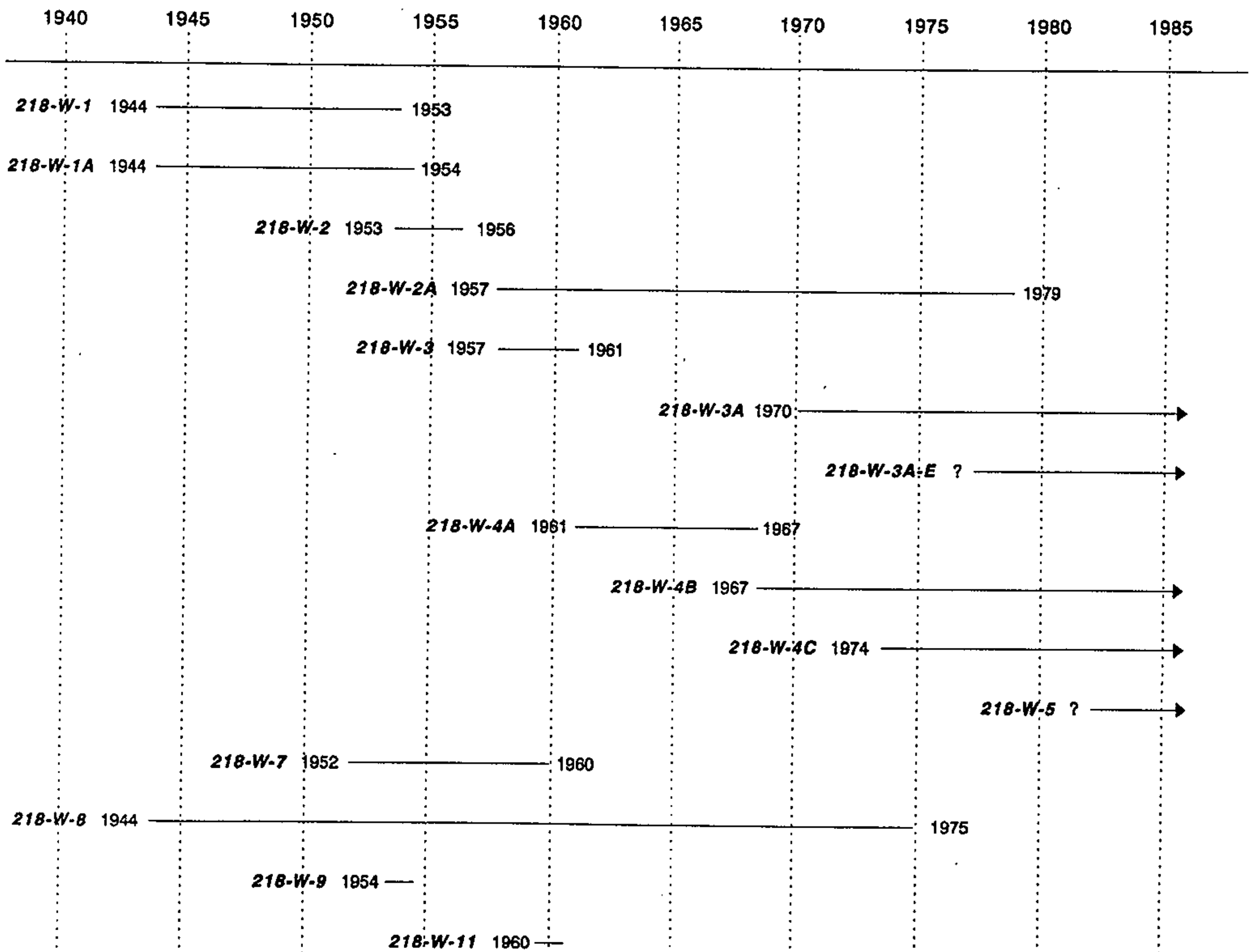


Figure 7-22. A Timeline of the 200 West Burial Ground Operations.

7.4.3 300 Area

The 300 Area, which contained research and fuel preparation facilities, is located 18 to 27 m (60 to 90 ft) above the water table, but in a location where the soils have little ion exchange capability. The total curie content of the waste disposed to these burial grounds was comparatively small. Material placed in the 300 North and Wye burial grounds was diverse, because of the research facilities located in the 300 area served by them (Backman et al. 1963). After 1968, the solid waste generated by the 300 Area operations was sent to the 200 Areas for burial (Rogers and Rickard 1977). The burial grounds that served the 300 Area are shown in Figure 7-23 and Figure 7-24. The materials buried in the 300 Area present no severe radiation and contamination hazards; they could be dug up with little problem (Parks 1966). For a timeline of the operational years of the 300 Area Burial Grounds, see Figure 7-25. Table 7-4 summarizes burial ground information about the 300 Area.

There were also sites in the 300 Area that were accidentally contaminated. During the early and middle years of 300 Area operations, some other solid waste disposal sites were used on both a planned and inadvertent basis. In 1950, contaminated topsoil was removed from the region surrounding the 303 Building and placed 0.8 to 1.2 km (0.5 to 0.75 mi) northwest of the 300 Area. Two feet of clean earth was placed over the contaminated soil at that time. In 1954, approximately 19,000 L (5,000 gal) of drummed solvent wastes (primarily uranyl nitrate hexahydrate and hexone) from 321 Building tests were buried about 0.8 km (0.5 mi) due west of the 300 Area north perimeter fence. In this operation, nearly 100 drums that had been generated in 1949 to 1950, but stored on an outdoor pad for nearly 5 years, were placed in what then was designated the 300 West Burial Grounds (now 618-9). About 20 batches, 1,900 L (500 gal) each, of used ammonium nitrate solution and unused powdered ammonium nitrate were disposed. Nearby, a 1,900 L (500 gal) Columbian stainless steel tank and several agitators used by duPont in early 321 Building bismuth phosphate tests had been buried in 1947 (Gerber 1992b).

Additionally, many sites to the northwest of the 300 Area along the railroad tracks leading to the 300 Area received aboveground deposits of uranium-contaminated aluminum and aluminum-silicon turnings. Throughout the nearly three decades of single-pass reactor operations, rejected aluminum fuel element "cans" were loaded into rail cars for sale as scrap offsite, with the specification that these scraps not be used in the food canning industry. The loading spot, about 1.6 km (1 mi) northwest of the 313 Building, received the most concentrated deposits. However, spills of uranium-contaminated aluminum and aluminum-silicon occurred along the intervening grounds throughout the north of this region, and especially near the 300 West Quonset Hut, a small station from which rail loadings were recorded and tracked. Another contaminated waste disposal site was located just west of the 300 Area West Gate along the highway. There, used resins from ion exchange columns in the 325 Building, and later the 324 Building, were disposed above ground in 113-L (30-gal) cardboard drums known as "paper drums." Over time, they decomposed into the soil. This practice stopped in the late 1960's. Additionally, it is possible that other burial grounds exist that have thus far been completely forgotten in written and oral records (Gerber 1992b).

Figure 7-23. 300 Area Retired Radioactive Solid Waste Burial Grounds.

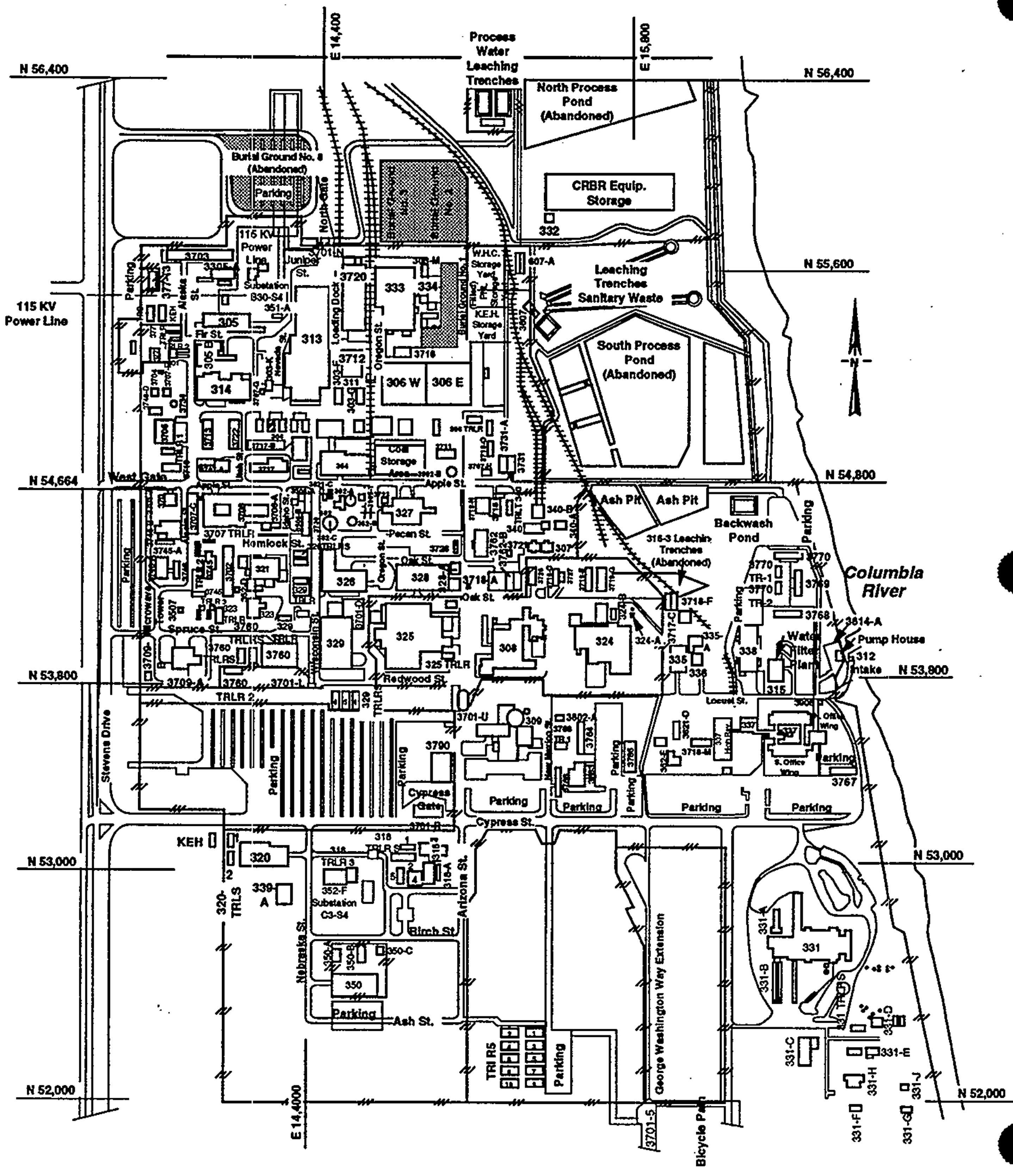


Figure 7-24. 600 Area Retired Radioactive Solid Waste Burial Grounds.

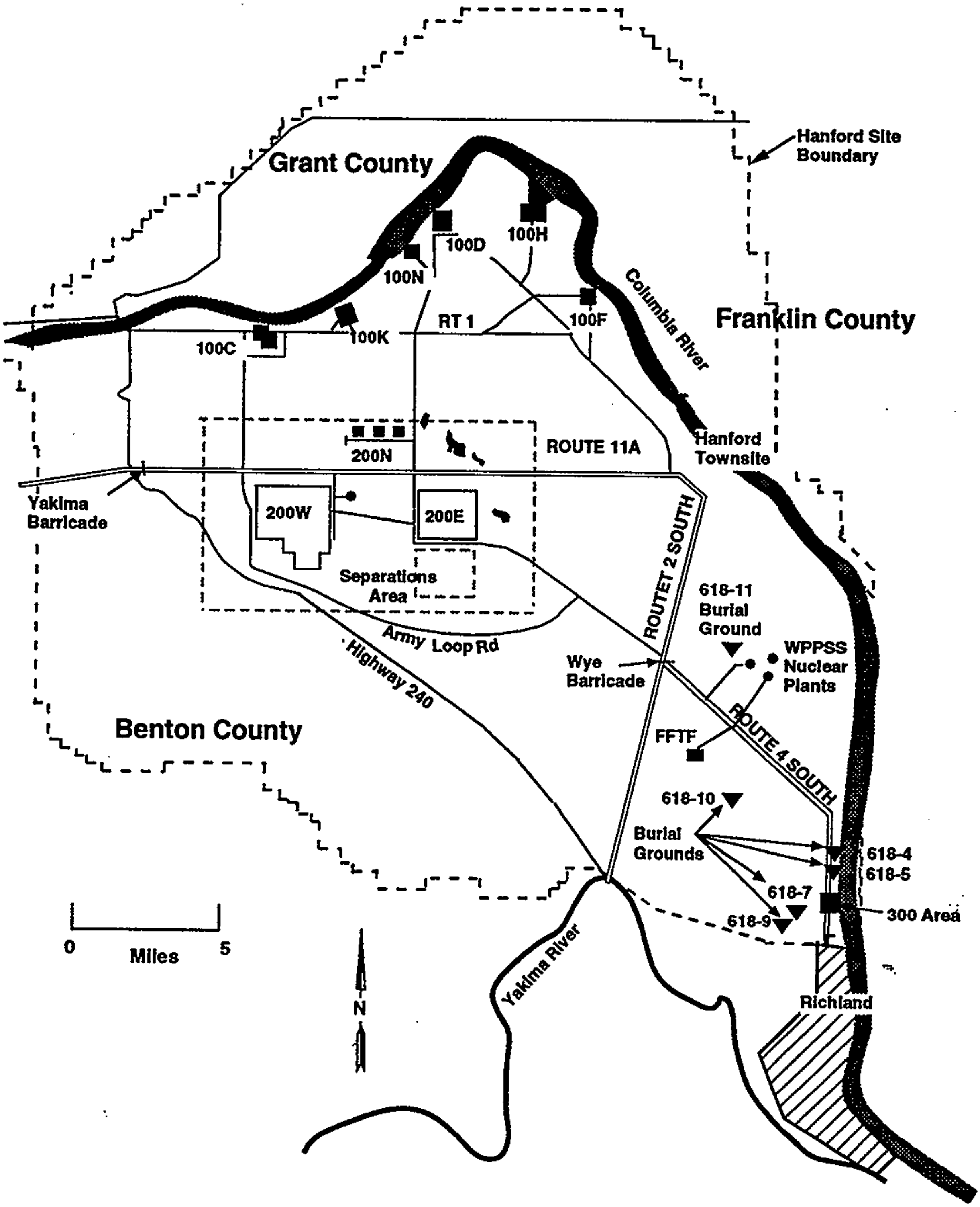


Figure 7-25. A Timeline of the 300 Area Burial Ground Operations.

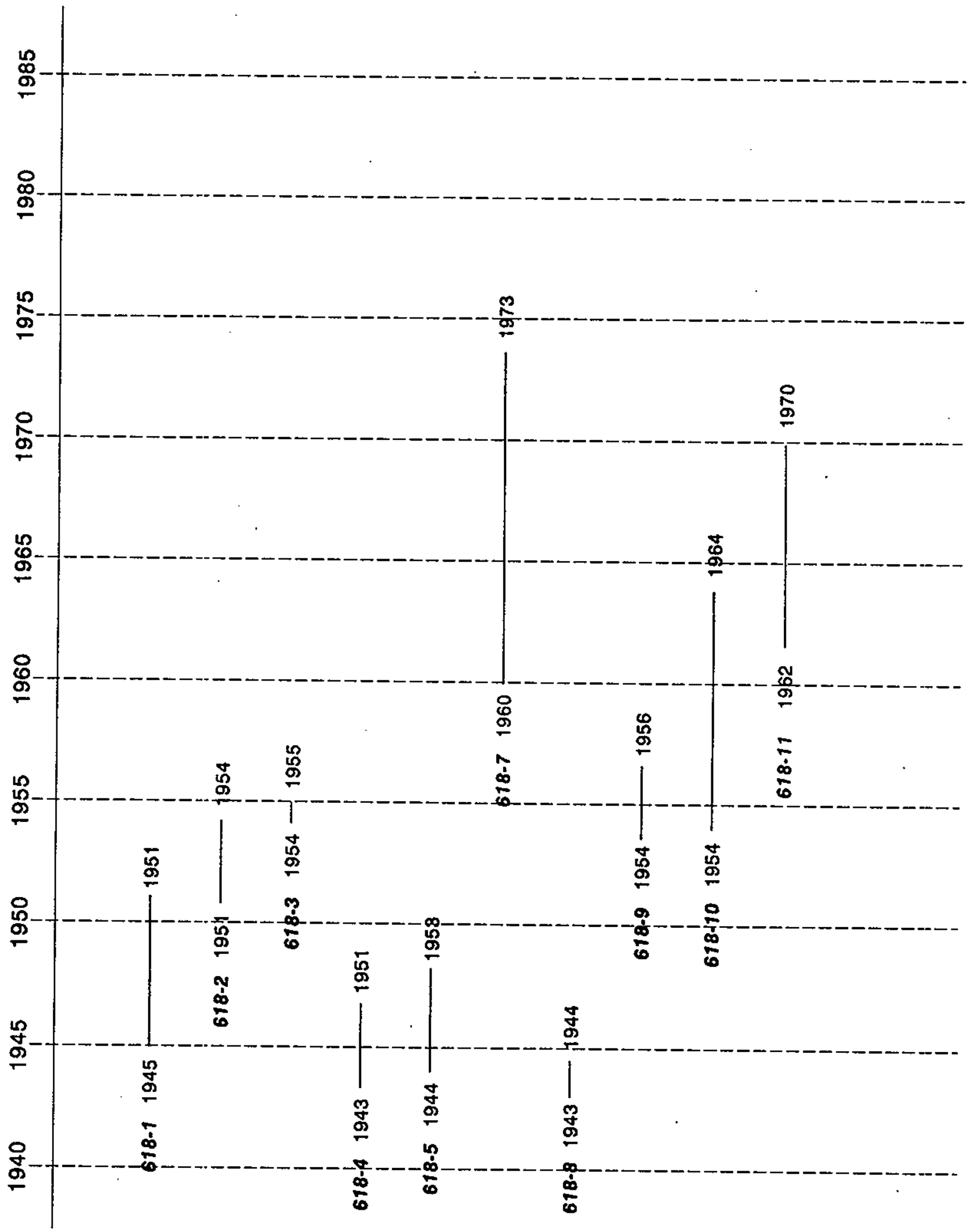


Table 7-4. 300 Area Burial Grounds. (2 sheets)

Facility number	Years of operation	Description
618-1	1945 - 1951 Retired	This was the second 300 Area waste burial site and was located just inside the northeast corner of the 300 Area. This facility consisted of three east-west trenches and an unknown number of longer north-south trenches. It received some highly contaminated wastes from early 3741 building operations and from the initial cleanout of the 3706 Building during 1946 to 1947. About 1965, nitric acid leaking from tanks of the 334 Chemical Handling Facility, located above this burial ground, dissolved some of the below ground uranium and ferrous compounds in the south end, allowing them to migrate to groundwater. From 1975 to 1985, a solvent evaporator (a large, open container similar to a dumpster), used to evaporate some waste acids from the 313 and 333 Building's processes, operated over a portion of the north end of this burial ground (Gerber 1992b).
618-2	1951 - 1954 Retired	Located just north of 518-1, this burial ground consisted of four east-west trenches. Wastes disposed on in these trenches included uranium, plutonium, and mixed fission products. Most of the contents in this burial ground were destroyed by fire on February 17, 1954 (Gerber 1992b).
618-3	1954 - 1955 Retired	This was the fourth waste burial site and was located just west of 618-2. It filled up quickly because it received the demolition and construction debris, including large equipment parts and structural materials, from the remodeling of the 313, 303-J, and 303-K Buildings and from the construction of the 311 Facilities (Gerber 1992b).
618-4	1943 - 1951 Retired	Located 700 m (2300 ft) north of the 333 Building, this site was originally a burning ground for uncontaminated trash. However, contamination occurred in the late 1940's when some contaminated solid waste was disposed and uranium-contaminated trash was burned. The site was designated as a burial ground in the early 1960's (Gerber 1992b).
618-5	1944 - 1953 Retired	Located 120 m (400 ft) north of the North Process Pond, this site also originated as a burning ground for uncontaminated trash. Like 618-4 it was also contaminated with unknown quantities of uranium. It was designated as a burial ground in the early 1960's (Gerber 1992b).
618-7	1960 - 1973 Retired	This burial ground includes trenches and a V-shaped pit, containing materials primarily form 300 Area fuel manufacturing processes contaminated slightly with uranium or thorium (ERDA 1975).
618-8	1943 - 1944 Retired	This is the earliest 300 Area waste burial ground and was located abut 686 m (750 yds) north of the 300 Area beneath the site of the current 300 Area North Parking Lot (just north of the electrical substation that is east of the 3703 Building). This burial ground was accidentally discovered while post holes were being dug for a power line in the 1952 expansion (Gerber 1992b).
618-9	~1954 - 1956 Retired	Once referred to as the 300 West Burial Grounds, this site received approximately 18,000 l (5000 gal) of drummed solvent wastes (primarily uranyl nitrate hexahydrate and hexone) from 321 Building tests. The site is located about 0.8 km (0.5 m) due west of the 300 Area north perimeter fence. It was terminated and marked in 1963.

Table 7-4. 300 Area Burial Grounds. (2 sheets)

Facility number	Years of operation	Description
618-10	1954 - 1964 Retired	This burial ground also known as "300 North", was located about 6.9 km (4.3 mi) northwest of the 300 Area. This burial ground consisted of trenches and rows of burial caissons known as "pipe fields". These caissons were made of five to six open-bottomed 55-gal drums welded together and buried upright (Gerber 1992b).
618-11	1962 - 1970 Retired	This burial ground was also known as the Wye Burial Ground and was located about 9.7 km (6 mi) north of the 300 Area near the present site of the Washington Public Power Supply System (Supply System) reactor number 2. The Wye Burial Ground consisted of three trenches, three rows of burial drums (caissons) and, after 1966 to 1967, other rows of fabricated burial caissons (Gerber 1992b).

In 1970, all of the principal operating contractors of the Hanford Site joined together to conduct a study of solid waste disposal practices. One of their recommendations was that all future burials take place in the 200 East and West Areas. The implementation of this recommendation resulted in the final closure of the Wye Burial Grounds in 1970 and ended solid waste burials in the 300 Area and vicinity from that time on (Gerber 1992b).

7.5 BURIAL SITE DEACTIVATION PROCEDURES

Waste disposal sites were deactivated only when it was not feasible to use any of the existing sites (Masa 1983a). Stabilization of the are was necessary upon closure of the site. A burial site was to be deactivated or closed when the following conditions were met (Shord 1979):

- Authorized burial space was filled.
- Total site activity limit was reached.
- A significant release of activity indicated that a basic noncorrectable error was made in the design of the burial system or in the environmental assessment of the site.
- A serious accident or natural disaster altered condition at the site.

When a burial site was to be deactivated for any of these reasons, requirements of termination had to be met. These requirements changed throughout the years of operations of the burial grounds at the Hanford Site and are discussed in the following sections.

7.5.1 Pre-1970 Burial Site Deactivation Requirements

Currently available documentation of burial site deactivation procedures and practices for the year prior to 1970 is scanty. In 1966, the requirements and practices for burial ground termination included the following:

Requirements for 1966 burial ground termination were (Parks 1966):

- Trenches were to be backfilled with at least 1.2 m (4 ft) of dirt cover, with humps or mounds not permitted in meeting this maximum requirement.
- A maximum radiation level of <1 mrad/hour was permitted over the filled trench.
- The site was to be clearly marked with permanent monuments as a radiation disposal area.

Changes to these requirements were made in 1967 and include the following (ARHCO 1967):

- The site shall be inspected periodically (minimum of once/month the first year, quarterly thereafter) to assure that surface levels radiation <1 mad/hour are maintained.

- Locations of terminated solid waste disposal sites shall be accurately and permanently marked according to Hanford Standard AC-5-40.

Personnel were required to conduct continuing surveillance of the burial sites, visual inspections and measurements of surface radiation. When plants became radioactive, the ground was sterilized (Tomlinson 1969). One account in 1969 states, "when a site is abandoned, concrete posts are erected to designate the boundary. A building and a parking lot have been constructed in and on abandoned burial grounds." The burial ground in 100K Area had a locked gate to control access (Corbit 1969).

7.5.2 1970 to 1990 Burial Site Deactivation Requirements

The only change from the 1967 regulations recorded in the 1970 requirements regarded marking the locations of former burial sites. At this time, deactivated disposal sites were to be accurately and permanently marked and recorded according to the guidance of AEC RL Supplement 0510, Section C-4. Markers used were to meet Hanford Standard AC-5-40 requirements (Hanson and Oberg 1970).

The requirements for burial ground deactivation were changed slightly in 1977 as noted below (Anderson 1977a):

- Additional backfill or permanent shielding shall be provided as necessary to reduce surface radiation levels to <1 mad/hours and be free of surface contamination (less than 200 cpm beta/gamma and less than 500 d/m per 100 cm^2 alpha).

- The sites shall be accurately and permanently marked and recorded according to the guidance of AEC-RL supplement 0510, Section C-4. Markers used shall meet Hanford Standard AC-5-40 requirements.

- The site shall be periodically inspected, at least semiannually, to assure that the required conditions in Sections 4.3.1 and 4.3.2 are maintained. Deficiencies noted on inspection shall be corrected.

By 1980, the requirements had been changed again to include six conditions that necessarily had to be met (McCall 1980). The requirements were the following:

1. **Maintain Radiation Levels** — Additional backfill or permanent shielding were to be provided as necessary to reduce surface radiation level to 0.5 mrem/hour.

2. **Maintain Contamination Levels** — Surface soil contamination must be maintained below the standards set forth in RHO-CD-783, "Surface Soil Contaminating Standards."

3. **Site Inspections** — All deactivated solid waste disposal sites were to be periodically inspected at least annually. Deficiencies shall be corrected by Rockwell Tank Farm Services.

4. **Trench Identification** — Trench markers shall be established prior to trench excavation and must be maintained in place, repaired or replaced as necessary. Permanent markers (HWS-05-04) would be installed upon completion of storage/disposal activities.

5. **Soil Stabilization** — The stabilization of soil must be maintained.

6. **Unusual Conditions** — Burial areas were to be checked for unusual conditions (such things as slumping or earth cave-ins).

By 1982, the requirements were changed slightly; the significant change being maintenance radiation level changed back to <1 mrem/hour (Masa 1982).

1. **Maintain Radiation Levels** — Additional backfill or permanent shielding were to be provided as necessary to reduce surface radiation levels to <1 mrem/hour.

An explanation of the terms was given in the 1982 *Active and Retired Radioactive Solid Waste Burial Grounds Safety Analysis Report*. All corrective actions were to be performed to provided personnel and environmental safety. Surface stabilization meant that non-TRU trenches are stabilized by adding a soil overburden requirement to reduce surface levels to less than or equal to 50 μrem/hour and TRU trenches are not stabilized with grasses but rather with 15 cm (6 in) of gravel to prevent wind erosion. Another method of stabilizing TRU waste burial ground was to exhume the contents. A safety analysis was required prior to exhuming the buried contents of any burial ground (Christenson et al. 1984).

Again in 1983 and 1984 the requirements for burial site deactivation specifications remained the same (Masa 1983a). In 1984 the phrase "minimize contamination levels" requiring soil contamination to be maintained below the standards set forth in RHO-CD-782 was placed back into the burial site deactivation specifications as stated in the *Active and Retired Radioactive Solid Waste Burial Grounds Safety Analysis Report*. Minimum soil overburden requirements were set to reduce surface radiation readings and guard against burrowing animals. Stabilization of trenches consisted of load testing, seeding with perennial grasses, and selective herbicide application (Christenson et al. 1984). Routine surface surveillance included measurement of surface radiation levels, sampling plant growth for radionuclide uptake, and visual inspection of subsidence, animal burrows, and wind erosion. Deficiencies were corrected as necessary (Albaugh et al. 1985).

7.5.3 Post-1990 Burial Site Deactivation Procedures

In 1992, requirements for retired burial grounds were made more specific and applied to the following areas: radiation; backfilling and stabilization; and maintenance and inspections. Each of these areas is discussed separately below:

7.5.3.1 Radiation. Surface dose rates were to be maintained at or less than 50 μR/hour when measured from a height of 0.9 m (3 ft). Surface dose rates were not to exceed 1.0 mrem/hour for retired burial ground sites which had not been stabilized, or 50 μR/hour for retired burial ground sites which had been surface stabilized.

7.5.3.2 Backfilling and Stabilization. Each subsidence that occurred in an unstabilized burial ground was to be backfilled and compacted as soon as practical following discovery. In addition, each subsidence that occurred in a surface stabilized burial ground was to be backfilled, compacted, and restabilized as soon as practical following discovery. Stabilization was to consist, as a minimum, of providing enough soil cover to reduce the surface radiation to less than 50 μR/hour and establish a growth of short-rooted vegetation.

7.5.3.3 Maintenance and Inspections. A schedule of equipment inspections, calibrations, and site surveillance requirements was to be established, and each requirement was to be performed within the specified time interval. Cutie Pie meters were to be recalibrated every 3 weeks. Geiger-Mueller meters were to be recalibrated every 5 weeks, in accordance with DOE Order 5480.1A.

8.0 SOLID WASTE DOCUMENTATION

Throughout the past forty years a number of documents and databases have been used to archive waste content information and to track waste containers. The first formal recording of specific solid waste packages was probably in October of 1959. These records related solely to the measured discards of failed stainless steel equipment. In the following year, information regarding the waste source, general type and volume was required to be recorded for each waste shipment.

In the first specifications and standards document for solid waste disposal, (ARHCO 1967), written for BNW waste, records were required, but the exact format of the record was not specified. Recommended items to be covered in this report included date, shipment number, number of packages, package type, total volume, plutonium in grams, uranium grams, enrichment, activity other than uranium or plutonium (curies), principle activity descriptions and remarks on packed items or special conditions. With the publication of ARH-919 in 1968 (ARHCO 1968), specific burial records forms were required to accompany each waste shipment. Table 8-1 summarizes the waste acceptance documentation since 1968. Each of the required documents mentioned in this table is discussed in the following sections along with the databases that evolved to capture the information recorded on these forms.

8.1 SOLID WASTE STORAGE AND BURIAL RECORDS

The use of the standardized Solid Waste Burial Records (SWBR) began about 1968. From 1968 until 1974, both onsite and offsite generators filled out the same SWBR. This SWBR form underwent only minor revisions over this period; examples of two SWBRs from 1968 are shown in Figures 8-1 and 8-2.

From 1974 until 1982, two separate SWBRs were used: one for ARHCO (and, after 1974, RHO) use only (Form 54-6500-028) and the other for use by either ARHCO (RHO) or other contractors (Form 54-3000-581). These two forms were simply updates of the SWBRs shown in Figure 8-1 and 8-2. The 1977 versions of these two forms are shown in Figure 8-3 and 8-4, respectively.

Also beginning in the early 1970's, an additional *Transuranic Dry Waste Storage* form (BC-6800-076) was required as an attachment to the SWBR for all TRU waste. This form is shown in Figure 8-5.

In 1982, the basic SWBR forms were replaced with two more specialized forms: the *Solid Waste Burial Record - Non-Transuranic* (Figure 8-6) and the *Solid Waste Storage Records - Transuranic SWSR* (Figure 8-7) for LLW and TRU waste, respectively. Both forms were required to be accompanied by a DOE/NRC 741 form, *Nuclear Material Transaction Report*, if reportable quantities of plutonium, uranium, or other source or special nuclear material as defined in DOE Order 5630.2 was present. This form is shown in Figure 8-8. In addition, the TRU storage record was to be accompanied by two more pieces of documentation: a *Contents Inventory Sheet* (Figure 8-9) and a *WIPP Certification Checksheet* (Figure 8-10).

Table 8-1. Documentation Requirements for Solid Wastes Handled at Hanford. (4 sheets)

Document	Radioactive waste		Mixed waste
	Low-level waste	Transuranic	
ARH-183 (ARHCO 1967) *Battelle Northwest only*	*"A record of solid waste transferred shall accompany each shipment."*		Not specifically mentioned
ARH-919 (ARHCO 1968)	*Solid Waste Burial Record*, Form BC-6000-028 (9-68)		Not specifically mentioned
ARH-1842 (Hanson and Oberg 1970)	*Solid Waste Burial Record*, Form 54-6500-028 (10-68)		Not specifically mentioned
ARH-3032, REV. 0 (Anderson 1974b)	*Solid Waste Burial Record*, Form 54-6500-028 (10-68) or Form 54-3000-581 (3-68)	Same as for LLW plus *Transuranic Dry Waste Storage* Form BC-6800-076 (10-72)	Not specifically mentioned
ARH-3032, REV. 1 (Anderson 1977b)	*Solid Waste Burial Record*, Form 54-6500-028 (3-77) for use by ARHCO or Form 54-6500-581 (3-77) for use by ARHCO and other contractors	Same as for LLW plus *Transuranic Dry Waste Storage* Form BC-6800-076 (10-75)	Mixed Waste not specifically mentioned, but waste with hazardous constituents required a *Request for Disposal of Hazardous Materials*
RHO-LD-64 (Anderson 1978) *Offsite Generators only*	*NRC Form 741* if reportable quantities of accountable nuclear material is present; *Solid Waste Burial Record*	Same as for LLW plus *Transuranic Dry Waste Storage* Form	Not specifically mentioned
RHO-MA-222, REV. 0 (McCall 1980)	*Shipping Records*; *Solid Waste Burial Record*: Form 54-6500-028 (4-79) for Rockwell use only and Form 54-3000-581 (4-79) for all others; *Special Nuclear Material Item Transfer* for containers with reportable quantities of plutonium, uranium, or other source and special nuclear material originated at RHO	Same as for LLW plus *Transuranic Dry Waste Storage* Form BC-6800-079 (4-79)	Not specifically mentioned

Table 8-1. Documentation Requirements for Solid Wastes Handled at Hanford. (4 sheets)

Document	Radioactive waste		Mixed waste
	Low-level waste	Transuranic	
RHO-MA-222, REV.1 (Masa 1982)	*Burial Compliance Checksheet;* *Solid Waste Burial Record* Form 54-3000-581; *DOE/NRC Form 741* if reportable quantities of plutonium, uranium, or other source or special nuclear material as defined in DOE Order 5630.2	*Burial Compliance Checksheet; Solid Waste Storage Record* Form 54-3000-623; *Contents Inventory Sheet* Form BC-6400-131; *WIPP Certification Checksheet* Form BC-6400-132; *DOE/NRC Form 741* if required	Not specifically mentioned
RHO-MA-222, REV. 2 (Belgrair 1984)	*Burial Compliance Checksheet;* *Solid Waste Burial Record - Non-Transuranic* Form 54-3000-581	*Burial Compliance Checksheet;* *Solid Waste Storage Record - Transuranic* Form 54-3000-623 (8-84); *Contents Inventory Sheet;* *WIPP Certification Checksheet* Form BC-6400-132 (5-83)	Not specifically mentioned
RHO-MA-222, REV. 3 (Pauly 1985)	*Burial Compliance Checksheet;* *Solid Waste Burial Record - Low Level* Form 54-3000-581	**Contact Handled:** *Burial Compliance Checksheet;* *DOE/NRC Form 741* or equivalent if the waste contains accountable material; *Contents Inventory Sheet* Form BC-6400-131; *WIPP Certification Checksheet* Form BC-6400-132; *Solid Waste Storage Record - Transuranic* Form 54-3000-623 **Remote Handled:** All of the above except the *WIPP Certification Checksheet*	Not specifically mentioned
RHO-MA-222, REV. 3A (Pauly 1987)	This revision was written specifically to address changes promulgated by the *Resource Conservation and Recovery Act (RCRA)*, the *Hazardous Solid Waste Amendment of 1984 (HSWA)*, and the *Dangerous Waste Regulations* for Washington State amended June 1986 (Washington Administrative Code 173-303). As such, this revision only affected the documentation for mixed wastes.		*Burial Compliance Checksheet;* *Chemical Waste Disposal Request Form* (H-VI); *Solid Waste Burial Record - Low Level; Uniform Hazardous Waste Manifest* (EPA Form 8700-22)

Table 8-1. Documentation Requirements for Solid Wastes Handled at Hanford. (4 sheets)

Document	Radioactive waste		Mixed waste
	Low-level waste	Transuranic	
RHO-MA-222, REV. 4 (Amir et al. 1987)	*Burial Compliance Checksheet*; *Shipping papers*; *Solid Waste Burial Record* Form 54-3000-581	*Burial Compliance Checksheet*; **Contact Handled** *Shipping Papers*; *DOE 741 Form* or equivalent if the waste contains accountable nuclear material; *Contents Inventory Sheet* Form BC-6400-131; *WIPP Certification Checksheet* Form BC-6400-132; *Solid Waste Storage Record - Transuranic* Form 54-3000-623 **Remote Handled** All of the above except for the *WIPP Certification Checksheet*	All of the documentation required for radioactive waste and the following: *Chemical Waste Disposal Request* Form A-6400-245; *Uniform Hazardous Waste Manifest* EPA Form 8700-22
WHC-EP-0063, REV. 0 (Stickney 1988)	*Request for storage/disposal*; *Storage and Disposal Approval Form*; *DOE/NRC 741 Form* if the waste contains accountable nuclear material; *Solid Waste Storage/Disposal Record*	*Request for storage/disposal*; *Storage and Disposal Approval Form*; *DOE/NRC 741 Form* if the waste contains accountable nuclear material; *Solid Waste Storage/Disposal Record*; *Contents Inventory Sheet*; *WIPP Certification Checksheet*	All of the documentation required for radioactive waste and the following: *Chemical Waste Disposal Request* Form A-6400-245; *Uniform Hazardous Waste Manifest* EPA Form 8700-22
WHC-EP-0063, REV. 1 (Stickney 1989a)	*Request for storage/disposal*; *Storage and Disposal Approval Form*; *DOE/NRC 741 Form* if accountable material is present; *Solid Waste Storage/Disposal Record*; *Rigging Details* if special handling is required; *Waste Inventory Sheet*	*Request for storage/disposal*; *Storage and Disposal Approval Request*; *DOE/NRC 741 Form* if accountable material is present; *Solid Waste Storage/Disposal Record*; *WIPP Contents Inventory Sheet*; *WIPP Certification Checklist*	All of the documentation required for radioactive waste and the following: *Chemical Waste Disposal Request* Form A-6400-245; *Uniform Hazardous Waste Manifest* EPA Form 8700-22

Table 8-1. Documentation Requirements for Solid Wastes Handled at Hanford. (4 sheets)

Document	Radioactive waste		Mixed waste
	Low-level waste	Transuranic	
WHC-EP-0063, REV. 2 (Willis 1991)	*Request for storage/disposal*; *Storage and Disposal Approval Form*; *DOE/NRC 741 Form* if accountable material is present; *Solid Waste Storage/Disposal Record*; *Rigging Details* if special handling is required; *Waste Inventory Sheet*	*Request for storage/disposal*; *Storage and Disposal Approval Request*; *DOE/NRC 741 Form* if accountable material is present; *Solid Waste Storage/Disposal Record*; *WIPP Contents Inventory Sheet*; *WIPP Certification Checklist*	All of the documentation required for radioactive waste and the following: *Chemical Waste Disposal Request* Form A-6400-245; *Uniform Hazardous Waste Manifest* EPA Form 8700-22
WHC-EP-0063, REV. 3 (Willis and Triner 1991)	*Waste Storage/Disposal Record* (Request to store/dispose of waste); *Storage/Disposal Approval Record*; *DOE/NRC 741 Form* if accountable material is present; *Low Level Waste Storage/Disposal Record*; *Rigging details* as required	*Waste Storage/Disposal Record*; *Storage/Disposal Approval Record*; *DOE/NRC 741 Form* if accountable material is present; *Transuranic Waste Storage Record*; *WIPP Contents Inventory Sheet*; *WIPP Certification Checksheet*	All of the documentation required for radioactive waste and the following: *Radioactive Mixed Waste Attachment Sheet*; *Uniform Hazardous Waste Manifest* EPA Form 8700-22
WHC-EP-0063, REV. 4 (Willis 1993)	*Waste Storage/Disposal Record*; *Storage/Disposal Approval Record*; *DOE/NRC 741 Form* if accountable material is present; *Surface dose rate documentation*; *Documentation of LLW category*; *Low Level Waste Storage/Disposal Record*; *Difficult Waste Information Sheet* if applicable	*Waste Storage/Disposal Record*; *Storage/Disposal Approval Record*; *Shipping papers*; *DOE/NRC 741 Form* if accountable material is present; *Transuranic Waste Storage Record*; *WIPP Contents Inventory Sheet*; *WIPP Certification Checklist*; *Difficult Waste Information Sheet* if applicable	All of the documentation required for radioactive waste and the following: *Radioactive Mixed Waste Attachment Sheet*; *Uniform Hazardous Waste Manifest* EPA Form 8700-22; *Hazardous/Mixed Waste Debris Determination Checklist*

ARHCO = Atlantic Richfield Hanford Company.
DOE = U.S. Department of Energy.
EPA = U.S. Environmental Protection Agency.
LLW = low-level waste.
NRC = U.S. Nuclear Regulatory Commission.
RHO = Rockwell Hanford Operations.
WHC = Westinghouse Hanford Company
WIPP = Waste Isolation Pilot Plant.

Figure 8-1. Solid Waste Burial Record Form 54-6500-028 Dated 10/68.

Atlantic Richfield Hanford Company

SOLID WASTE BURIAL RECORD
200 AREA PLATEAU

DISPOSAL SITE THIS PORTION OF FORM TO BE COMPLETED BY ARHCO REPRESENTATIVE AT DISPOSAL SITE

AREA | BURIAL GARDEN NO. | TRENCH NO.

CAISSON NO. | COORDINATES N ______ W ______

REMARKS

SIGNATURE | DATE

SHIPPER

SHIPMENT NO.

COMPANY
ATLANTIC RICHFIELD HANFORD COMPANY | BUILDING

SUBSECTION | AREA

REMARKS

SIGNATURE | DATE

PHYSICAL DESCRIPTION

MATERIAL CONTENTS: (E.G. DISSOLVER, PUMP, PROCESS OR LAB MISC. WASTE, TIMBERS)

VOLUME: (SEE BACK FOR FT³ TABLE)

CONTAINER	UNIT VOLUME-(FT³)	X NUMBER	=	TOTAL VOLUME (FT³)
222-S LAB CARDBOARD 10"X10"X25"	(1.5)	X ______	=	______
SMALL STD CARDBOARD 16"X15"X16"	(2.2)	X ______	=	______
LARGE STD CARDBOARD 18"X18"X24"	(4.5)	X ______	=	______
30 GALLON IRON DRUM	(4.1)	X ______	=	______
47 GALLON FIBER DRUM	(6.3)	X ______	=	______
55 GALLON IRON DRUM	(7.4)	X ______	=	______
		FILL FRACTION		
202-A LOAD LUGGER	(139)	X ______	=	______
222-S LOAD LUGGER	(139)	X ______	=	______
221-T LOAD LUGGER	(264)	X ______	=	______
OTHER (DESCRIBE)		______	=	______
		______	=	______
		______	=	______
		______	=	______
	GROSS VOLUME (FT³)		=	______

ACTIVITY

ACTIVITY DESCRIPTION: (E.G. LONG LIVED ISOTOPES SUCH AS Pu, Co, Sr, Cs; MIXED FISSION PRODUCTS)

ACTIVITY LEVEL: (SEE INSTRUCTIONS ON BACK)

C P WINDOW CLOSED READINGS AT SURFACE (2") | AT 3 FT

IDENTIFY CONTAINER BY VOLUME ABOVE EACH COLUMN

______ FT³	______ FT³	______ FT³	______ FT³	______ FT³
TOTAL mR hr	TOTAL mR hr	TOTAL mR hr	TOTAL mR hr	TOTAL mR hr

TOTAL mR hr	X	FACTOR	=	CURIES
______	X	______	=	______
______	X	______	=	______
______	X	______	=	______
______	X	______	=	______
______	X	______	=	______

GROSS ACTIVITY (CURIES) = ______

PLUTONIUM ______ GRAMS

URANIUM ______ GRAMS ______ ENRICHMENT

54-6500-028 (10-68)   DISTRIBUTION: WHITE – ACCOMPANY SHIPMENT TO SUPERVISOR OF BURIAL GROUND

Figure 8-2. Solid Waste Burial Record Form 54-3000-581 Dated 3/68.

SOLID WASTE BURIAL RECORD

200 AREA PLATEAU DISPOSAL SITE OPERATED FOR RL - AEC
BY ATLANTIC RICHFIELD HANFORD COMPANY

DISPOSAL SITE THIS PORTION OF FORM TO BE COMPLETED BY ARHCO REPRESENTATIVE AT DISPOSAL SITE

AREA	BURIAL GARDEN NO.	TRENCH NO.
CAISSON NO.	COORDINATES N ______ W ______	
REMARKS		
DATE	TIME	
SIGNATURE		

SHIPPER

SHIPMENT NO.	
COMPANY	
BUILDING:	AREA:
ADDRESS (OFF SITE)	
DATE	
SIGNATURE	

PHYSICAL DESCRIPTION

MATERIAL CONTENTS (NOTE ANY SPECIAL CONDITIONS) E.G., DISSOLVER, PUMP, SAMPLING OR LABORATORY PAPER WASTE, TIMBERS, RESIN.

CONTAINER						
	BOX	NO.	LENGTH	WIDTH	HEIGHT	☐ HANFORD STANDARD CARDBOARD
	DRUM	NO. AND SIZE				
	OTHER	NO. AND SIZE				
	TOTAL VOLUME (FT^3)					

ACTIVITY DESCRIPTION

GENERAL ACTIVITY DESCRIPTION (E.G. LONG-LIVED ISOTOPES SUCH AS Pu, Co, Sr, Cs; MIXED FISSION PRODUCTS; ACTIVATION PRODUCTS)

PLUTONIUM ______ GRAMS	URANIUM ______ GRAMS ______ ENRICHMENT	ACTIVITY (IF Pu OR U, ONLY UNITS IN GRAMS REQUIRED) ______ CURIES

DOSE RATE ______ mR/hr at ______ ☐ SURFACE ☐ INCHES ☐ FEET

DISTRIBUTION:

BY ORIGINATOR
- WHITE – } ARHCO
- YELLOW – } ARHCO
- PINK – RETAIN
- GOLDENROD – (SNW) WOOD, 325 BLDG.
- GOLDENROD – (DUN) WASTE DISPOSAL COORDINATOR, 1760-H BLDG.
- GOLDENROD – (ITT/FEG) ENGINEERING PLANNING, RM. 477, FED. BLDG.

BY ARHCO – SIGN AND FORWARD TO:
- WHITE – ARHCO SUPERVISOR OF BURIAL GROUND
- YELLOW – SNW WASTE DISPOSAL AND DECONTAMINATION, 325 BLDG.
- YELLOW – DUN WASTE DISPOSAL COORDINATOR, 1760-H BLDG.
- YELLOW – ITT/FEG ENGINEERING PLANNING, RM. 477 FED. BLDG.

54-3000-581 (3-68) [illegible]

Figure 8-3. Solid Waste Burial Record Form 54-6500-028, Dated 3/77, For Use By ARHCO Only.

Atlantic Richfield Hanford Company	ARHCO SOLID WASTE BURIAL RECORD 200 AREA PLATEAU

DISPOSAL SITE THIS PORTION OF FORM TO BE COMPLETED BY ARHCO REPRESENTATIVE AT DISPOSAL SITE

AREA	BURIAL GARDEN NO.	TRENCH NO.
CAISSON NO.	BEGINNING COORDINATES N ______ W ______ ENDING COORDINATES N ______ W ______	
REMARKS		
SIGNATURE		DATE

SHIPPER

SHIPMENT NO.	ERDA AUTHORIZATION NO.
COMPANY ATLANTIC RICHFIELD HANFORD COMPANY	BUILDING
SUBSECTION	AREA
I certify that no capital property is included in this burial unless documented by a Property Disposal Request, and described below; and that the contents are packaged in ARHCO approved containers per ARH-3032 Rev.	
SIGNATURE	DATE

PHYSICAL DESCRIPTION

MATERIAL CONTENTS: (E.G. DISSOLVER, PUMP PROCESS OR LAB MISC WASTE, TIMBERS, INCLUDE PBR NUMBERS AND PROPERTY NUMBERS).

VOLUME: (SEE BACK FOR FT³ TABLE)

CONTAINER	UNIT VOLUME (FT³)	X NUMBER	= TOTAL VOLUME (FT³)
222-S LAB CARDBOARD 10" X 13" X 25"	(1.3)	X ______	= ______
SMALL STD. CARDBOARD 16" X 15" X 16"	(2.2)	X ______	= ______
LARGE STD. CARDBOARD 18" X 18" X 24"	(4.5)	X ______	= ______
30 GALLON IRON DRUM	(4.1)	X ______	= ______
47 GALLON FIBER DRUM	(6.3)	X ______	= ______
55 GALLON IRON DRUM	(7.4)	X ______	= ______
202-A LOAD LUGGER	(139)	X ______ FILL FRACTION	= ______
222-S LOAD LUGGER	(159)	X ______	= ______
221-T LOAD LUGGER	(264)	X ______	= ______
OTHER (DESCRIBE)		______	= ______
		______	= ______
		______	= ______
		GROSS VOLUME (FT³)	= ______

ACTIVITY

ACTIVITY DESCRIPTION: (E.G. LONG LIVED ISOTOPES SUCH AS Pu, Co, Sr, Cs; MIXED FISSION PRODUCTS)

ACTIVITY LEVEL: (SEE INSTRUCTIONS ON BACK)

C.P. WINDOW CLOSED READINGS AT SURFACE (2") | AT 3 FT

IDENTIFY CONTAINER BY VOLUME ABOVE EACH COLUMN

____ FT³	____ FT³	____ FT³	____ FT³	____ FT³
TOTAL mR/hr	TOTAL mR/hr	TOTAL mR/hr	TOTAL mR/hr	TOTAL mR/hr

TOTAL mR/hr	X	FACTOR	=	CURIES
______	X	______	=	______
______	X	______	=	______
______	X	______	=	______
______	X	______	=	______
______	X	______	=	______

GROSS ACTIVITY (CURIES) = ______

PLUTONIUM ______ GRAMS Gross Weight ______ ☐ Kilograms ☐ Pounds

URANIUM ______ GRAMS ______ ENRICHMENT

DISTRIBUTION: ALL ACCOMPANY SHIPMENT IF COMPLETED. PINK COPY TO BE RETURNED. WHITE AND YELLOW WITH SHIPMENT IF NO RETURNED COPY DESIRED.

54-6500-028 (3-77)

Figure 8-4. Solid Waste Burial Record Form 54-3000-581, Dated 3/77, For Use By Contractors Other Than ARHCO.

SOLID WASTE BURIAL RECORD
200 AREA PLATEAU DISPOSAL SITE OPERATED FOR RL - ERDA
BY ATLANTIC RICHFIELD HANFORD COMPANY

DISPOSAL SITE THIS PORTION OF FORM TO BE COMPLETED BY ARHCO REPRESENTATIVE AT DISPOSAL SITE.

AREA	BURIAL GARDEN NO.	TRENCH NO.
CAISSON NO.	BEGINNING COORDINATES N ____ W ____	
	ENDING COORDINATES N ____ W ____	
REMARKS		
DATE	TIME	
SIGNATURE		

ORIGINATOR

PACKAGE NO.	ERDA AUTHORIZATION NO
COMPANY	
BUILDING:	AREA:
ADDRESS (OFF SITE)	
I certify that no capital property is included in this burial unless documented by a Property Disposal Request, and described below; and that the contents are packaged in ARHCO approved containers per ARH-3032 Rev.	
SIGNATURE	

PHYSICAL DESCRIPTION

MATERIAL CONTENTS (NOTE ANY SPECIAL CONDITIONS) E.G., DISSOLVER, PUMP, SAMPLING OR LABORATORY PAPER WASTE, TIMBERS, RESIN. INCLUDE FOR NUMBERS AND PROPERTY CONTROL NUMBERS)

CONTAINER						
	BOX	NO.	LENGTH	WIDTH	HEIGHT	☐ HANFORD STANDARD CARDBOARD
	DRUM	NO. AND SIZE				
	OTHER	NO. AND SIZE				
	TOTAL VOLUME (FT^3)			Gross Weight ____		☐ Pounds ☐ Kilograms

ACTIVITY DESCRIPTION

GENERAL ACTIVITY DESCRIPTION (E.G. LONG-LIVED ISOTOPES SUCH AS Pu, Co, Sr, Cs; MIXED FISSION PRODUCTS; ACTIVATION PRODUCTS)

PLUTONIUM	URANIUM		ACTIVITY (IF PU OR U, ONLY UNITS IN GRAMS REQUIRED)
____ GRAMS	____ GRAMS	____ ENRICHMENT	____ CURIES

DOSE RATE ____ mR/hr at ____ ☐ SURFACE ☐ INCHES ☐ FEET

DISTRIBUTION:

BY SHIPPER		BY ARHCO	
WHITE, YELLOW, PINK	WITH SHIPMENT	WHITE	— S S MH, 222-S
GOLDENROD	— RETAIN	YELLOW	— NUCLEAR MATERIALS, 2704-Z
		PINK	— RETURN TO SHIPPER

54-3000-581 (3-77)

Figure 8-5. Transuranic Dry Waste Storage Form Dated 10/75.

Atlantic Richfield Hanford Company	TRANSURANIC DRY WASTE STORAGE								
NON-COMBUSTIBLE MATERIALS					COMBUSTIBLE MATERIALS				
DRUM NO.	GRAMS PU	MEASUREMENT METHOD	OPERATOR	TRENCH	DRUM NO.	GRAMS PU	MEASUREMENT METHOD	OPERATOR	TRENCH

CERTIFIED BY (SUPERVISOR)	DATE

DISPOSAL SITE:			DISPOSAL SITE:		
AREA	BURIAL GARDEN NO.	TRENCH NO.	AREA	BURIAL GARDEN NO.	TRENCH NO.
CAISSON NO.	COORDINATES NORTH: WEST:		CAISSON NO.	COORDINATES NORTH: WEST:	
REMARKS:			REMARKS:		
SIGNATURE		DATE	SIGNATURE		DATE
DRUMS ARE ACCEPTED PER SOP 100.8			DISTRIBUTION: ALL ACCOMPANY SHIPMENT IF COMPLETED; PINK - TO BE RETURNED; WHITE & YELLOW - WITH SHIPMENT IF NO RETURNED COPY DESIRED.		
SIGNATURE:		DATE:			

BC-6800-075 (10-75)

Figure 8-6. Solid Waste Burial Record - Non-Transuranic Form 54-3000-581, Dated 4/82.

Rockwell Hanford Operations	SOLID WASTE BURIAL RECORD — NON-TRANSURANIC
USE BLACK BALL POINT PEN OR TYPE	SWSDT RECORD NO.:

DISPOSAL SITE — This portion of form to be completed by Rockwell Representative at Disposal site.	ORIGINATOR
Area / Burial Ground No. / Trench No.	End Function - Shipment No.: YX-234-5-7-82-011 / DOE Authorization No. (RRM)
Caisson No. / Beginning Coordinates N ____ W ____	Company: Rockwell
Ending Coordinates N ____ W ____	Building: 234-5Z / Area: 200W
Remarks	Address/Phone: 3-9999
Signature - Acceptance / Date	I certify that no capital property is included in this burial unless documented by a Property Disposal Request, and described below, and that the contents meet RHO-MA-222 requirements and are packaged in Rockwell approved containers per RHO-MA-222.
Accepted Per SOP No.	Signature: [signature] Date: 10-1-82
Signature - Burial / Date	I certify that the waste package description below is complete based on an internally approved inspection system and that the waste package conforms to RHO-MA-222 and the approval authorization. Signature (Independent Reviewer): [signature] Date: 10-1-82
PHYSICAL DESCRIPTION	Method of Inspection/File No.: Spot Check/QC-82-XX

Material Contents: 40% paper, 10% rags-cotton, 4% metal-carbon steel, 10% wood-2x6-7 ft. long, 5% glass-crushed bottles, 5% rubber-hood gloves, 10% plastic-polyethylene, 5% dirt, 5% rock and concrete, 5% roofing material-asphalt, 1% mercury (encased in concrete).

Toxic/Hazardous Materials: Hg

Property Disposal Request No.	Vol. % Combustible	Vol. % Noncombustible
N/A	80	20

Container (All Containers Must be Approved by Rockwell Hanford Operations)	Approval Number(s)	Quantity	55 Gallon Drum	Hanford Standard Fiberboard (18" x 18" x 24")
	HCS-XXX-XX-XXX	4	3	
	Length: 4' / Width: 4'	Height: 7.5'	Diameter:	Material of Construction: carbon steel
	General Description:			

TOTAL VOLUME (FT³): 502.2 | Gross Weight: 10,360 ☒ Pounds ☐ Kilograms | Nuclear Transaction No.: N/A

ACTIVITY DESCRIPTION

General Activity Description (E.G. long-lived isotopes such as Pu, Co, Sr, Cs; mixed fission products, activation products.): 0.8 Ci MFP

Plutonium	TRU other than Pu	
None Grams	None Grams	

Fissile Content	Uranium	Enrichment	Activity (TRU/U - not included) Total Shipment	Max/Container
3.34 Grams	462 Grams	0.722	0.8 Curies	0.3

Dose Rate - Package	Dose Rate - Shipment
100 mr/hr at ____ ☒ Surface ☐ Inches ☐ Feet	100 mr/hr at ____ ☒ Surface ☐ Inches ☐ Feet

DISTRIBUTION: BY SHIPPER — White, Yellow, Pink } With Shipment; Goldenrod - Retain. BY ROCKWELL — White - SWSDT, 2750-E; Yellow - Nuclear Materials, 2704-Z; Pink - Return to Shipper

54-3000-581 (R-4-82)

Figure 8-7. Solid Waste Burial Record - Transuranic, Form 54-3000-623, Dated 4/82.

Rockwell Hanford Operations	SOLID WASTE BURIAL RECORD — TRANSURANIC

USE BLACK BALL POINT PEN OR TYPE

SWSDT RECORD NO.:

DISPOSAL SITE This portion of form to be completed by Rockwell Representative at Disposal site.

Area	Burial Ground No.	Trench No.

Caisson No.	Module No.	Beginning Coordinates	Ending Coordinates
		N ______ W ______	N ______ W ______

Remarks

Signature - Acceptance ______ Date

Signature - Storage Mode ______ Date

Accepted Per SOP No.

ORIGINATOR Check One: [X] Combustible [ ] Non Combustible

End Function - Shipment No.: WH-1572

DOE Authorization No. (RRM):

Company: Westinghouse Hanford Company

Building: 327 Area: 300

Address/Phone: Postirradiation Testing Lab (PITL) Mail Stop: W/A-72 6-5431

I certify that no capital property is included in this burial unless documented by a Property Disposal Request, and described below, and that the contents meet RHO-MA-222 requirements and are packaged in Rockwell approved containers per RHO-MA-222.

L. R. Skrips (signature) Signature — 2-28-83 Date

I certify that the waste package description below is complete based on an internally approved inspection system and that the waste package conforms to RHO-MA-222 and the approval authorization.

M. J. Yeas (signature) Signature (Independent Reviewer) — 2-28-83 Date

Method of Inspection/File No.: Visual/N/A

PHYSICAL DESCRIPTION

Material Contents: One gallon buckets containing hot cell waste products consisting of irradiated fuel pin specimens with Activated SS Alloys. TRU caisson waste. Contents: 40% plastic, 40% metal, 15% cloth, 5% glass. 8 containers.

Vol. % Combustible	Vol. % Noncombustible	Toxic/Hazardous Materials
55	45	N/A

CONTAINER INFORMATION Not WIPP Certified

[ ] 55 Gallon Drum	Approval Number(s)	Material of Construction	Nuclear Transaction No.	Property Disposal Request No.
	78-78-4	metal	RM-2250 & RM-2251	N/A

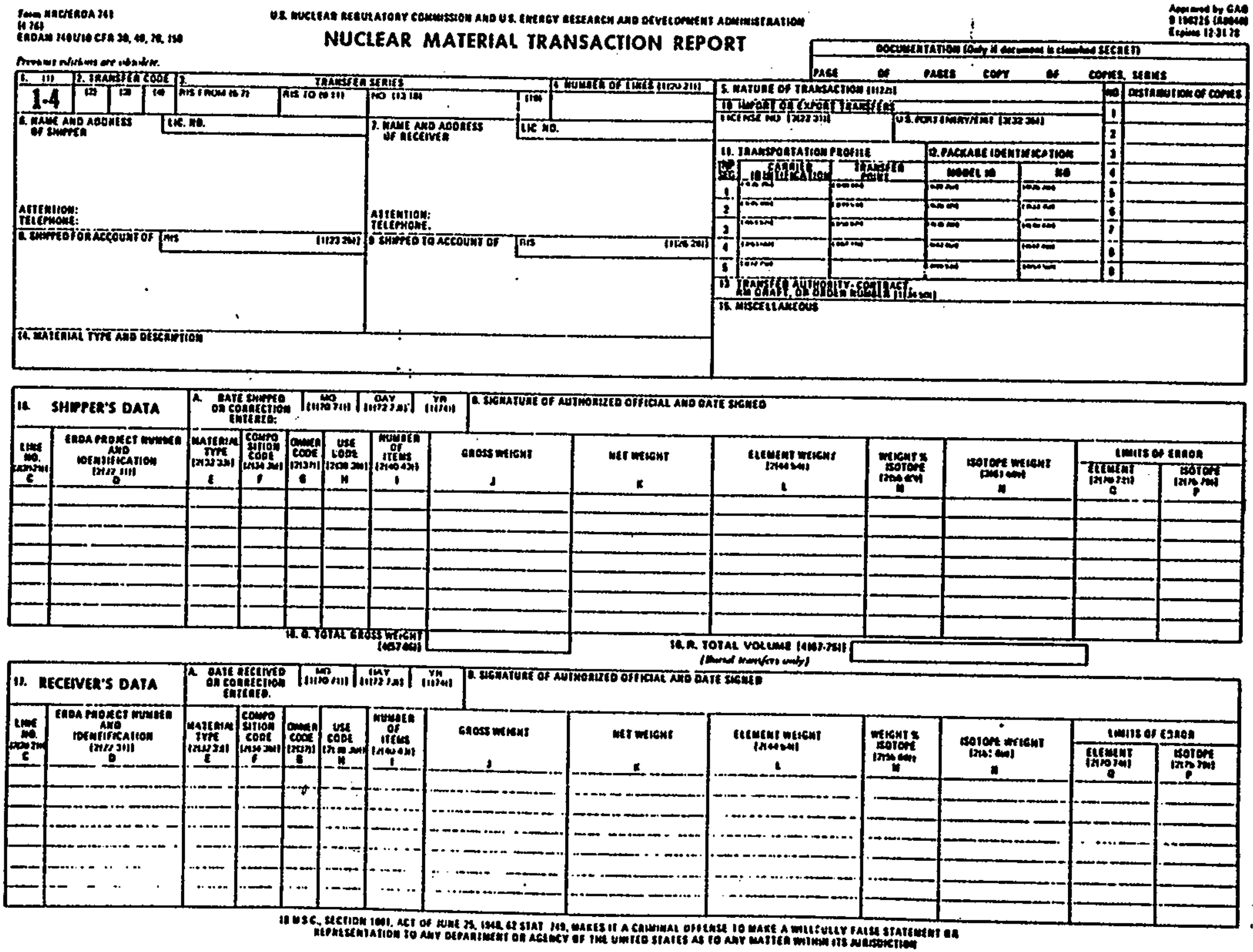
Length	Width	Height	Diameter	Total Volume (m³)	Gross Weight
		7.50"	6.63"	0.035	27 [ ] Pounds [X] Kilograms

Container Number	Measurement Method	Grams: Pu	Grams: U/Enrichment	Grams: Fissile	Grams: TRU	TRU/U - Not Included: Curies (ci)	TRU/U - Not Included: Isotopes	Surface Dose (mrem/hr)	Seal Numbers	Tier
83-073	MBA	2.75	6.99/79	8.27	None	10	Co-60			
83-074	MBA	2.95	6.97/79	8.46	None	22	Co-58			
83-075	MBA	2.95	7.17/79	8.61	None	41	Mn-54			
83-076	MBA	2.75	6.99/79	8.27	None	25	Cr-51			
83-077	MBA	2.75	6.99/79	8.27	None	30	Fe-59			
83-078	MBA	2.68	6.62/.4	2.68	None					
83-079	MBA	2.98	7.03/79	8.53	None					
83-080	MBA	4.99	12.08/37	5.02	None					
			42.18/EU							
			2.13/NU							
			16.53/DU					50		
TOTALS		24.80	60.84	58.11	None	128	Assay Performed By J. D. Yassa			

General TRU or Fissile Activity Description: Pu-238, .05%; Pu-239, 87%; Pu-240, 12%; Pu-241, 1%.

DISTRIBUTION: SHIPPER White, Yellow, Pink } With Shipment; Goldenrod - Retain. ROCKWELL White - SWSDT, 2750E; Yellow - Nuclear Materials, 2704-Z; Pink - Return to Shipper

54-3000-623 (4-82)


Form NRC/ERDA 741 (4-76)
ERDAM 7401/10 CFR 30, 40, 70, 150
Previous editions are obsolete.

U.S. NUCLEAR REGULATORY COMMISSION AND U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

NUCLEAR MATERIAL TRANSACTION REPORT

Approved by GAO
Expires 12-31-78

DOCUMENTATION (Only if document is classified SECRET)
PAGE OF PAGES COPY OF COPIES, SERIES

1. 1-4 | 2. TRANSFER CODE | 3. TRANSFER SERIES: RIS FROM, RIS TO, NO | 4. NUMBER OF LINES
5. NATURE OF TRANSACTION | DISTRIBUTION OF COPIES
6. NAME AND ADDRESS OF SHIPPER, LIC. NO., ATTENTION:, TELEPHONE:
7. NAME AND ADDRESS OF RECEIVER, LIC. NO., ATTENTION:, TELEPHONE:
8. SHIPPED FOR ACCOUNT OF, RIS
9. SHIPPED TO ACCOUNT OF, RIS
10. IMPORT OR EXPORT TRANSFERS: LICENSE NO, U.S. PORT ENTRY/EXIT
11. TRANSPORTATION PROFILE: TRIP SEQ., CARRIER IDENTIFICATION, TRANSFER POINT
12. PACKAGE IDENTIFICATION: MODEL NO, NO
13. TRANSFER AUTHORITY: CONTRACT, AM DRAFT, OR ORDER NUMBER
14. MATERIAL TYPE AND DESCRIPTION
15. MISCELLANEOUS

16. SHIPPER'S DATA
A. DATE SHIPPED OR CORRECTION ENTERED: MO, DAY, YR
B. SIGNATURE OF AUTHORIZED OFFICIAL AND DATE SIGNED

LINE NO. C	ERDA PROJECT NUMBER AND IDENTIFICATION D	MATERIAL TYPE E	COMPOSITION CODE F	OWNER CODE G	USE CODE H	NUMBER OF ITEMS I	GROSS WEIGHT J	NET WEIGHT K	ELEMENT WEIGHT L	WEIGHT % ISOTOPE M	ISOTOPE WEIGHT N	LIMITS OF ERROR: ELEMENT O	LIMITS OF ERROR: ISOTOPE P

16. Q. TOTAL GROSS WEIGHT
16. R. TOTAL VOLUME (Burial transfers only)

17. RECEIVER'S DATA
A. DATE RECEIVED OR CORRECTION ENTERED: MO, DAY, YR
B. SIGNATURE OF AUTHORIZED OFFICIAL AND DATE SIGNED

LINE NO. C	ERDA PROJECT NUMBER AND IDENTIFICATION D	MATERIAL TYPE E	COMPOSITION CODE F	OWNER CODE G	USE CODE H	NUMBER OF ITEMS I	GROSS WEIGHT J	NET WEIGHT K	ELEMENT WEIGHT L	WEIGHT % ISOTOPE M	ISOTOPE WEIGHT N	LIMITS OF ERROR: ELEMENT O	LIMITS OF ERROR: ISOTOPE P

18 U.S.C., SECTION 1001, ACT OF JUNE 25, 1948, 62 STAT. 749, MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

Figure 8-8. Nuclear Material Transaction Report (NRC/ERDA Form 741).

CONTENTS INVENTORY SHEET

(1) Sheet 1 of 1

Container No. (2) Z-83-4-20

Initials (3)	Article Description (4)	Vol. ☐ft³ ☒m³ (5)	Wt. ☐lb ☒kg (6)	Physical Composition of Contents: Noncombustible Material (List Type) (7)	Noncombustible Vol % (8)	Combustible Material (List Type) (9)	Combustible Vol % (10)	Physical Form G - Gas L - Liquid P - Solid Powder S - Solid (11)	Chemical Contents: Chemical Name (12)	DOT Hazard Classification (13)	TRU, U, and Th Content: Isotopes (14)	Grams (15)	Other Radioactive Content: Isotopes (16)	Curies (17)
[illegible]	Rags	.014	4.54			Rags	100	S	None (acid rinsed off)	None	Pu-238 Pu-239 Pu-240 Pu-241 Pu-242 Np-237 Am-241	.01 63.84 3.90 .23 .02 4.0 1.0	Sr-90 Cs-137	10 10
JA	Plastic Bags (for cont. control)	.028	3.18			Plastic	100	S	None	None	None	0	None	0
	Surgeons Gloves	.014	2.27			Rubber	100	S	None	None	Pu-239 (93.88%)	1	None	0
[illegible]	Gasket	<.003	1.81			Neoprene	100	S	Beryllium oxide (trace <1g)	Poison B	Pu-239 Pu-240 Pu-241 U-233 U-235	2.35 .14 .01 3.0 5.0	None	0
[illegible]	Rags	.071	19.05			Rags	100	S	Beryllium oxide (trace <1g)	Poison B	Pu-239 Pu-240 Pu-241 Pu-242 U-233 U-235	12.20 .75 .04 .01 10.0 8	None	0
[illegible]	Plastic Bags (cont control)	.071	8.62			Plastic	100	S	None	None	None	0	None	0
	TOTALS		(18) 39.47		(19)		(20) 100					(21) 115.5		(22) 20

Container Type (23) Galvanized Drum

Container Size (24) 55 Gal.

Begin Loading (25) April 13, 1983

Gross Weight (26) 69

Organic Weight (27) 39.47

Complete Loading/Sealed (28) April 14, 1983

Organic Concentration (Average per Shipment) (31)

(29) Rust C. Zipper
Operations Signature/Date

(30) Ona Coolduda
Independent Reviewer Signature/Date

USE BLACK BALL POINT PEN OR TYPE

BC-6400-131 (N-5-83)

Figure 8-9. Example of the Contents Inventory Sheet Required for TRU Waste Shipments.

Figure 8-10. Example of the WIPP Certification Checksheet Required for Contact-Handled TRU Waste Shipments. (4 sheets)

WIPP CERTIFICATION CHECKSHEET FOR CONTAINER NUMBER (1) Z-83-14

(a)	WIPP Certified Yes (b)	WIPP Certified No (b)	Method of Certification (c)	Operations Signature/Date (d)	Independent Reviewer Signature/Date (e)
I. Waste Container Requirements					
A. WIPP Approved Container.	X		DOT Tests		
B. Purchased or fabricated per approved drawings or specifications.	X		Purchase Inspection		
C. Approved coating, labeling and color coding materials were used.	X		Random Inspection		
D. Heavy, bulky items are blocked or restrained from shifting.	X		Procedure Control		
E. Container free of defects prior to shipment.	X		Visual Insp.		
II. Waste Form Requirements					
A. Immobilization	X		Administrative Control		
B. Free Liquids	X		Procedure Control		

II. A. Immobilization

- [X] No Solid Powders Present

Solid Powder: Size Distribution (wt%)

a. ______ > 200 microns (include solid material)

b. ______ 10 ≤ wt% < 200 microns

c. ______ < 10 microns

- [ ] Immobilized; c > 1% or b+c > 15%, unknown, or could degrade.
- [X] Not immobilized; c ≤ 1% and b+c ≤ 15% or waste will not degrade.

II. B. Free Liquids

- [ ] Liquid-Organic
  - Flashpoint ______
  - [ ] Free (not WIPP Certifiable)
  - [ ] Absorbed
    - Absorbent/Liquid Ratio ______
    - based on [ ] Vol [ ] Wt

BC 6400 132 (N 5 83)

Page 2 of 4

WIPP CERTIFICATION CHECKSHEET FOR CONTAINER NUMBER Z-83-14

(a)	WIPP Certified Yes (b)	WIPP Certified No (b)	Method of Certification (c)	Operations Signature/Date (d)	Independent Reviewer Signature/Date (e)
B. Free Liquids (continued) ☐ Liquid-Nonorganic ☐ ~~Absorbed~~ Absorbent/Liquid Ratio ______ based on ☐ Vol ☐ Wt ☐ Solidified by ______ ☒ None Present					
C. Pyrophoric Material ☒ None Present ☐ Metal Fines Mixed with ______ Vol % of metal fines ______ Ignition temp. of the mixture ______ ☐ Oxidizers Mixed with ______ Vol % of Oxidizer ______ ☐ Pyrophoric forms of Radionuclide Metals Mixed with ______ Wt% of Pyrophoric ______ ; > 1% not acceptable	X		Admin. Control		
Organic peroxides and flammable solids, except metal fines, are not present.	X		Admin. Control		
D. Explosives; or compressed gases, > 7 psig, are not present.	X		Admin. Control		
E. Toxic Material Poison A and Poison B – Reportable quantities ☒ No ☐ Yes - Color code	X		Admin. Control		
F. Corrosive Material ☐ Liquids pH ______ ; > 4.0 not acceptable	X		Procedure Control		
☒ Contents within the container will not react with each other and will not create internal pressurization above 7 psig	X		Admin. Control		

BC-6400-132 (N-6-83)

Figure 8-10. Example of the WIPP Certification Checksheet Required for Contact-Handled TRU Waste Shipments. (4 sheets)

WIPP CERTIFICATION CHECKSHEET FOR CONTAINER NUMBER Z-83-14

(a)	WIPP Certified Yes (b)	WIPP Certified No (b)	Method of Certification (c)	Operations Signature/Date (d)	Independent Reviewer Signature/Date (e)
F. Corrosive Material (continued)					
[X] One of the following: [X] Contents will not readily react with the storage (outer) container; [ ] Contents are readily reactive with the storage (outer) container but are packaged as follows to assure >25 year life ______	X		Admin. Control		
G. Combustibility: Waste package contains > 25% combustibles [X] Yes - Color code [ ] No	X		Admin. Control		
III. Waste Package Requirements					
A. Weight: >11,300 kg	X		Weighed		
≥ Type A gross weight limit of 657 kg	X		Weighed		
B. Nuclear Criticality: [X] ≤200g for 55-gal drum [ ] ≤350g for 4' x 4' x 7' [ ] ≤600g for DOT 6M [ ] ≤5g/cu. ft. for other container. [ ] Special criticality analysis with a Fissile limit of ______	X		Counting and Inventory Control Procedures		
C. Surface Dose Rate: ≤200 mrem/hr at any point	X		Survey		
D. Surface Contamination: 50 pCi/100 sq. cm. for alpha (≤50 pCi/100 sq. cm. is acceptable)	X		Smear		
450 pCi/100 sq. cm. for beta gamma (≤450 pCi/100 sq. cm. is acceptable)	X		Smear		
E. Thermal Power: [X] ≤0.1 watt/cu. ft. [ ] ______ watt/cu. ft.	X		Calculations		

BC-6400-132 (N-5-83)

Figure 8-10. Example of the WIPP Certification Checksheet Required for Contact-Handled TRU Waste Shipments. (4 sheets)

Page 4 of 4

WIPP CERTIFICATION CHECKSHEET FOR CONTAINER NUMBER Z-83-4-14

(a)	WIPP Certified Yes (b)	WIPP Certified No (b)	Method of Certification (c)	Operations Signature/Date (d)	Independent Reviewer Signature/Date (e)
F. Gas Generation	X		Admin. Control		
Organic Content Concentration: 11.76 ☒ lb/cu. ft. ☐ g/cu. m.; ☒ ≤ 22 lb/cu. ft. for 55 gal drum; ☐ ≤ 10 lb/cu. ft. for other containers					
G. Color Coding — Applied Correctly for:					
☐ Surface Dose Rate		X			
☐ Toxics		X			
☐ Combustibles		X			
H. Labeled Correctly	X		Visual Insp.		

The described waste package is unclassified and meets all of Rockwell WIPP certification criteria except for the following:

(2)

(3) Ben E. Factor — Operations Signature (4) 6/21/83 — Date (5) Magdalena Montezuma — Independent Reviewer (6) 6/21/83 — Date

INSTRUCTIONS FOR WIPP CERTIFICATION CHECKSHEET

Block No. 1. The waste generator assigned number for the container.

Column a. These are criteria statements. Check all appropriate boxes and fill in the appropriate information. Specific criteria are in HS-BS-0012.

b Indicate whether the waste package is WIPP certifiable or not. There must be a yes or no entry made for each criteria statement (i.e. each line).

c. Indicate the method of certification used for each criteria statement.

d. Use as desired.

e. Use as desired.

Block No. 2. Fill in criteria for which a "no" appeared in column b.

3. Signature of packager or authorized representative.

4. Date Signed

5. Signature of Independent Reviewer.

6. Date Signed

DISTRIBUTION: White - With Shipment - SWPDU, 2750E
Yellow - Retain

USE BLACK BALL POINT PEN OR TYPE

BC-6400-132 (N-6 83)

Figure 8-10. Example of the WIPP Certification Checksheet Required for Contact-Handled TRU Waste Shipments. (4 sheets)

The TRU and Non-TRU waste storage and burial record forms were modified over the next six years, and, in 1984, the SWBR Non-TRU was renamed the *Solid Waste Burial Record - Low Level.* Examples of the SWBR-LL and the SWSR-TRU from the 1985-86 time period are shown in Figures 8-11 and 8-12, respectively. The *WIPP Certification Checklist* was also simplified and shortened to one page in the mid-1980's. See Figure 8-13.

In response to the DOE mixed byproduct ruling in 1987, Hanford required that burial and storage records for MW be accompanied by the EPA's *Uniform Hazardous Waste Manifest*. This form is shown in Figure 8-14. This requirement has remained in effect to the present, although it has been augmented with the *Radioactive Mixed Waste Attachment Sheet* (Figure 8-15) since 1991.

As a result of the change in site management from RHO to WHC, the SWBR-LL and the SWSR-TRU were combined to create one *Solid Waste Storage/Disposal Record* (SWSDR) in 1988. This form, which is shown in Figure 8-16, was replaced by two specialized forms again in 1991. These two forms, the *Low-Level Waste Storage/Disposal Record* (Figure 8-17) and the *Transuranic Waste Storage Record* (Figure 8-18), are currently still in use.

Most recently, two supplementary forms have been devised for special waste forms. The first, the *Difficult Waste Information Sheet*, is shown in Figure 8-19. The second, the *Hazardous/Mixed Waste Debris Determination Checklist*, is designed to make a preliminary determination of whether the waste generated is land disposal prohibited hazardous or mixed debris waste. This checklist is shown in Figure 8-20.

In addition to the formal waste storage and disposal records discussed above, various waste acceptance criteria documents have required supplementary data be supplied by waste generators. This information includes shipping papers, waivers, rigging details for packages, documentation of surface dose rates and LLW category, and other pertinent data. Table 8-1 lists these requirements. Microfilmed copies of Solid Waste storage and burial records and their supporting documents, for waste shipments dating form 1968 to the present, are archived by the WHC Solid Waste Program.

8.2 WASTE ACCEPTANCE DOCUMENTATION

In addition to the records required from the generators at the time of the waste shipment, various documents were required to be completed prior to shipping the waste to Hanford's storage and disposal facilities. A formal request to store/dispose of waste was generally the first document generated by a new waste shipper. In 1991, this request was standardized with the *Waste Storage/Disposal Request* form shown in Figure 8-21. Beginning in 1982, each request for storage/disposal was followed with a *Burial Compliance Checksheet* (BCC). Approval of this checksheet was required prior to the shipment of waste. One BCC was required for each type of waste being shipped. A BCC is shown in Figure 8-22.

In 1988, the BCC was replaced by the *Storage and Disposal Approval Form*. This form, shown in Figure 8-23, is still in use. A hard copy file of BCC's and SDARs is maintained by the WHC Solid Waste Program.

Figure 8-11. Solid Waste Burial Record-Low Level Dated 1986.

Rockwell Hanford Operations	SOLID WASTE BURIAL RECORD – LOW LEVEL

USE BLACK BALL POINT PEN OR TYPE — SWBR NO. 1 (DO NOT WRITE IN THIS SPACE)

DISPOSAL SITE — This portion of form to be completed by Rockwell Representative at Disposal site.

Area	Burial Ground No.	Trench No.
30	31	32

Caisson No.	Beginning Coordinates	Ending Coordinates
33	N ____ W ____ 34	N ____ W ____ 35

Remarks: 36

Signature - Acceptance: 37 — Date

Signature - Burial: 38 — Date

WASTE GENERATOR: 2

Charge Code	DOE Authorization No. (RRM)
3	4

Address/Phone: 5

I certify that: 1. No capital property is included in this burial unless documented by a Property Disposal Request and described below. 2. The waste package description below is complete and the waste package conforms to RHO-MA-222 and the approved Burial Compliance Checksheet (BCC). 3. The charge code is correct.

6 ____ Signature ____ Date

WASTE DESCRIPTION

COMBUSTIBLE MATERIALS		NONCOMBUSTIBLE MATERIALS	
Paper Products	%	Glass	%
Plastic	%	Concrete	%
Cloth	%	Stainless Steel	%
Rubber	%	Other Metals	%
	%		%
	%		%
	%		%
	%		%
Total	%	Total	%

CONTAINER INFORMATION

Quantity & Name 7 ____ 55 Gallon Drums ____ Hanford Standard Fiberboard Boxes (18" x 18" x 24")

____ Other: ____

BCC Approval Number	Dose Rate - Package
8	____ mrem/hr at ____ 9

Diameter or Length x Width	Height
10	11

Material of Construction: 12

Nuclear Transaction No.	Property Disposal Request No.
13	14

Total Volume 15 ____ Gross Weight ____ 16 ☐ Pounds ☐ Kilograms

HAZARDOUS/CORROSIVE CONSTITUENTS

Name	Quantity (Lb or Kg)

WASTE CATEGORIES: 17
☐ BW ☐ OS
☐ CE ☐ SS
☐ DD ☐ NC

Thermal Power: 18
☐ 0.1 w/ft^3 or less
____ Other

REMARKS

29

RADIOACTIVE MATERIAL CONTENT

TRANSURANIC AND URANIUM			NONTRANSURANIC	
Element	Isotopic Distribution (Wt %)	Total Element Weight	Isotope	Grams or Curies
21	22	23	24	25
Totals		26		26

Measurement Method:	Determined By:
27	28

DISTRIBUTION: White - SWPOU 2750-E/200 E
Canary - 17S 272-W/200 W
Pink - Return to Shipper 200-W

54-3000-501 (7-85)

Figure 8-12. Solid Waste Storage Record - Transuranic Dated 1985.

Rockwell Hanford Operations | **SOLID WASTE STORAGE RECORD — TRANSURANIC**

USE BLACK BALL POINT PEN OR TYPE | Container Number 2 | SWSR NO. 1 DO NOT WRITE IN THIS SPACE

STORAGE SITE This portion of form to be completed by Rockwell Representative at Storage Site.

Area	Burial Ground No.	Trench No.
33	34	35

Caisson No.	Module No.	Beginning Coordinates
36	37	39 N ______ W ______
	Tier 38	Ending Coordinates 40 N ______ W ______

Remarks 41

Signature - Acceptance 42 | Date

Signature - Storage Mode 43 | Date

WASTE GENERATOR: 3

Charge Code 4

Address/Phone 5

I certify that: 1. No capital property is included in this burial unless documented by a Property Disposal Request and described below.
2. The waste package description below is complete and the waste package conforms to RHO-MA-222 and the approved Burial Compliance Checksheet (BCC).
3. The charge code is correct.

6
Signature ______ Date ______

WASTE DESCRIPTION 20

COMBUSTIBLE MATERIALS	%	NONCOMBUSTIBLE MATERIALS	%
Paper Products	%	Glass	%
Plastic	%	Concrete	%
Cloth	%	Stainless Steel	%
Rubber	%	Other Metals	%
	%		%
	%		%
	%		%
	%		%
Total	%	Total	%

HAZARDOUS/CORROSIVE CONSTITUENTS 21

Name	Quantity (KG)

CONTAINER INFORMATION

NAME 7 ☐ 55 Gal Drum Other:

BCC Approval Number	Surface Dose (mrem/hr)
8	9 Total ______ Neutron ______
Diameter or Length x Width 10	Height 11
Nuclear Transaction No. 12	Property Disposal Request No. 13
Total Volume 14 M^3	Gross Weight 15 Kilograms

WASTE CATEGORIES: 16
☐ BW ☐ DS
☐ CE ☐ SS
☐ DD ☐ NC

Organic Material Vol. % 17

Organic Material Wt. (KG) 18

Thermal Power 19
☐ 0.1 watts/ft³ or less
______ Other (watts/ft³)

RADIOACTIVE MATERIAL CONTENT

TRANSURANIC AND URANIUM						NONTRANSURANIC	
Element	Isotopic Distribution (Wt %)	Total Element Weight	Total Alpha Curies	Pu-239 Fissile gram equiv.	PE - Ci	Isotope	grams or Curies
22	23	24	25	26	27	28	29
TOTALS		30	30	30	30		30

Measurement Method: 31 | Determined by: 32

DISTRIBUTION: White - SWPOU, 2750E
Canary - TFS, 272W/200W
Pink - Return to Shipper

54-3000-823 (7-85)

Figure 8-13. WIPP Certification Checklist, Modified 1986.

WIPP CERTIFICATION CHECKLIST

CONTAINER NUMBER ____1____ DATE CONTAINER SEALED ____2____

YES	NO		WASTE ACCEPTANCE CRITERIA
☐	☐	3	DOT Type A Container.
☐	☐	4	Heavy or bulky items are blocked to prevent shifting.
☐	☐	5	Container is free of defects.
☐	☐	6	Waste contains less than 1% by weight powders.
☐	☐	7	Waste does not contain any free liquids.
☐	☐	8	Waste does not contain any explosives or compressed gases.
☐	☐	9	Waste does not contain any organic peroxides, oxidizers, flammable solids or metal fines.
☐	☐	10	Waste does not contain any sludges with pH < 4.0.
☐	☐	11	Waste contents will not react with each other or with container.
☐	☐	12	Surface contamination is < 50 pCi (100 dpm) / 100 sq cm alpha and < 450 pCi (1000 dpm) / 100 sq cm beta-gamma.
☐	☐	13	Proper labeling has been applied.
☐	☐	14	Hazardous and corrosive co-contaminants are identified on Contents Inventory Sheet.
☐	☐	15	Gross weight is less than qualified DOT Type A limit (kg)
☐	☐	16	Pu-239 Fissile Gram Equivalent content is less than WIPP specified limit (g)
☐	☐	17	Pu-239 equivalent TRU activity (PE-Ci) is less than the WIPP specified limit of 1000 PE-Ci.
☐	☐	18	Surface dose rate is < 200 mrem/hr (beta, gamma and neutron) at any point.
☐	☐	19	Neutron dose rate contribution is < 50 mrem/hr

The waste package described above is unclassified and meets all WIPP Waste Acceptance Criteria

20 ☐ With no exceptions
☐ With the following exceptions:

____

____

____

____

____

____

____

21 ____________________ 22 ____________________

Plant Operations Authority signature and date | Independent Reviewer signature and date

White - SWP&OU, 2750E, 200-E
Yellow - TFO, 272WA, 200-W
Pink - Retain, Shipper

BC-6400-132 (7-86)

Figure 8-14. Uniform Hazardous Waste Manifest.

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039 Expires 9-30-91

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No | Manifest Document No. | 2. Page 1 of | Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address

A. State Manifest Document Number

B. State Generator's ID

4. Generator's Phone ( )

5. Transporter 1 Company Name | 6. US EPA ID Number

C. State Transporter's ID

D. Transporter's Phone

7. Transporter 2 Company Name | 8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9. Designated Facility Name and Site Address | 10. US EPA ID Number

G. State Facility's ID

H. Facility's Phone

GENERATOR

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	HM	12. Containers No.	12. Containers Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.						
b.						
c.						
d.						

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name | Signature | Month Day Year

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Month Day Year

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name | Signature | Month Day Year

Style F15REV-6 LABELMASTER, Div. of AMERICAN LABELMARK CO., CHICAGO, IL 60646

EPA Form 8700-22 (Rev. 9-88) Previous editions are obsolete.

Figure 8-15. Radioactive Mixed Waste Attachment Sheet.

RADIOACTIVE MIXED WASTE ATTACHMENT SHEET (REV 2, 6/24/93)			1. Page ___ of ___
2. PIN	3. Manifest No.		4. Manifest Date
5. ☐ Land Disposal Restricted ☐ Debris	Source of Restriction ☐ RCRA, ☐ F-Listed, ☐ EHW		6. Waste Designation ☐ EHW ☐ DW
Dose Equivalent Curies if applicable.			
8. Waste numbers that apply to this package. ________			

WASTE DESCRIPTION		
9. Hazardous Constituent	10. Weight (kg)	11. Physical Properties
TOTAL WEIGHT (Kg)		
12. Estimated Liquid Volume (Liters)		

Figure 8-16. Solid Waste Storage/Disposal Record.

SOLID WASTE STORAGE/DISPOSAL RECORD

8 Page 1 of ________

Storage/Disposal Site

I certify that a physical inspection of the waste packages to the extent possible and a cross-check of the applicable documentation have been performed in accordance with TO-100-050 or TO-100-110

2. Signature – Acceptance | Date

3. Area | 4 Facility | 5 Unit

6 Storage Location (S01)

Module | Tier | Position

7. Disposal Location (D81)

Beginning Coordinates N W

Ending Coordinates N W

9 Waste Designation ☐ TRU ☐ LLW ☐ MW ☐ C+ ☐ Classified

1 SWSDR No. (DO NOT WRITE IN THIS SPACE)

10 Waste Generator

11 Charge Code, SO No , or MPO No

12. WRM No

13. Name of Contact *(Type or Print Clearly)*

14 Address/Phone

I certify that: (1) No capital property is included in this waste unless documented by a Property Disposal Request and described below (2) To the best of my knowledge, the information entered below is complete and accurate, and the waste package is in compliance with WHC-EP-0063 and the Storage/Disposal Approval Record (SDAR) (3) Unless designated as Mixed Waste (MW), this waste is not a dangerous waste as defined by Chapter 173-303 WAC or other applicable state or federal regulation governing the management of hazardous waste (4) The charge code is correct.

15. Signature | Date

WASTE PACKAGE INFORMATION

16. PIN	17. POINT OF ORIGIN
18. CONTAINER TYPE	19. L x W x H OR D x L
20. CONTAINER VOLUME (m³)	21. EMPTY TARE WEIGHT OF CONTAINER (kg)
22. DATE PACKAGED	23. GROSS WEIGHT (kg)
24. THERMAL POWER ☐ <0.1 W/ft³	25. ORGANIC MATL. VOL % / 26. ORGANIC MATL. WT. (kg)
27. Dose Rate (mrem/hr) at	NEUTRON (>20 mrem/hr)

28. Physical Description of Waste and Comments

REFERENCES

29. DOE/NRC 741 NO.	30. RSR NO. (HANFORD ONSITE WASTE GENERATORS ONLY)
31. PROPERTY DISPOSAL REQUEST NO.	32. SDAR NO.

33. WASTE CATEGORY (CHECK ONE)

☐ BW ☐ CE ☐ DO ☐ DS ☐ SS ☐ NC

34. WASTE CODE (CHECK ONE)

☐ FW ☐ HM ☐ CL ☐ WD ☐ SL ☐ GL ☐ CM ☐ TW ☐ DM ☐ SO ☐ PB ☐ NC ☐ LM ☐ PA

WASTE CONTENTS DESCRIPTION

35. WASTE DESCRIPTION	36. VOLUME %	37. WEIGHT (kg)
TOTALS		

39. LAND DISPOSAL RESTRICTED ☐ SOURCE OF RESTRICTION F-LISTED ☐ RCRA ☐ WASHINGTON STATE EHW ☐

38 FISSION/ACTIVATION RADIONUCLIDES *(Do not include Uranium, Thorium, or TRU elements)*

RADIONUCLIDE	Ci	RADIONUCLIDE	Ci
		TOTAL	

40. TRU/FISSILE/SOURCE MATERIAL *(Uranium, Thorium, and TRU elements)*

40a. ELEMENT	40b. ISOTOPIC DISTRIBUTION (Weight %)	40c. WEIGHT (g)	40d. U235–FGE	40e. Σ Ci	40f. ALPHA Ci
	TOTALS				

(40d–40f: TRU WASTE ONLY)

White - Solid Waste Engineering (R2 82) Yellow - Solid Waste Operations Pink Return to Shipper Goldenrod Retained by Shipper 54-6000-226 (09 90)

Figure 8-17. Low-Level Waste Storage/Disposal Record.

LOW-LEVEL WASTE STORAGE/DISPOSAL RECORD (REV 2, 5/25/93)

8. PAGE 1 OF ______

Storage/Disposal Site Information

I certify that a physical inspection of the waste package to the extent possible and a cross check of the applicable documentation have been performed in accordance with SW-100-050 or SW-100-110.

1. Signature-Acceptance		2. Date
3. Area	4. Facility	5. Unit
6. Storage Location (S01)		
Module	Tier	Position
7. Disposal Location		
Beginning Coordinates N	W	
Ending Coordinates N	W	

REFERENCES

16. RSR No	17. SDAR No.
18. DOE/NRC 741 No.	19. PDR. No.

9. PIN

10. Waste Generator

11. Charge Code, SO No., or MPO No.

12. WRM No.

13. Name of Contact

14. Address/Phone

I certify that. (1) No capital property is included in this waste unless documented by a Property Disposal Request and described below. (2) To the best of my knowledge, the information entered below is complete and accurate, and the waste package is in compliance with WHC-EP-0063 and the Storage/Disposal Approval Record (SDAR). (3) Unless designated a Radioactive Mixed Waste (RMW), this waste is not a dangerous waste as defined by WAC 173-303 or other applicable state or federal regulation governing the management of hazardous waste. (4) The charge code is correct.

15. Signature | Date

20. Waste Designation ☐ Category 1 ☐ Category 3 ☐ >Category 3 ☐ RMW ☐ Classified

21. Point of Origin	
22. Container Type	23. LxWxH or DxL
24. Cont. Vol: (m^3)	25. Tare Weight (kg)
26. Date Packaged	27. Gross Weight (kg)

30. Waste Category (Check One)
☐ BW ☐ DS
☐ DD ☐ NC
☐ CE ☐ SS

31. Waste Code (Check one)
☐ FW ☐ HM ☐ CL ☐ WD
☐ SL ☐ GL ☐ CM ☐ TW
☐ DM ☐ SO ☐ PB ☐ NC
☐ LM ☐ PA

28. Thermal Power ______ ☐ <0.1 W/ft³

29. Dose Rate (mrem/hr) ______ at ______

32. Seal No.

WASTE CONTENTS DESCRIPTION

33. Article Description	34. Estimated Volume %	35. Est. Weight (kg)	36. Radio-nuclide	37. Curies (Fission/Activation Products only)	38. Weight (g) (TRU, Uranium, and Thorium only)
39. TOTAL			TOTAL		

Figure 8-18. Transuranic Waste Storage Record (1993).

TRANSURANIC WASTE STORAGE RECORD (REV 1, 1/15/93)

7. PAGE 1 OF ______

Storage/Disposal Site Information

I certify that a physical inspection of the waste package to the extent possible and a cross check of the applicable documentation have been performed in accordance with SW-100-050 or SW-100-110.

2. Signature-Acceptance		2. Date
3. Area	4. Facility	5. Unit
5. Storage Location (S01)		
Module	Tier	Position

8. Waste Designation ☐ RMW ☐ Classified

9. Waste Generator

10. Charge Code, SO No., or MPO No.

11. WRM No.

12. Name of Contact

13. Address/Phone

I certify that. (1) No capital property is included in this waste unless documented by a Property Disposal Request and described below. (2) To the best of my knowledge, the information entered below is complete and accurate, and the waste package is in compliance with WHC-EP-0063 and the Storage/Disposal Approval Record (SDAR). (3) Unless designated a Radioactive Mixed Waste (RMW), this waste is not a dangerous waste as defined by WAC 173-303 or other applicable state or federal regulation governing the management of hazardous waste. (4) The charge code is correct.

14. Signature   Date

REFERENCES

15. RSR No	16. SDAR No.
17. DOE/NRC 741 No.	18. PDR. No.

WASTE PACKAGE INFORMATION

19. PIN	20. Tare Weight (kg)
21. Container Type	22. Gross Weight (kg)
23. Organic Mtl. Vol. %	24. Point of Origin,
25. Organic Mtl. Wt. (kg)	26. LxWxH or DxL
27. Cont. Vol. (m^3)	28. Thermal Power ☐ <0.1 W/ft^3
29. Date Packaged	30. Seal Number

31. Waste Category (Check One)
☐ SW ☐ DS
☐ DD ☐ NC
☐ CE ☐ SS

32. Waste Code (Check one)
☐ FW ☐ HM ☐ CL ☐ WD
☐ SL ☐ GL ☐ CM ☐ TW
☐ DM ☐ SO ☐ PB ☐ NC
☐ LM ☐ PA

WASTE CONTENTS DESCRIPTION

33. Article Description	34. Est. Vol. %	35. Est. Wt. (kg)
Total Liquid Volume (Liters) ______ TOTALS		

FISSION/ACTIVATION NUCLIDES (Do not list Uranium, Thorium, or TRU Elements)

36. Nuclide	37. Curies	Nuclide	Curies
		TOTAL	

TRU/FISSILE/SOURCE MATERIAL (Uranium, Thorium and TRU Elements)

38. Element	39. Isotopic Distribution	40. Wt. (g)	41. FGE	42. PE-Ci	43. Alpha Ci
44. Dose mrem/hr) ______ at ______ Neutron (> 20 mrem/hr) ______	TOTALS				

DIFFICULT WASTE INFORMATION SHEET (DFWIS)REV1

GENERATOR , #______________ DIFFICULT WASTE (DFW) PIN#______________

Generator must answer the following questions to the best of their knowledge. A "Y" or "?" answer to any of the questions will require action by the generator, see the fine print below each question to determine the action. A DFWIS must be completed for each DFW package which is to be shipped to interim storage. If any questions are encountered during this process, please contact Generator and Waste Acceptance Services (GWAS) Send the completed DFWIS forms with CC:Mail form variances provided by the GWAS to D. L. Allen, T3-05.

WASTE CHARACTERISTICS	YES(Y), NO(N), UNKNOWN(?)	INITIAL
1. Does the waste contain any prohibited material? Prohibited materials include: • Etiologic Agents (49 CFR 173.386) • Chemically incompatible materials in any waste container (40 CFR 265.313) • Explosives (10 CFR 61.56) • Pyrophorics (10 CFR 61.56) • Gas cylinders that are not permanently vented		
2. Does the container violate any of the following requirements? Shipping Container ______________ Gross Weight ______ lbs or kg • Containers MUST be in good condition with no visible cracks, holes, bulges, severe corrosion, or other damage that could compromise integrity. Any containers that are bulged, severely corroded, or otherwise damaged shall not be used and the waste must be repackaged or overpacked in a container meeting the criteria in this section. • Containers shall not be used for shipment or storage of wastes that could react with or degrade the container or liner by physical, chemical, or radiological mechanisms. • All containers shall be either metal, composite, or wood and shall be fire retardant. • If Container does not meet DOT shipping requirements, contact GWAS.		
3. Is dose rate of package > 100 mrem/hr at any point? Dose Rate ______ mrem/hr TI Dose Rate(For Type A and Greater only)______ The maximum surface-radiation dose rate shall not exceed 100 mrem/hr at any point. If the dose rate exceeds the limit, the package shall have to be shielded down to the acceptable limit.		
4. Are any liquids present in the waste? Is the container properly labeled for these liquids? Double containment is required for all containers containing liquids. If the container does not have double containment, overpack the container (contact GWAS for assistance), absorbent shall be placed in the annulus. "This end up," or directional arrows will be marked on the sides and near the top to indicate proper package orientation for packages containing inner containers of liquids. "LIQUID ORGANIC WASTE" shall be marked on the side of each drum containing free organic liquids in inner containers		

5. Give as complete of a description as possible of the contents of the waste package.

(Check One)LLW______ LLMW______ TRU______ TRU-Mixed______, Does this waste contain aerosol containers? ______

Physical Description:______________

____

Radionuclides:______________

Total Curies:______________Is the waste greater than Type A______________Point of origin:______________

Have samples been taken, if so when?

6. Does the waste exceed these surface contamination limits? Removable contamination on the exterior surfaces of all waste packages shall not exceed the following limits: • 220 dpm/100 cm^2 for alpha contamination • 2,200 dpm/100 cm^2 for beta-gamma contamination.		
7. Does the waste package exceed the nuclear criticality limits? • The total fissile content of any one container will not exceed 15 grams. • If this limit is exceeded, contact GWAS for further instructions.		

Figure 8-19. Difficult Waste Information Sheet. (3 sheets)

GENERATOR PIN #________________ DIFFICULT WASTE (DFW) PIN#________________ PAGE 2 OF 3

WASTE CHARACTERISTICS	YES(Y); NO(N); UNKNOWN(?)	INITIAL
8. Is this waste TRU, If so what is the PE-Ci content? PE-Ci Content ________ If the curie content is not known or cannot be determined from the dose rate, contact GWAS for further instructions.		
9. Does a potential exist for gas generation? If the potential exists for gas generation, contact GWAS for assistance.		
10. Is the flashpoint of the waste ≤ 140 °F? Flashpoint ________ °F If the flashpoint is less than 100 °F, the container shall be labeled with a DOT Flammable Liquid label. If the flashpoint is unknown, the container will be labeled with a "Flashpoint < 100 °F" marking and DOT Flammable label and D001 waste code on the Hazardous Waste Sticker. If the flashpoint is ≤ 140°F, mark flashpoint or flashpoint range ("Flashpoint < 100°F" or "Flashpoint > 100°F and < 140°F") on container and D001 waste code on the Hazardous Waste Sticker.		
11. Is the waste corrosive? If the waste is corrosive, or it is unknown if the waste is corrosive, label the container with a DOT Corrosive label, "pH < 2" marking, or "pH > 12.5" marking (only if known), and a D002 waste code on the Hazardous Waste Sticker.		
12. Is the waste potentially Listed? If the waste is U/P-Listed, F-Listed or potentially F-Listed, label the appropriate code(s) on the Hazardous Waste Sticker.		
13. Are PCB's present in the waste? If PCB's are present, label the drum with the appropriate "PCB" sticker, mark the PCB concentration or concentration range on the container, and apply the applicable waste codes. Indicate PCB concentration or concentration range ________ ppm If concentration or range is unknown and PCBs are suspected, contact GWAS.		
14. Are any of the following present in the waste? (check one, if applicable) ____OXIDIZER ____POISON ____FLAMMABLE SOLID ____PIH If the waste contains Poisons, flammable solids, or oxidizers, label the drum		
15. Does the waste exhibit any of the Washington State characteristics of toxicity, persistence, or carcinogenicity? If any of these waste codes are known, include these waste codes on the Hazardous Waste Sticker and label container as required by CHAPTER 173-303 WAC.		
16. Is the waste Extremely Hazardous Waste (EHW)? If the waste is EHW or if the waste class is unknown, label the container with a "MW-EHW" marking.		
17. Is the waste reactive? If the waste is reactive or it is unknown if the waste is reactive, contact GWAS for further instructions.		
18. Does the package require additional labeling and marking? The packages shall be labeled or marked with the following: • Point of origin • DFW PIN # assigned by GWAS • DOT Radioactive Label as specified by PSN • Gross weight in pounds or kilograms • "Bottom Tier Only" (for drums weighing 1,000 lb or greater) • Hazardous Waste marking with PSN and waste codes (if applicable) • Other hazard marking and labels as applicable		

Figure 8-19. Difficult Waste Information Sheet. (3 sheets)

GENERATOR . . # ____________ DIFFICULT WAS.. (DFW) PIN# ____________ PAGE 3 OF 3

WASTE CHARACTERISTICS	YES(Y), NO(N), UNKNOWN(?)	INITIAL

19. CHEMICAL INFORMATION

Chemical Constituents(if known) ____________

Proper Shipping Name(RQ?) ____________ Hazard Class ____________ UN/NA# ____________

Waste Codes(if known) ____________

List GWAS attachment Control Numbers ____________

Placards Required ____________

GENERATOR CERTIFICATION

I hereby declare that the contents are fully and accurately described above by proper shipping name and are classified, packed, and labeled (per WAC 173-303-070), and are in all respects in proper condition for transport according to state and federal regulations to the best of my knowledge.

PRINTED/TYPED NAME ____________ SIGNATURE ____________ DATE ____________

GENERATOR AND WASTE ACCEPTANCE SERVICES

This container shall be placed in ____________ DE-Ci Content ____________

Generator and Waste Acceptance Services (signature/date) ____________ Charge Code ____________

PRE-SHIPMENT INSPECTION CERTIFICATION

I hereby confirm that this Difficult Waste package meets the Difficult Waste acceptance criteria based upon the information provided above by the generator.

Hazardous Materials Operations (signature) ____________ Date ____________

Solid Waste Management (signature) ____________ Date ____________

RECEIPT AND STORAGE VERIFICATION

The Difficult Waste package has been received at interim storage by Solid Waste Management and placed in the appropriate facility as specified in the Generator and Waste Acceptance Services section of this document

(signature/date) ____________ Location ____________

Figure 8-19. Difficult Waste Information Sheet. (3 sheets)

Figure 8-20. Hazardous/Mixed Waste Debris Determination Checklist. (2 sheets)

NOTE. Completion of this form makes a preliminary determination of whether the waste generated is land disposal prohibited hazardous or mixed debris waste. The preliminary determination will be verified during the preparation of a Storage/Disposal Approval Record (SDAR) or Hazardous Waste Disposal Analysis Record (HWDAR). In evaluating the waste, consider the bulk of the waste stream (and not the container it is packaged in) rather than minor components. However, if minor components exist like those in Section 3.0, please note these in the comments section. When completing this checklist, use the best information available. Physical measurements or inspections are not necessarily required.

WASTE CHARACTERISTICS	Yes (Y) No (N) Unknown (UN)
1.0 Determine if the waste is dangerous or mixed waste.	
1.1 Is the waste a EPA hazardous or Washington State dangerous waste? If it is known to possess hazardous or dangerous constituents, then answer yes. If it is known to not possess hazardous or dangerous constituents, then answer no. Otherwise, answer unknown.	
If the answer is no to question 1.1, then the waste is not hazardous or mixed waste and the preparer is finished with this checklist. Go to box 4.0. If yes or unknown, then continue.	
2.0 Determine if the waste is a material that is not debris.	
2.1 Is the waste a liquid or gas? If the material requires a container to maintain its shape at room temperature, it considered a gas or liquid.	
2.2 Is the waste a process waste? Process wastes are incinerator ash, water treatment sludges, slag, vitrified material, air emission residues, and residues from the treatment of waste.	
2.3 Is the waste soil or fine-grained material? Soil, clay, absorbents, or any other fine-grained material that may be agglomerated or compacted to hold its shape.	
2.4 Is the waste cement that has been used to stabilize waste?	
2.5 Is the waste intact containers? Intact containers are defined as unruptured and able to contain at least 75 percent of original volume capacity.	
2.6 Does the waste possess a specific treatment standard? The EPA has promulgated treatment standards found in 40 CFR parts 268.41, 268.42, or 268.43. At present the only known waste-specific treatment standards that are also debris are batteries or radioactively contaminated lead metal (not salts of lead!).	

Figure 8-20. Hazardous/Mixed Waste Debris Determination Checklist. (2 sheets)

WASTE CHARACTERISTICS	Yes (Y) No (N) Unknown (UN)
2.7 Is the waste primarily smaller than 2.5 in.? At least 50 percent of the material must be smaller than 2.5 in. in all dimensions.	
If any one of the answers provided in section 2.0 is yes, then the waste is not a debris, and the preparer is finished with this checklist. Go to box 4.0. If all the answers are no or unknown, then continue.	
3.0 Determine if the waste is a debris material.	
3.1 Is the waste a manufactured object? Manufactured objects are equipment, tools, pipe, cloth, glass, plastic, rubber, concrete, etc.	
3.2 Is the waste plant or animal material? Plant or animal materials are tumble weeds, animals, wood, etc.	
3.3 Is the waste natural geologic material? Natural geologic materials are rocks, course gravel, etc.	
<u>THE WASTE IS HAZARDOUS DEBRIS</u> If the answer to any one question in section 3.0 is yes, then the waste is a hazardous or mixed debris waste. Please so indicate by placing yes in this row. If the all the answers in section 3.0 are no or unknown, then further evaluation is required. Please so indicate by placing unknown in this row.	
<u>4.0 THE WASTE IS NOT HAZARDOUS DEBRIS</u> Because conditions in section 1.0 or 2.0 were failed, the waste is not hazardous debris. Please so indicate by placing a yes in this row.	
Comments: Preparer: Name: Date: Tel. #:	

Figure 8-21. Waste Storage/Disposal Request. (2 sheets)

WASTE STORAGE/DISPOSAL REQUEST (REV 1, 1/12/93) COMPLETE AND SUBMIT TO: ACCEPTANCE SERVICES: N3-11/WHC: P.O. BOX 1970: RICHLAND, WA 99352. FOR DETAILS REFER TO WHC-EP-0063		WHC Tracking #
...any Generator Log Number/Tracking Number	Qualified Generator/MSIN	Accumulation Date (If Applicable)
Approved Generating Facility (Per Cert. Plan)	Signature/Date	Phone

Waste Type

(Mark all that apply)

___ Low-Level
___ Transuranic
___ > Class C
___ High-Level
___ Nonradioactive (Include Attachment)
___ RMW (Include Attachment)
___ Compactible
___ Classified
___ Heat Generating Potential
___ Remote Handled
___ Contact Handled
___ Gas Generating Potential

Additional Information For Low-Level, RMW, TRU, and High-Level Waste ONLY

General Waste Description: ____________________

Physical Properties
___ Solid ___ Solidified
___ Debris (Attach Debris Checklist)
___ Absorbed Liquids
___ Labpacked Free Liquids
pH _____ Flashpoint ________ °F
Hazards ____________________

Transport Category
(Mark all that apply)
___ < 2 nCi/g
___ Limited Quantity
___ Low Specific Activity
___ Type A ___ Type B
___ Highway Route Control
___ SARP #__________

Special Package Form
___ Lab Pack
___ Disposable Overpack
COC #__________
___ Returnable Overpack
COC #__________
___ Liner (______) mils

PIN (Specific Shipment): ____________________

RADIONUCLIDES (CHECK APPROPRIATE CATEGORY) CATEGORY 1 ___ CATEGORY 3 ___ GREATER THAN CATEGORY 3 ___
List ____________________

Container Information

External Dimensions: ____________________
Maximum Gross Weight: ____________________
Drawing/Specification Number: ____________________
General Description: ____________________

Closure Mechanism: ____________________

Special Rigging Requirements: ____________________

WASTE STORAGE/DISPOSAL REQUEST ATTACHMENT (REV 1, 1/12/93)									WHC Tracking #	
A Item No.	B Number of Containers	C Container Description	D Kgs Waste	E Waste/Process Description	F Chemical Components	G Weight %	H Physical Properties	I Hazards	J Waste Status	K Cont. Status

Figure 8-21. Waste Storage/Disposal Request. (2 sheets)

Figure 8-22. Burial Compliance Checksheet 1985. (4 sheets)

BURIAL COMPLIANCE CHECKSHEET
FOR RADIOACTIVE SOLID WASTE MATERIAL

Rockwell Storage & Disposal Approval Number	Date	Rockwell Solid Waste Processing & Disposal Unit Approval Signature

Waste Generator: ____________________

Waste Title: ____________________

Storage/Disposal Container: ____________________

Reference: RHO-MA-222, Rev.3 (Unclassified), August, 1985, T.R.Pauly, "Hanford Radioactive Solid Waste Packaging,Storage and Disposal Requirements"

Waste Type: [ ] Transuranic [ ] Low Level

[ ] Unclassified [ ] Classified

Disposal Type: [ ] Burial [ ] Retrievable Storage

[ ] Scheduled [ ] Contact Handled

[ ] Routine [ ] Remote Handled

[ ] One-Time Only

Transport Approval: [ ] U.S.Department of Transportation

[ ] Waste Generator

[ ] Rockwell Transport Approval Number: __________

Transport Category: [ ] Low Specific Activity [ ] Limited Quantity

[ ] Type A [ ] Type B [ ] Highway Route Controlled Quantity

Figure 8-22. Burial Compliance Checksheet 1985. (4 sheets)

A. WASTE DESCRIPTION

Rockwell Storage &
Disposal Approval
Number

page 2 of 4

1. Waste Contents Included:

Yes	No		Yes	No	
[ ]	[ ]	Miscellaneous Solid Waste	[ ]	[ ]	Tritium (>20 mCi/M^3)
[ ]	[ ]	Animal Carcasses	[ ]	[ ]	Alkali Metals
[ ]	[ ]	Unabsorbed Liquid Organics	[ ]	[ ]	Asbestos
[ ]	[ ]	Ion Exchange Resins	[ ]	[ ]	Lead Shielding
[ ]	[ ]	Significant Concentrations of C-14, Kr-85, Tc-99, I-129	[ ]	[ ]	Gas Generating Potential
[ ]	[ ]	Heat Generating Potential (Greater than 0.1 watts/cf)	[ ]	[ ]	Radioactive Mixed Waste
[ ]	[ ]	Other: ______			

Note: The following are prohibited: Free inorganic liquids, incompatible materials, pyrophorics, explosives, unreacted alkali metals, and unvented gas cylinders.

2. Physical Description of Waste:

3. Radiactive Material Description

Non-Transuranic:

Transuranic:

4. Radioactive Mixed Waste Hazardous Constituent Description:

5. Maximum Allowable Fissile Quantity:

6. Void Space Filler Material (Required if internal void space exceeds 1.5 cu ft and 20% of container):

Figure 8-22. Burial Compliance Checksheet 1985. (4 sheets)

B. WASTE PACKAGING SYSTEM

____
Rockwell Storage & Disposal Approval Number

1. Container Name: ______________________________

2. Drawing or Specification Number: ______________________

3. External Dimensions: ______________________________

4. Disposal Volume: ______________________

5. Maximum Gross Weight: ____________________

6. General Description:

7. Required Internal Packaging:

8. Closure Mechanism:

9. Maximum Allowable Radiation Levels: ______________________(Contact)
______________________(Other)

10. Maximum Allowable Surface Contamination: ______________________
____

11. Required Labels:

Figure 8-22. Burial Compliance Checksheet 1985. (4 sheets)

B. WASTE PACKAGING SYSTEM (Continued)

Rockwell Storage & Disposal Approval Number

12. Returnable Transport Overpacks:

Note: The Waste Generator must send a current Certificate of Compliance (COC) and Unloading and Handling Procedures for each type of Returnable Transport Overpack to Rockwell prior to the initial shipment and each time these documents are revised.

C. OTHER REQUIREMENTS

1. Administrative Controls:

2. Rockwell Storage/Disposal Instructions:

Figure 8-23. Storage/Disposal Approval Record. (3 sheets)

SDAR Number:

Page 1 of 3

Issued by: ____________
Date: ____________

STORAGE/DISPOSAL APPROVAL RECORD FOR RADIOACTIVE SOLID WASTE

Prepared by: ____________
Date: ____________

Reviewed by: ____________
Date: ____________

Waste Generator:
Reference Letter Number: ________ Dated: ________ File Number: ________

Waste: ____

Storage/Disposal Container: ____________________________

Reference: WHC-EP-0063 (unclassified), September 1988, R. G. Stickney, "Hanford Radioactive Solid Waste Packaging, Storage and Disposal Requirements."

DISPOSAL TYPE:

___ Burial
___ Contact Handled
___ One-Time Only
___ Remote Handled
___ Retrievable Storage
___ Routine
___ Scheduled

WASTE TYPE:

___ Classified
___ High-Level
___ Low-Level
___ Mixed Waste
___ Transuranic
___ Unclassified

WASTE TRANSPORT CATEGORY:

___ Highway Route Controlled Quantity
___ Less than 2 nCi/g
___ Limited Quantity
___ Low Specific Activity
___ Type A
___ Type B

CONTAINER TRANSPORT TYPE:

___ Low Specific Activity
___ Type A
___ Type B

TRANSPORT APPROVAL:

___ Other (Specify) ____________
___ Transport Approval Number ____________
___ U.S. Department of Transportation

WASTE DESCRIPTION:

1. Waste Contents Included:

___ Miscellaneous Solid Waste
___ Unabsorbed Liquid Organics
___ Ion Exchange Resins
___ Significant Concentrations of ^{14}C, ^{99}Tc, and ^{129}I
___ Heat Generating Potential (>0.1 W/ft^3)
___ Tritium (>20 mCi/m^3)
___ Alkali Metals
___ Asbestos
___ Lead Shielding

Figure 8-23. Storage/Disposal Approval Record. (3 sheets)

SDAR Number ______

____ Gas Generating Potential
____ Hazardous Material
____ Other:

2. Physical Description of Waste:

3. Radioactive Material Description:

   Low Level:
   Transuranic:

4. Mixed Waste Hazardous Constituent Description:

5. Maximum Allowable Fissile Quantity:

6. Void Space Filler Material:

PACKAGING DESCRIPTION:

1. Container Name:

2. Drawing/Specification Number:

3. External Dimensions:

4. Disposal Volume:

5. Maximum Gross Weight:

6. General Description:

7. Required Internal Packaging:

8. Closure Mechanism:

Figure 8-23. Storage/Disposal Approval Record. (3 sheets)

SDAR Number

Page 3 of 3

9. Maximum Allowable Radiation Levels:

   Contact:
   Other:

10. Maximum Allowable Surface Contamination:

    Less than ____ dpm/100 cm^2 alpha
    Less than ____ dpm/100 cm^2 beta-gamma

11. Description of Returnable Transport Overpacks:

12. Required labels:

OTHER REQUIREMENTS:

1. Administrative Controls:

2. Hanford Storage/Disposal Information:

Approval of storage disposal for hazardous and MW required the completion of several additional forms to support the approved BCC or SDAR.

In 1987, the *Chemical Waste Disposal Request* was developed. This form was revised in 1989 and used until 1991. Figures 8-24 and 8-25 provide examples of the earlier and later versions of this form.

8.3 SOLID WASTE DATABASES

8.3.1 Richland - Solid Waste Information Management Systems Database

The R-SWIMS database was designed to track all radioactive solid waste that has been buried or stored in the 200 East Area of 200 West Area burial grounds and waste storage facilities since 1944. This database was begun in 1968 and was the Hanford equivalent of the Solid Waste Information Management System at Idaho National Engineering Laboratory. The information in R-SWIMS was extracted from data recorded on the SWSDR; its predecessors, the Solid Waste Disposal Record and the SWBR; the SDAR; and the shipping manifest.

The information that was contained in the R-SWIMS database can be grouped in the following categories:

- Generator or source
- Container
- Storage site and location
- Radioactive material contents
- Hazardous/corrosive contents
- Waste form
- Reference documents
- Calculations.

A brief summary of the input fields that were in each category is presented in Table 8-2.

As the requirements, regulations, and needs for waste characterization were changed over the years, R-SWIMS was amended and updated to reflect the changes. In order to track and maintain information about regulated solid waste from "cradle to grave," a database was required that would supply an accurate inventory of regulated solid waste that had been accumulated, stored, and/or disposed on the Hanford Site. The SWITS database was created to meet these needs by merging information from three existing solid waste tracking systems:

- R-SWIMS
- Hazardous Waste Tracking Database
- Generator Waste Tracking System.

Complete unshaded parts and forward to: SWP&DU 2750E/A105/200E Rockwell	Rockwell Hanford Operations **CHEMICAL WASTE DISPOSAL REQUEST**	Logbook No. Manifest(s) cross-reference

Requested by	Telephone Number	Address	Company

Signature ____________________ Date ____________ Waste Location: ____________________

WASTE DESCRIPTION (For additional items, continue on the back of this form)

A Item No.	B No. of Containers	C Container Size	D Total Waste Quantity (kg)	E Container Description	F Waste Description	G Chemical Components	H Weight %	I Physical State	J Hazards	K Waste Status	L Container Status	M Accumulation Date
Example 1	1	55 gal	205	Steel Drum	PCB Motor Oil	MSDS Attached	10.0 90.0	L	C	O	F	N/A
Example 2	1	5 gal	34	Metal Can	Waste from Hg Cleanup	Mercury Rags Soil	1.3 4.0 94.7	S	EP	S	PF	N/A

INSTRUCTIONS

COLUMN A - ITEM NUMBER — Item number for each unique waste.

COLUMN B - NUMBER OF CONTAINERS — Number of containers of a unique waste to be disposed.

COLUMN C - CONTAINER SIZE — Size of containers specified in Column B. If multiple container sizes, specify number and size of each.

COLUMN D - TOTAL WASTE QUANTITY — Total waste quantity (in kilograms only) of each unique waste to be disposed.

COLUMN E - CONTAINER DESCRIPTION — Specify container type e.g. steel drum, glass bottle.

COLUMN F - WASTE DESCRIPTION — Specify trade name or general description of each unique waste.

COLUMN G - CHEMICAL COMPONENTS — List all organic and inorganic components of

COLUMN H - WEIGHT (%) — For each waste component indicate percent or range of percents in which the component is present in the waste. Trace amounts of pesticides, herbicides, heavy metals and PCB's should be specified. Components must add up to 100% including water, earth, or other components. If a unit other than percent is used, indicate the unit. When possible, provide test results or other documentation to verify percentages.

COLUMN I - PHYSICAL STATE — Indicate whether Solid (S), Liquid (L), or Gas (G) or any combination of these phases.

COLUMN J - HAZARDS — Indicate whether waste is Corrosive (C), Ignitable (I), Reactive (R), Toxic (T), Explosive (E), Persistent (P), EP Toxic (EP) or Carcinogenic (X).

COLUMN K - WASTE STATUS — Indicate whether waste is: Reacted (Rx), Treated (T) New (unused) (N), Used (U), Old (or expired) (O), Spill Material (S).

COLUMN L - CONTAINER STATUS — Indicate whether container is: Full (F), Partially Full (PF), Empty (< ½ in. in 55 Gal Drums) (MT), Triple Rinsed (TR).

Figure 8-24. Chemical Waste Disposal Request (1987).

CHEMICAL WASTE DISPOSAL REQUEST

Qualified Generator	MSIN	Telephone No.	Company	Manifest No.
Signature/Date	Accumulation Date		Generator Log Number	Generating Facility

WASTE DESCRIPTION

A Item No	B Number of Containers	C Container Description	D Kg Waste	E Waste Description	F Chemical Components	G Weight %	H Physical Properties	I Hazards	J Status / K
Example 1	1	55 gal DOT 17E	205	TURCO Decon 4512A Solution, 10% in Water	TURCO 4512A MSDS Attached Water	10.0 90.0	Liquid, pH<2 Flash point > 200 °F	C	O / F
Example 2	1	5 gal DOT 37M	34	Waste from Hg Cleanup	Mercury Rags Soil	1.3 4.0 94.7	Solid	EP	S / PF
Example 3	23	55 gal Steel Drum	0	Empty Conoco 32 Oil Drums - Contained Used Oil	Oil-MSDS Attached PCB - Lab Data Attached	100 0 <1 ppm	Liquid, pH = 8.2 Flash Point > 200 °F	None	U / MT

A - Item number
B - How many containers
C - Size, Type, DOT Spec
D - Kilograms of Waste
E - Trade name or description
F - List everything! Attach MSDS, Lab analysis, etc.

G - Weight must total 100%
H - Physical properties: pH, Flashpoint, (G)as, (L)iquid, (S)olid
I - (C)orrosive, (I)gnitable, (T)oxic, (E)xplosive, (P)ersistant, Carcinogen (X)

J - Waste status: (S)pill, (U)sed, (O)ld, (R)eacted
K - Container status: (F)ull, Partfull (PF), Empty (MT), Triple rinsed (TR)
See WHC-CM-5-16 for detailed instructions

Complete and submit to:

SITE HAZARDOUS WASTE ENGINEERING SUPPORT
R1-51/WHC
Westinghouse

Figure 8-25. Chemical Waste Disposal Request (1989). (2 sheets)

A Item No.	B Number of Containers	C Container Description	D Kg Waste	E Waste Description	F Chemical Components	G Weight %	H Physical Properties	I Hazards	J Status K

A-6400-245 (08/89)

Figure 8-25. Chemical Waste Disposal Request (1989). (2 sheets)

Table 8-2. Data Categories in R-SWIMS Database.

Generator or source	Container data	Storage site and location	Radioactive material content	Hazardous corrosive constituents and quality	Waste form information	Reference documents	Calculations
Company	Type	Area	Isotope	MW hazardous constituents	Waste contents description	Record number (SWBR/SWSDR)	Calculated curies
Site	Volume	Facility	Quantity	Manifest waste number, TSD process	Waste type	SDAR number	Isotope data
Year/month/day received	Weight	Unit	Dose rate	(Post - 1985 waste only)	SWIMS category	Manifest number	Compaction data
Record number	Package ID number	Module	Neutron dose	--	WRAP category	--	--
--	Closure date	Tier	Thermal power	--	Organic weight and percentage	--	--
--	Certification date	Coordinates	--	--	Compaction data	--	--
--	--	Disposal date	--	--	Percent noncombustible	--	--
--	--	Status	--	--	--	--	--

MW = mixed waste.
SDAR = Storage/Disposal Approval Record.
SWBR = Solid Waste Burial Record.
SWSDR = Solid Waste Storage/Disposal Record.
SWIMS = Solid Waste Information Management System.
WRAP = Waste Receiving and Packaging Facility.

The conversion of the data fields in the R-SWIMS database to the new data fields in the SWITS database took place in October 1991.

8.3.2 Solid Waste Information and Tracking System Database

The SWITS database uses Oracle as a database manager system. As a relational database manager, the Oracle System provides much greater flexibility of data retrieval, manipulation and analysis than was possible in the R-SWIMS database.

The SWITS database also contains numerous data fields that were not previously present in R-SWIMS. Many of these fields were created in anticipation of retrieval, sampling, and certification activities; others were created to provide for database security and integrity. A list of the tables present in the SWITS database, with a brief description of each can be found in Table 8-3.

Table 8-3. Tables Present in SWITS. (3 sheets)

Table Name (CODE)	Description
COMPANY (COMPANY)	Contains information about any company that generates, transports, treats, stores or disposes of waste at Hanford. Includes address, EPA identification number.
CONTAINER TYPE (CONTYPE)	Contains codes to identify container types and their descriptions.
PRIMARY WASTE TYPE CODE (PRIWASTPE)	Contains code to identify basic waste type along with descriptions and time allowed before that waste type must be shipped.
SECONDARY WASTE TYPE CODE (SECWASTYPE)	Contains information about waste in a particular container or waste stream.
STORAGE CATEGORY (STORAGECAT)	Describes storage categories such as acid, caustic, flammable, PCB's, etc.
FACILITY (FACILITY)	Contains information on a specific facility where waste is generated, received, or stored on the Hanford Site.
GENERATOR (GENERATOR)	Contains information about an individual who has had proper waste shipment certification training. Includes address, phone and EPA identification.
SOURCE ORGANIZATION (ORGSOURCE)	Identifies waste source and responsible manager.
PHYSICAL COMPONENT DESCRIPTION (PHYSDESC)	Descriptions of physical components of radioactive waste (paper, plastic, rags, etc.)
MATERIAL SAFETY DATA SHEETS (MSDS)	Contains MSDS identification numbers and description of waste package on an MSDS.
MISCELLANEOUS CODE (CODECHECK)	Contains the names of data fields for which code validation edits are required along with code description and valid values.

Table 8-3. Tables Present in SWITS. (3 sheets)

Table Name (CODE)	Description
ISOTOPE (ISOTOPE)	Contains the names of data fields for which code validation edits are required along with code description and valid values.
CWDR RECORD (CWDR)	Contains codes for specific isotopes, half life information, conversion factors, class limits, etc.
UNCONTAINERIZED TSD RECORD (UNCONTAIN)	Describes the physical and chemical characteristics of uncontainerized waste as well as information on generator and regulatory codes.
COMPACTOR RECORD (COMPACTOR)	Tracks and provides data for compacted waste packages.
CONTAINER/ CONTENT RECORD (WASTE)	This large table contains most of the package data including physical and chemical characteristics, container type and volume, generator, shipping and status information.
HAZARDOUS CHEMICAL COMPONENT RECORD (CHEMCOMP)	Describes the hazardous waste package and the contents.
PHYSICAL COMPONENT RECORD (PHYSCOMP)	Describes the physical contents in a given waste package.
SAMPLE DATA RECORD (SAMPLE)	Tracks samples taken from waste packages for laboratory analysis.
APPLICABLE MSDS (APPMSDS)	Identifies the applicable MSDS for a given waste package.
RADIOACTIVE WASTE CONTAINER DETAIL RECORD (RADDETAIL)	Another very large table that contains many of the data fields that the R-SWIMS record did previously. It includes waste package storage location, document references, radioactive data, compaction information, and waste makeup.
RADIOACTIVE ISOTOPE QUANTITY RECORD (ISOQTY)	Identifies the isotopes present in a waste package along with quantity, plutonium equivalent curies, alpha count, etc.
OLD HWTD CONTENTS RECORD (CONTENTS)	Waste package content information from the now obsolete HWTD database.
RELOCATION HISTORY RECORD (RELOCHIST)	Tracks the movement of a waste package from one storage or disposal unit to another.
SHIPMENT RECORD (SHIPMENT)	Tracks the shipment of a waste package to a TSD facility.
SHIPMENT ITEM RECORD (SHIPITEM)	Provides information about a hazardous waste shipment including number of containers, cost, DOT required data and processing information.
SHIPMENT HISTORY RECORD (SHIPHIST)	Contains information about each waste shipment and applicable documentation (NMIT, RSR, 741 Forms).

Table 8-3. Tables Present in SWITS. (3 sheets)

Table Name (CODE)	Description
CONTAINER RELATIONSHIP RECORD (CONREL)	Tracks the relationship between two containers (combined, overpacked or split).
DECAY VALUES MIXTURE TABLE (DECAYMIX)	Contains the information needed to calculate the decay of mixed activation products.
DECAY VALUES ISOTOPE TABLE (DECAYISO)	Contains the information needed to calculate the decay of a specific isotope.
SYSTEM STATUS RECORD (SYSTATUS)	Tracks the effective date of most recent decay calculations and the date for uncontainerized TSD's being recorded.
ERROR MESSAGE TABLE (ERRMESSAGE)	Contains error descriptions and messages.
USER (USERS)	Contains information about individual users.
PROCEDURE (PROCTABLE)	Contains information concerning database procedures.
SECURITY (SECURITY)	Contains information concerning database procedures.
SECURITY ACTION LOG (SECLOG)	Lists user identification numbers and the privileges granted to that user.
SYSTEMS BULLETINS (SYSBULL)	Tracks user privileges granted or revoked.
STATE CODE (STATE)	Stores state abbreviation codes and names.
REPORT FILE LOG (RLOG)	Tracks user generated reports.

DOT = U.S. Department of Transportation.
EPA = U.S. Environmental Protection Agency.
HWTD = Hazardous Waste Tracking Database.
PCB = polychlorinated byphenyl.
R-SWIMS = Richland - Solid Waste Information Management System.

8.3.3 Waste Information Data System

The Waste Information Data System (WIDS) is an electronic database which is the official source identifying known and reported solid waste management units within the DOE-RL controlled area, as well as other waste management units. Section 3004(u) of the 1984 amendments to RCRA required owners of hazardous waste management facilities to make notification of all solid waste management units at their facility. In order to implement the corrective action requirements of section 3004(u) of RCRA, the EPA amended 40 Code of CFR 270.14 to require the permit application of a RCRA treatment, storage, or disposal unit to identify each solid waste management unit located on the contiguous property of the owner/operator seeking the permit. The WIDS system fulfills all requirements of Section 3.0 of the Action Plan is the TPA. The annual update of the

Hanford Site Waste Management Units Report provides current summary information on all waste management units contained within the WIDS system and reflects all units added to the database during the preceding year.

The WIDS has been existence since 1980. Information in the WIDS database includes the location, type, and current status of each unit, date(s) the unit was operated, general dimensions and description of each unit, and general descriptions of waste placed in the unit. Information also includes any release potential as well as estimated quantities of radionuclides and hazardous chemicals for some units. A change control system documents all changes dealing with the status of each waste site.

8.3.4 Solid Waste Forecast Database

The Solid Waste Forecast has been in existence since 1989. It is a formal data request sent out annually to all onsite and offsite waste generators who plan to ship their hazardous and/or radioactive solid waste to the Hanford Site for treatment, storage or disposal over the next 30 years. The waste volume forecast helps establish fiscal year budget allocations, provides data to support planning of future solid waste facilities and operational requirements and provides data that are incorporated into the Integrated Data Base report.

Forecast forms are developed and updated annually and include information on waste volumes, container type, physical waste forms, hazardous constituent and radionuclide data. The data supplied by the generators on the forecast forms is entered into the Solid Waste Forecast Database. Initially, only waste volumes are entered for the current year to facilitate storage, disposal and planning rates for Program/Budget personnel. After this task, data from all of the tables are entered in the data base for the 30 year forecast.

Forecast data are used to compile the forecast summary report. This report, which updates WHC-EP-0567 (*Solid Waste Reference Forecast Summary*) on an annual basis, forecasts the volumes of solid wastes to be generated or received at the Hanford Site during the 30-year forecast period. The wastes include LLW, mixed LLW, TRU, TRU MW, and nonradioactive hazardous waste. The objective of this report is to present a documented set of data that may be used consistently for both short- and long-term planning of solid waste treatment, storage, and disposal activities.

Hanford is also required to provide input to the DOE Integrated Data Base. Much of the required information is extracted from the solid waste forecast database. The forecast data, together with information provided by the SWITS database, is used as input to the Solid Waste Forecast Database. This database is a modeling tool developed and maintained by PNL, is currently used for reporting the TRU/TRUM portion of the Integrated Data Base.

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APPENDIX A

DRAWING LIST

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DRAWING LIST

Appendix A is a list of drawings numbers and titles for approved packaging, transportation, and burial/storage containers at the Hanford Site.

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-0-01092	Sample Container	N/A
H-1-02424	Bio Lab Bldg 108F Isotope Storage Cont.	concrete - 5′ x 4′ x 3.5′ on inside
H-1-34709	Filter Burial Container	cylinder - metal w/concrete - 11 gauge 4.2′ od x 4′
H-1-39667	Burial Cask 100N Irradiated Balls	concrete - 4′ x 4′ x 0.5′
H-1-42664	Ball Chann Renov Burial Cask Funnel Liner	cylinder - metal 55 gal drum - 1.4′ x 1.9′ x 2.7′
H-1-42701	4′x4′x8′ Plywood Box	FRP - 4 x 4 x 8
H-1-42702	4 x 4 x 8 Plywood Box	FRP - 4 x 4 x 8
H-1-42998	DOT Spec 7A UNI 4476 Shipping Cont.	metal - 3.7′ x 3.8′ x 7.5′
H-1-42999	DOT Spec 7A UNI 667 Shipping Container	metal - 5.83′ x 6″ x 7′
H-1-44784	Sludge Removal System Shipping and Burial Containers	cylinders - metal - 5, 10, 15 gal drums
H-1-44980	Concrete Burial Box for N-Reactor Fuel Spacers	concrete - 6′ x 10′4" x 28′
H-1-48523	Shielded Burial Container	metal - 7.6′ x 10.6′ x 12.33′
H-1-48532	Shielded Burial Container	cylinder - metal - 1.9′ o.d x 2.9′ w/ 55 gal and 16 gal inside.
H-1-48634	MSP Shipping and Burial Container	metal - concrete - 1.9′ x 1.8′ x 2.9″ - 55 gal drum inside
H-1-72013	Five Ton Container	concrete - 4′ x 4′ x 6′
H-1-80317	Fuel Basin Waste Cask Overpack Tie-Down	metal - 4′ x 8′ x 8.1′ & 4′ x 6.4′ x 8′
H-1-80318	Fuel Basin Waste Cask Overpack Modification	metal -5.9′ x 5.9′ x 5.9′
H-2-02478	Radioactive Material Waste Carton	FRP - 1.5′ x 1.5′ x 2′ and 1.3′ x 1.3′ x 1.3′
H-2-02767	Structural Burial Boxes Typical Plans and Details	FRP - 10′ x 10′ x 12′, 12′ x 12.5′ x 20′ - 1958
H-2-03178	Lab Waste Dolly for Ice Cream Cartons	N/A misc Dolly w/wheels
H-2-05170	Dry Waste Burial Ground 218-W-7	N/A misc burial ground

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-07207	Cart-Oil Container for Pump Lubrication	N/A misc - not burial
H-2-15257	Container	cylinder - Tantalum - 2.8′ x 4.1′ od & 3.7′ id
H-2-22254	Container	metal - 6.1′ x 7.1′ x 17.3′
H-2-24045	Gallon Ice Cream Carton Sphincter Seal	cylinder metal - 2" x 9.3" od; 7 1/2" id
H-2-24483	Burial Box 234-5Z Material	FRP - 4.2′ x 4.7′ x 10′ Box in a box & filled around space w/concrete at site - 2′ x 2.3′ x 7.7′ inside dimensions
H-2-24925	Removable Wall Horizontal Burial Box for HC-39 Hood	FRP - 4.3′ x 5.8′ x 8.5′ or 4′ x 6′ x 9′
H-2-25038	234-5 Building Services Waste Disposal Burial Containers	N/A - H-2-26564 & H-2-268-26
H-2-25152	Aluminum Container	metal - 2.093 x 2.062 square "A" dim = 1.094, 0.563, 0.281, 0.982, 0.23, 0.932
H-2-25397	PR Can Container Storage Building Plans and Details	misc building blueprint
H-2-25479	L-10 Shipping Container Bottle Vent Assembly	cylinder - bottle vent 3.1" diameter x 2.5" polyethylene/container 2.25" od x 5"
H-2-25915	Storage Container Assembly 10 Liter Size	N/A references only
H-2-25916	Storage Container Assembly 10 Liter Bottle Size	cylinder metal - 55 gal drum 1.8′ od x 6′
H-2-25918	Storage Receptacle Storage Container Assembly 10 Bottle Liter Size	metal - 4.7′ x 8′ x O.D. 5.625′
H-2-26141	Pu NO_3 R L-10 Class 2, Shipping Container, Drum and Cage ASS 2102	cylinder metal - 2 (55 gal drum & 16 gal drum inside)(5.55′ x 1.88′)
H-2-26325	Duo-Vent Cap	N/A unkown
H-2-26418	PR Can Container Mark IV/Mark V and Emergency	cylinder metal - (304LSS) 1.88′ x 2.9′ w/cover; 1.88′ x 2.88′ w/o cover 18 gauge
H-2-26525	Burial Box for Dry Waste	metal - 3′ x 4′ x 10′; 3′ x 4′ x 16′; 4′ x 6′ x 10′; 4′ x 6′ x 16′
H-2-26526	Burial Box for Filters	metal - 2.3′ x 2.3′ x 6.3′; 2.3′ x 2.6′ x 4.7′; 2.3′ x 3.8′ x 4.7′
H-2-27042	Hood Burial Box	metal - 4′ x 10′ x 21′ carbon stl
H-2-27044	Multipurpose Burial Box	metal - 4′ x 4.8′ x 14.3′ carbon stl

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-27045	Burial Box for Hoods 45 and Room 179-C	metal - A Box - 3.9' x 8.5' x 8.5'; B Box - 4.25' x 4 x 9'; C Box - 4.8' x 5' x 8.5'
H-2-27069	24 in. x 24 in. x 12 in. Filter Burial Box	metal - 12 gauge carbon steel; 2' x 2' x 3.2'
H-2-27433	Retrievable Storage Container Lifting Frame	metal - pulleys - wire rope
H-2-27440	Retrievable Storage Container 20 ft. Modular	FRP - w/skids 1919 cu ft - 9' x 10.7' x 20'; inside w/spacer 6.5' x 8' x 18.5'
H-2-27441	Retrievable Storage Container 16 ft. Modular	FRP - w/skids 1535 ft^3 - 9' x 10.7' x 16' 9' ; 760 ft^3 - 6.5' x 8 x 14.7'
H-2-27442	Retrievable Storage Container 12 ft. Modular	FRP - 1551 ft^3 - 9' x 10.7' x 12'; 565ft^3 - 6.5' x 8' x 10.7'
H-2-27445	Retrievable Storage Container 12 ft. Custom	FRP - 695 10.7' x 8' x 8.25' inside - - 1343 ft^3 12' x 10.5' x 10.7'
H-2-27499	Revise and Relocated Barrel Lifting Device	N/A misc metal - A frame w/ hook
H-2-27927	Moisture Container Assembly	cylinder - metal - 25' x 0.5' od
H-2-28313	R C Can Wood Container Assembly	FRP - 3' x 3.2' x 3.3'
H-2-28798	Vent Clip for Waste Storage Barrels	N/A misc metal hooked clip 2"L^1 x 1/2"L^2 x 1/2"r for top
H-2-30171	Structural Burial Box Liner Plans/Details	FRP - 10' x 11.24' x 20'
H-2-30174	Standard Burial Box Plans and Details	FRP - canyon box & Silo Jumper Box - 3.6' x 5.3' x 9.7'
H-2-30325	Burial Box for TK-109	Concrete & wooden box beams w/vent (wood skids) 10.3' x 12.2' x 12.5' - steel base plate
H-2-30346	Vent Burial Cover for 6"/8" Nozz. Flanges	cylinder - metal - radius of 1.4' or 1.5'
H-2-30595	Burial From H-4 to H-5 Vapor Line Tower	metal - Hang-man shape 4.7' x 12.6'
H-2-30668	REDOX Burial Box	FRP - 1' x 13.1' x 23.1'
H-2-30757	REDOX Burial Box Dissolver Tower	FRP on skids 3' (?) x 6' x 18'
H-2-30817	Standard Precast Burial Box	concrete - A - 11' x 12' x 15.5' (13 x 13.5' x 15.5) B - 9.4' x 11.8' x 12.5' (10' x 12.5' x 16'); C - 8.3' x 10' x 10' (8' x 11' x 14') - 1961
H-2-30952	Outer Burial Box for H-2-30951	FRP - 27' x 12.5' x 10.7'

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-30958	Burial Box H-4 and H-5 Vapor Line Tower	metal - 18.3' x 6.6' x 2' or 3.8' (11 GA liner)
H-2-30998	Burial Box for H-4 Tower	concrete - 17' x 5.2' x 7.3' - strong enough for 4'6" soil cover & wt of D8 tractor
H-2-32102	218-W-2A Disposal Site Trench Cross Section	N/A - Misc - trench cross section
H-2-32317	Cask Container Insulation and Modif HAPO 2-2	cylinder -steel - 4.4' radius, 18ga, 12.2' tall
H-2-32369	Cask Container Modification HAPO I, IA, II-1 and II-2	N/A misc - use H2-57708,-57981,-57841, 57982
H-2-32588	Foil Container Assembly and Details	N/A
H-2-32714	Burial Capsules	cylinder - A - 9.5' x 0.3' od; B - 14.5' x 0.3' od; C - 18' x 0.4' od; D - 8' x 1.3' od
H-2-32973	Viton O-Ring	N/A
H-2-33134	218-W-13 Additional UO3 Storage Site Plan and Sections	N/A
H-2-33312	Waste Container Arrangement	cylinder - H-2-33431,32 r = 0.8'
H-2-33564	Dry Waste Disposal Caisson in 218-W-4 Site	N/A
H-2-33631	Waste Container Assembly and Details	cylinder - m -1.79' high x 2' od
H-2-33632	Waste Container Assembly	cylinder - m - 2.6' high x 2' od
H-2-33659	Waste Container Seal Retaining Ring	cylinder - m - 2.6' od
H-2-33695	Pu-NO_3/4 L-3 Class 2 Shipping Container Assembly and Details	cylinder - 55 gal drum 2.8' tall x 16 ga carbon steel
H-2-33955	Burial Capsules Arrangement Assembly and Details	N/A misc - crane & platform
H-2-34088	Burial Box Jumper No. 3 Pump Pit Tank 241-C-103	FRP - 2' x 9' x 13'
H-2-34162	Burial Box for Giler Assembly	concrete - designed for 6' dirt cover 4.2' x 4.9' x 10.6'
H-2-34163	Burial Box for Stack Gas Filter	metal - w/concrete - 6.75' x 9.5' x 12.25' or 8' x 10' x 13'
H-2-34511	Burial Box for F-22-5 Filter Assembly	metal - w/concrete - 4.25' x 9.5' x 15.5'
H-2-34520	Burial Box for 12 x 8 x 12 High General Purpose	FRP - 9.5' x 12' x 13.5'

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-34999	Cell Equipment Burial Box	metal - 3.75' x 5.67' x 11.7' 192ft³ vol inside & outside is 300ft³ (painted) TRU waste (steel)
H-2-35000	Transuranic Filter Burial Box	metal - 2.67' x 2.67' x 5.67' ex vol 42 ft³ inter vol 29.75 ft³
H-2-35001	Transuranic Dry Waste Burial Box Type I & II	metal - 4.2' x 6.6' x 10' & 4.2' x 6.6' x 16'
H-2-35279	Details - Dry Waste Disposal Caisson in 218-W-4B Site	cylinder - 14' soil cover - O.D. 8.7' x 12.25'
H-2-35396	Pump and Agitator Burial Capsules Assembly and Details	misc - metal
H-2-35570	Alpha Dry Waste Disposal Caisson in 218-W-4B Site	misc - metal
H-2-35753	Slit Vent Cap	N/A
H-2-36088	Metal Burial Box	metal - 5.5' x 10' x 18.5'
H-2-36441	Burial Box for ITS-2 Heater	metal - wood - 6.75' x 16.25' x 48'
H-2-36442	Burial Trench Cross Sections	N/A - misc - cross section plans
H-2-36768	Hood Burial Box Type I and II	metal - 5.4' x 8.5' x 11' vol 501 & 6' x 8' x 12' vol 582
H-2-37254	Cleated Plywood Burial Box	FRP - 3.75' x 4' x 6.75'
H-2-37434	Transuranic Multiple Burial Container for 42 in. Liners	concrete - 6.3' x 5.5' x 5.5' around 4 metal cylinders; lead seal 0.5' x 0.8'
H-2-37511	Transuranic Multiple Burial Container for 15 in. Liners	concrete - 5.4' x 5.4' x 4'; lead shield 9.75 " thick
H-2-37598	Burial Box for Hood 2 Room 41-43 6Z	metal - 4.4' x 8.5' x 12.9'
H-2-38022	10 ft. Diameter Underground Silo - High Level Beta Gamma - Solid Waste Burial	N/A - misc - diagram of silo
H-2-38030	118 TX Exhauster Filter Burial Box	metal -3.3' x 3.3' x 3.5' / 3' x 3' x 4'
H-2-38078	Assembly Cask-Transfer Container	metal -1.5' x 1.5' x 1.9'
H-2-38099	Burial Capsule 84 dia x 42	cylinder - 7' od x 3.5'
H-2-38179	Burial Box for B-Plant Agitator	metal -w/concrete, 6' x 10.6' x 27.5' - 6' x 10' x 24'
H-2-38426	Burial Box for Jumpers from 24 4-AR Vault	metal - w/ wood, 6' x 5.33' x 14' including sled 10.6''w/o
H-2-38431	T-18-2 Column Burial Box	concrete - w/steel 7.5' x 11.5' x 21.5'

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-38615	Standard Burial Box with Yoke	concrete - 11' x 5.3' x 6' & 18" above beam
H-2-38647	Wooden Burial Box for Dry, Low Level Beta-Gamma Waste	FRP - 8' x 4' x 4'
H-2-38663	Pump and Agitator Burial Capsule Assembly and Details	metal - 7' x 5.1' x 5.2'
H-2-38720	K-3 Filter Box	concrete - 7.3' x 10.7' x 21'
H-2-39848	Burial Box for H-4 Tower Capsule	N/A unknown - 5.4' x 7.7' x 18.3'
H-2-43412	1 Gallon Nitric Acid Container	cylinder - metal - 8" O.D. x unknown
H-2-45215	Concrete Burial Box for PUREX Jumpers	N/A
H-2-52984	PR Can Container Assembly and Details	cylinder - metal - 2' O.D. x 2.7' (3.4' w/legs)
H-2-55586	218-E-14 Disposal Tunnel #1 for Failed Equipment Plot Plan	N/A - misc - tunnel plan
H-2-55587	218-E-14 Tunnel No. 1 Structural Floor Plan and Section	N/A - misc - tunnel blue prints
H-2-56522	Burial Box for Towers T-H2 and J2 Plan and Details	FRP - 54.7' x 10' x 12.5' on RR car wood GE Purex
H-2-56658	Burial Box for Tower G-2	FRP - 9.2' x 10.2' x 50' (202A Bldg GE)
H-2-56661	Burial Box for T-L3, E-L4, E-L5, TK-L6, E-L7, and E-L8	FRP - 12' x 15.7' x 39.5' GE
H-2-56668	Burial Box for T-K2	FRP - 10.5' x 11.2' x 48' GE
H-2-56823	Burial Box for Canyon Filters F-A1, F-B1, F-C1, and F-F1	FRP - Purex 12.5' x 12.5' x 12.5' GE
H-2-56862	Burial Box for T-F5	FRP - Purex 33' x 17.5' x 12.3' GE
H-2-56927	Concentrator Tube Bundle Burial Box	FRP - 6' x 10.2' x 19.7'
H-2-56987	Double Package Concentrator Tube Bundle Burial Box	FRP - GE 5' x 10.2' x 18'
H-2-57250	Burial for T-H3, T-J7, T-K3	FRP - GE tunnel use - 10' x 11' x 40.2'
H-2-57252	Burial Box for Tower T-J2	FRP - GE RR 10' x 12.8' x 54.4'
H-2-57253	Jumper Burial Box 22 ft. Length	N/A misc - sieve plate
H-2-57275	Pulse Generator Burial Box	FRP - GE tunnel 12' x 13' x 16'
H-2-57278	Cover for Outer Box for Jumper Burial and Box for Long Jumpers	FRP - GE 10' x 14.5' x 37' inside - 11' x 15.8' x 38.3' os
H-2-57439	Silver Reactor Burial Box	metal - 10' x 12.5' x 32' GE

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-57440	HA Column Cartridge Burial Container	metal - GE 6' x 6' x 30'l
H-2-57708	Cask Container HAPO-I	cylinder - metal 13.7' x 4.3' od & takes a cask 6' x 3.4' od
H-2-57763	Burial Box for T-L1 Tower Plan and Sections	metal w/ wood GE 49.3' x 14' x 14.6'
H-2-57764	Burial Box for T-L1 Tower Details	N/A misc - GE lid
H-2-57765	Burial Container for PUREX Concentrator Tube Bundles	FRP - GE Purex 8 x 8 x 32" with tube inside wood
H-2-57780	Burial Box for Filter No. F-A1	FRP - 13' x 13' x 14' wood GE
H-2-57802	Burial Box for T-H3, TK-3, and T-J7 Construction Details	N/A misc - GE 8' x16.5' metal frame
H-2-57810	SST Liner Tray for M.P. Diss. Burial Box	metal - GE 12' x 11' x 4.3'
H-2-57815	Column Removal Dolly Burial Box	FRP - 4' x 5.2' x 48'
H-2-57818	Precast Burial Box for GE-2 and GE-4 Centerfuges	concrete - 6.7' x 9.9' x 11' or round to 7' x 10' x 11'
H-2-57836	Burial Box Modifications	N/A misc wood sleds
H-2-57841	Cask Container HAPO 2-1	cylinder - metal - 11.9' x 8.2' O.D. with hold inside 4.7' x 3.4' I.D.
H-2-57862	L-1 Tower Burial Box	FRP - 4' x 11.5' x 14.2' flat car aquaeous foam
H-2-57866	HS or HA Col. Cartridge Burial Box	FRP - 4.3' x 4.8' x 29'
H-2-57886	Concentrator Tube Bundle Burial Box C-7 19 x 10 x 6	N/A misc remote gauge ring & lifting yoke
H-2-57889	Jumper Burial Box	FRP - 11.3' x 16.6' x 41.5'
H-2-57910	Outer Burial Box for Jumpers	FRP - 9.8' x 18.8' x 20.7'
H-2-57923	Burial Box for B-Plant Resin Tank	concrete w/ metal 12' x 13' x 21'
H-2-57947	Jumper Burial Box	concrete 6.8' x 15.8' x 27.8' built to withstand 8' of soil
H-2-57981	Cask Container HAPO-IA	cylinder - 13.7' x 9.8' od w/inside hole 5.9' x 4.4' id steel
H-2-57982	Cask Container HAPO II-2	cylinder - 11.9' x 8.2' od w/inside hole 4.75' x 3.4' id steel
H-2-57997	Cask Container HAPO 4	cylinder - 12' x 9.2'
H-2-58017	Silo Burial Box for 202S Building	FRP - 6.5' x 19' x 7.1'
H-2-58021	Burial Box for PUREX Dissolver	concrete - 11.2' x 13.2' x 14.75'
H-2-58023	Burial Box Cover Slab Hold-Down Mechanism	N/A misc big bolt

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-58045	Concrete Box for REDOX Tube Bundles	concrete -13.5′ x 10.75′ x 5.2′ - 7 feet of soil
H-2-58051	1/4 Size Model Cask Container	cylinder - 3.3′ x 2.5′ od w/space 1.5′ x 1.1′ id
H-2-58092	Concrete Burial Box for PUREX Pumps	concrete - 5′ x 14′ x 15.6′
H-2-58116	Cask Container HAPO IB	N/A lid
H-2-58117	1/4 Size Model Cask Container Aluminum Core	cylinder - metal 2.7′ x 1.9′ od & inside 1.5′ x 1.1′ id
H-2-58118	Cask Container HAPO 2-B	N/A
H-2-58128	Burial Box for PUREX Concentrator	concrete - 1.4′ x 1.9′ x 12.5′ steel frame
H-2-58160	Burial Box for Silver Reactor TA2, TB2, TF2	concrete - 21.5′ x 12.8′ x 10′ (9.2′ inside) w/ metal frame
H-2-58349	Portable Jumper Burial Box	FRP - 4.3′ x 8.5′ x 5′
H-2-58372	Burial Box for T-H2 Plan Elevation Section	FRP - 4.3′ x 11.4′ x 11.5′
H-2-58373	Burial Box for T-H2 Details	FRP - 4.3′ x 11.4′ x 11.5′
H-2-58379	Burial Box for T-H3, T-J7, and T-K3	FRP - 2.3′ x 10.5′ x 42.5′
H-2-58380	Burial Box Details and Cover	N/A
H-2-58526	General Purpose Burial Box	concrete - 8′ x 10.8′ x 22.8′
H-2-58682	Burial Container for 10 ft-0 in. x 9 ft.-3 in. TK	cylinder - concrete - 14′ x 12.7′ od w/ 6′ earth cover
H-2-58722	Dissolver Burial Box	conrete w/ metal 11.3′ x 14.7′ x 15.7′ cover is 6′ x 11′ x 13′
H-2-58737	218-E-13 Disposal Tunnel #2 for Clearance Diagram for Tunnel Section	N/A
H-2-62998	Burial Box for Capsules A-01, 2,3 and 4, P-001, P-002-1, and P-00	concrete w/steel 7′ x 7.3′ x 30′
H-2-63004	Burial Box for Silver Reactor T-C2	FRP - 12′ x 13′ x 29.5′
H-2-63032	Burial Box for Tower T-J6	FRP - 1.1′ x 10′ x 41.4′ - (inside)
H-2-63050	Burial Box for L-2 Tower	FRP - 10′ x 12.5′ x 36.7′ inside - 11.5′ x 13.5′ x 36.7′
H-2-65095	Metal Liner, General Purpose Burial Box	metal - 7′ x 8′ x 18′
H-2-66092	L Cell Package Burial Box Assembly	metal 13.5′ x 26.7′ x 34′ flatcar for tunnel burial
H-2-66094	Burial Box Silver Reactor No. 5	concrete 10′ x 10.9′ x 22.8′ 1970
H-2-68182	General Purpose Burial Box	concrete - 8′ x 10.3′ x 19.3′ w/ steel - (8 x 10 x 20) -1975

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-69548	Retrievable Storage Container 12 L x 8 W x 12 H	FRP 8′ x 12′ x 12′ - 1975
H-2-69549	Retrievable Storage Container	FRP 8′ x 10.7′ x 16′ - 1977
H-2-69550	Retrievable Storage Container 20 L x 8 W x 12 H	FRP 8′ x 12.7′ x 20′
H-2-69551	Retrievable Storage Container 126 L x 915 W x 10 H	FRP 9.5′ x 10.7′ x 12′
H-2-69731	Installation Cask Transfer Container	FRP 29′ x 29′ x 44′ - 1975
H-2-71893	Shipping Container Overpack and Body	N/A 44′ x 28.5′ x 28.5′ inside 12′ x 12′ x 31′
H-2-72000	Dry Waste Burial Container	N/A
H-2-72106	Standard Air Vent for Non-Transuranic Burial Boxes	N/A
H-2-72153	Burial Box for Transuranic Waste	metal 4.6′ x 10′ x 11.3′
H-2-72163	Burial Boxes for TRU Waste	N/A array detector lifting assembly
H-2-72188	Lined Burial Box for Low Level Beta-Gamma Waste	FRP 4′ x 6′ x 10 - 1976
H-2-72194	Burial Container for Dual Walled Core Barrel	metal - modification 33′ x 23′ x 0.7′ flange - 1975
H-2-72200	Transuranic Dry Waste Burial Container for PUREX Jumpers	concrete w/metal 8′ x 11.7′ x 22.6′ plus sled = 8 x 12 x 23 1977
H-2-72342	Trombone Disposal Burial Sub Capsule	cylinder - metal 2.8′ od x 16′ - 2.1′id -1977
H-2-72560	Transuranic Dry Waste Burial Box Type I	metal - 4′ x 6.75′ x 10′ (4′ x 9.7′ x 6.25′)
H-2-72996	Clamp and 55 Gallon Drum Cover for Remote Installation	N/A cover - 1978
H-2-73016	Assembly Burial Capsule (P-002-1 Pump)	N/A metal - 1978
H-2-73017	Assembly Burial Capsule (Pump P-001)	N/A metal
H-2-73018	Assembly Burial Capsule (Agitator A-001 or A-002)	N/A metal
H-2-73019	Assembly Burial Capsule (Agitator A-003 & A-004)	N/A metal
H-2-73020	Assembly Burial Capsule (Pump P-002-2 TX Type)	N/A metal
H-2-73021	Assembly Burial Capsule (Pump P-002-2 Johnson Type)	N/A metal
H-2-74397	Slug Bucket Container	metal 19.5′ x 22.7′ x 23.5′ - 1980

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-74448	PIG Shipping Container	cylinder metal 14 1/8" x 9.895" o.d. - 1978
H-2-74449	Base Hold Down-16 FRP Modular Container	cylinder metal 1.9' od x 2.6' - 1978
H-2-74490	Base Hold Down-12 Custom FRP Modular Container	metal 12' x 9.6' x 0.4' base holds - clip 16' x 0.2'
H-2-74557	Container Shipping 5791 Model 131-AC-M6	cylinder 7.4 + 17.6 + 7.5 + 12 radius - 55 gallon drum - 1978
H-2-74561	Transuranic Dry Waste Burial Box Type II	metal 5.1' x 6' x 14' - 1978
H-2-74608	Transuranic Dry Waste Burial Box 8'x9'x12'	metal 8' x 9' x 12'- 1978
H-2-74714	Transuranic Dry Waste Burial Box	metal 6.3' x 9.2' x 11.8'; 6.3' x 9.2' x 14.5'; 6.3' x 9.2' x 18.5'; 3.5" walls
H-2-78293	Srtl-Arch Barrel Storage Pad Plan-Elev and Details	metal 12' x 25' x 38' - 1989
H-2-79490	DOT-6M Shipping Containers	cylinder 30 gallon - 1990
H-2-80046	Metal Burial Box Filtered Vent	N/A vent & gasket - 1987
H-2-80847	WINCO UO3 DOT-6M Shipping Container	cylinder 1991 - 55 gallon drum - DOT 6M
H-2-81013	Waste Box Container Fire Extinguishing	metal 1.6' x 1.7' x 2.8' - 1990
H-2-83306	Packaging Safety Engineering Plywood Shipping Container	FRP 2' x 4' x 8' - 1992
H-2-83734	Hydrogen Mixed Pump Storage Container	cylinder 8 pages - no dimensions - metal - 1994
H-2-85345	Waste Barrel Assembly and Details	cylinder metal 38.92' x 2.25' od
H-2-91273	RH-TRU Container Assembly	N/A
H-2-91279	TRU Waste Container Filter Assembly	N/A 1983 carbon composite filter
H-2-91284	RH-TRU Waste Container Assembly	cylinder 10.1' x 2.2' od & wood frame carbon steel
H-2-91405	RH-TRU Waste Container Welder Assembly	N/A complicated
H-2-91888	7'-0" X 6'-0" X 6'-0" Steel Corrugated Box Assembly	metal 1980 6' x 6' x 7'
H-2-92314	Dry Waste Burial Container Lifting Modification	N/A brackets only
H-2-92337	T.M.I. Shielding and Burial Container	cylinder concrete 1982 - 9.8' x 7.3' od & 2.3' id

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-92603	Burial Sub Capsule Trombone Disposal	cylinder metal 16′ tall x 3′ dia - 1987
H-2-92980	Burial Box for E5-2 or E20-2 Concentrators	FRP w/metal 1983 13′ x 15.5′ x 33′
H-2-93173	Dry Waste Burial Container	concrete w/metal 1982 8.5′ x 11.6′ x 22.6′ or 10 x 12 x 23
H-2-93184	T.M.I. Shielding and Burial Container Modifications	N/A
H-2-93482	Lard Can Rack Arrangement and Details Room 192-B	N/A 1984 - blueprints of rack stored in vault in Bldg 222T, Rm 192 B, C
H-2-95231	Liner, Burial Box Low Level Beta-Gamma Waste	metal 1984 - 0.67′ x 5.3′ x 8.8′
H-2-95423	K-3 Filter Box	concrete 7′ x 11′ x 19′ ; 7 x 11 x 23 - 1986
H-2-95481	Burial Box Resin Tank	FRP 16.5′ x 11.7′ x 13′ (4.25′ skid) - 4" concrete - metal liner in a Resin Box - 1987
H-2-95594	Calcium Overpack Assembly	cylinder (od 8.693)(in 8) x 11.1′ length metal - 1985
H-2-97901	Slip Lid Can Overpack Assembly	cylinder (8 3/4" w/ handle 6 1/2" w/o) x 5 1/8" od - 1987
H-2-97902	Juice Can Overpack Assembly	cylinder 12 1/2" w/ 10 1/4" w/o x 6 od - 1987
H-2-99110	Lifting Yoke Burial Capsules	N/A metal
H-2-99120	Lifting Yoke for Standard Burial Box	N/A metal - 1987
H-2-99184	Burial Box Bolt Assembly	N/A metal stainless steel - 1988
H-2-99187	Burial Box Corner Bolt Bearing Plate	N/A metal stainless steel - 1988
H-2-99188	Burial Box Bolt Bearing Plate	metal 7′ x 6′ x 6′ metal
H-2-99199	Standard Burial Box	concrete w/metal 5.3′ x 7′ x 11′ - 1988
H-2-99268	Pump and Agitator Burial Capsule Modification	N/A metal - 1989
H-2-99730	Drill String Burial Container Assembly	N/A complicated - 1988
H-2-99732	Drill String Burial Container Details	metal - 8.5 x 7.62 x 4.76 - 1988
H-2-99743	String Burial Container Support Stand Detail	metal - 18 x 12 x 17 - 1988
H-2-99790	CH-TRU Container Venting System General Arrangement	N/A metal 1989

Drawing number	Drawing title	Material of construction and dimensions (ft)
H-2-99795	Container Venting System Enclosure	cylinder metal 1989 - o.d. 3.2' x 2.9'
H-2-99799	Container Venting System Drawing Index	N/A a number of drawings
H-2-99957	Drill String Burial Container Field Arrangement	metal 1989 - 62.5' x small parts
H-2-100186	Cover Burial Box Liner	metal 1989 - 18.3' x 8.3' x L ; C7 x 9.8 x 18' 4" length
H-2-131501	Primary Container Assembly	cylinder metal 1989 - 9 x 5.6 od - metal shielding type 304 sst ASTM-A-240
H-2-131629	Canyon Burial Box Assembly (Lead)	metal 1989 - lead - 6.5' x 7' x (2 1/3" inside) & (3' outside)
H-2-131650	Sample Gallery Cart Waste Container	metal 19.25' x 15.4' x 9.4' - 1990 -
H-2-817864	Modified Fuel Spacer Burial Box	concrete1994 - 6' x 10' x 24' ; 7 x 11 x 27
H-2-821809	4'x3'x8' Plywood Box	FRP 1984 - wood - 3" x 4" x 8"
H-2-821822	Lifting Cradle Burial Box	N/A 1994 - 11.2' x 25.2' x 1" -6" fuel spacer box goes on top of it
H-3-39711	Burial Box Details 6.5 Ton	N/A
H-9-00103	Overpack Cesium Chloride Capsule Overall Assembly	cylinder metal 1989 - 2.8' x 2" od
P-14420-1	Rocky Flats DOT 7A Fiberglass Plywood Box	N/A
SK-2-03581	Class 1 Shipping Container Model D 19-9-20	N/A

APPENDIX B

APPROVED BURIAL CONTAINERS LIST

(Foster and Carter 1981)

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APPROVED BURIAL CONTAINERS LIST

Appendix B provides specific information regarding container description, specifications and restrictions, maximum weight, maximum fissile content, dose rate limit, maximum load, dimensions, and authorized contents for approved burial containers in 1981 (Foster and Carter 1981). This is the only year for which a table was located identifying approved burial container specifications.

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Approved Burial Containers List (Foster and Carter 1981).

Container Type	Description of the Container	Specifications and Restrictions	Maximum Weight (lbs)	Maximum Fissile Content (g)	Dose Rate Limit	Maximum load (lbs)	Length (ft)	Width (ft)	Height (ft)	Diameter (ft)	Authorized Contents
Drums											
55-Gallon Drum for non-TRU Waste Spec 17E/17H			840		*						U-235 fissile, non-TRU
55-Gallon Steel Drum, Spec 17H	18 gauge sides and bottom head sheet, 14 or 16 gauge removable head sheet (16 gauge authorized provided there are one or more corrugatios in the cover near the periphery)	Any bulky equipment with sharp corners, protusions, etc. must be securely positioned within drum. Gasket material must have minimum operating range of -40°F to +130°F. If sponge rubber gasket is used, minimum of 1/2 in. required.	840				interior (33.25) exterior (35)			interior (22.5) exterior (24)	
55-Gallon Steel Drum, Spec 17C	16 gauge body and head sheets	Any bulky equipment with sharp corners, protrusions, etc., must be securely positioned within drum. Gasket material must have minimum operating range of -40°F to +130°F. If sponge rubber gaskets are used, minimum of 1/2 in. required.	840				interior (33.25) exterior (35)			interior (22.5) exterior (24)	Type "A" quantites of solid radioactive material in normal or special forms.
55-Gallon Galvanized Drum for TRU Waste 17C, DOT Spec 7A			840	200	200						
30-Gallon Spec 17H Drum		Material must be packed to prevent shifting and sharp objects puncturing wall.	1050				29 1/8			18.25	Type "A" quantities of solid radioactive waste in normal or special form. No more than 20 curies of Po-210 contained in static eliminator devices. Each device shall be additionally contained in a plastic outer wrap.
Other Containers											
Steel Corrugated Box for TRU Waste			12000	1000	200		7	6	6	n/a	
CI 6712 Shipping/Burial Containers for TRU or non-Tru			30000	1000	200		12	6	7	n/a	
General Purpose Burial Box for Rockwell B Plant and T.F.P.E.			40000		5 at 1 m	16000	19	10	7	n/a	Non-fissile, Non- TRU waste
Burial Box for Purex Filters			41000		5 at 1 m	16000					Non-fissile, Non- TRU waste
Lined Burial Box for Low Level Beta-Gamma Waste (Wood with steel liner)			4400		*	3000	10	6	4	n/a	Non-fissile, Non- TRU waste
Wood Burial Box for Dry, Low-Level Beta-Gamma Waste			1900		*	1000	8	4	4	n/a	Non-fissile, Non- TRU waste
B-Plant Concentrator Burial Box			40000		*	10000	35	11	16	n/a	Non-fissile, Non- TRU waste
Standard Burial Box with Yoke			14800		3 at 1 m	4000	11	5	6	n/a	Non-fissile, Non- TRU waste
B-Plant Agitator Burial Box			39500		5 at 1 m	16000	24	10	6	n/a	Non-fissile, Non- TRU waste
Canyon Burial Box - Purex			41000		5 at 1 m	16000	19	10	8	n/a	Non-fissile, Non- TRU waste
K-3 Filter Burial Box			38000		3 at 1 m	20000	19	6	10	n/a	Non-fissile, Non- TRU waste
Fiberboard Box/Polyethylene Liner			65		*		1.5	1.5	2	n/a	Non-TRU waste
HEDL Non-TRU Concrete Filter Burial Box			2400								Non-fissile, Non- TRU waste
HEDL Wooded Container for Decon Hood Burial			1500			500	9.33	5	3.83	n/a	Non-fissile, Non- TRU waste
HEDL Steel Box Burial Container			5500		1		15.5	6.25	4.17	n/a	TRU waste
HEDL TRU Retrievable Storage Container			6000			2600	10	5	3	n/a	
Battelle - 6-1/2 ton Steel Burial Box W/Wood Overpack			8657			2000	8	4	4	n/a	Non-fissile, Non- TRU waste
Battelle - Fiberglass Reinforced Polyster (FRP) Wooden Box (1)			5000				7	4	4	n/a	Non-TRU waste
Battelle - Fiberglass Reinforced Polyster (FRP) Wooden Box (2)			5000				7	2	4	n/a	Non-TRU waste
Battelle - Non-TRU Wooden Burial Box			2000				12.5	4.5	4	n/a	
Concrete TRU Container	Steel culvert encased in concrete	For storage on asphalt pad.	8000		200					4	TRU waste
K-Area Ion Exchange Columns	Made of schedule-10 pipe; Transported in overpack		1000		*					1.5	Non-fissile, Non- TRU waste
Disposal Cask for Irradiated Balls			850		*						Non-fissile, Non- TRU waste
38" 1 cubic yard crate	DOT Type 7A Wood Crate	Material must be packed to prevent shifting. Not authorized for air shipments.	2700				interior (38.5)	interior (33.5)	interior (33.75)		Type "A" quantites of solid radioactive material in normal of special form. Not more than 20 curies of Po-210 contained in static eliminator devices. Each device shall be additionally contained in a plastic outer cover.
6' 2" cubic yard crate	DOT Type 7A Wood Crate	Material must be packed to prevent shifting. Not authorized for air shipment.	2700				interior (67.5)	interior (38.5)	interior (33.75)		Type "A" quantites of solid radioactive material in normal of special form. Not more than 20 curies of Po-210 contained in static eliminator devices. Each device shall be additionally contained in a plastic outer cover.
55-Gallon drum overpack crate	DOT Type 7A Wood Crate	Authorized for 55-Gallon drum overpack only. Not authorized for air shipment.	1600				interior (24.5)	interior (24.5)	inerior (34.625)		55-Gallon 17H drum
11' 4 1/2" Static Bar Crate	DOT Type 7A Wood Crate	Material must be packed to prevent shifting. Not authorized for air shipment	1250				interior (132)	interior (14 3/4)	interior (9)		Type "A" quantites of solid radioactive material in normal of special form. Not more than 20 curies of Po-210 contained in static eliminator devices. Each device shall be additionally contained in a plastic outer cover.
7' 3" Static Bar Crate	DOT Type 7A Wood Crate	Material must be packed to prevent shifting. Not authorized for air shipment.	1250				interior (82.5)	interior (14.75)	interior (9)		Type "A" quantites of solid radioactive material in normal of special form. Not more than 20 curies of Po-210 contained in static eliminator devices. Each device shall be additionally contained in a plastic outer cover.
30 Gallon Drum Overpack Crate	DOT Type 7A Wood Crate	Not authorized for air shipment. Authorized for 30 gallon 17H drum overpack only.	1200				interior (20.25)	interior (20.25)	interior (29.5)		30 Gallon 17H drum
Shielded Disposal Cask	12 gauge corrugated culvert lined with concrete		6000		*		5.5			4.5	Non-fissile, Non-TRU material

* Dose rate limits based on transport and burial methods

APPENDIX C

DRAWING NUMBERS FOR BURIAL GROUND FACILITIES

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DRAWING NUMBERS FOR BURIAL GROUND FACILITIES

Facility area	Facility number	Drawing numbers	Photograph numbers
100-B	118-B-1	H-3-57210 M-1600-B#8 H-1-4049 G-7-215	122440-309-CN
	118-B-2	H-3-57210 H-1-4049 G-7-215	122440-297-CN 122440-303-CN
	118-B-3	H-3-57210 G-7-215 H-1-4049	122440-302-CN
	118-B-4	H-3-57210 H-1-4049 G-7-215	122440-304-CN
	118-B-5	H-3-57210 H-1-4049 G-7-215	122440-300-CN 122440-301-CN
	118-B-6	H-3-57210 H-1-4049 G-7-215	122440-296-CN
	118-B-7	H-3-57210	---
100-C	118-C-1	H-3-57210 H-1-15394 H-1-15234 H-1-4049 G-7-215	122440-307-CN
	118-C-2	H-3-57210	---
100-D	118-D-1	H-3-57210 H-1-15395 H-1-14897 H-1-15449 H-1-4049 G-6-216	122440-326-CN
	118-D-2	H-3-57210 H-1-15395 H-1-15246 H-1-4046 G-7-216	122440-325-CN

Facility area	Facility number	Drawing numbers	Photograph numbers
100-D (continued)	118-D-3	H-3-57210 H-1-15395 H-1-15246 G-7-216	122440-331-CN
	118-D-4	H-3-57210 H-1-15395 H-1-15246 G-7-216	122440-335-CN
	118-D-5	H-3-57210 G-7-216	122440-330-CN
	118-DR-1	H-3-57210 G-7-216	122440-327-CN
100-F	118-F-1	H-3-57210 H-1-15396 H-1-14731 H-1-15081 M-1600-F#8 H-1-4048 G-7-219	122440-371-CN
	118-F-2	H-3-57210 H-1-15396 H-1-14731 H-1-15081 G-7-219	122440-385-CN
	118-F-3	H-3-57210 H-1-15396 H-1-14731 H-1-15081 H-1-15244 H-1-4048 G-7-219	122440-381-CN
	118-F-4	H-3-57210 G-7-219	122440-382-CN
	118-F-5	H-3-57210 H-1-15081 H-1-15396 G-7-219	---
	118-F-6	H-3-57210 H-1-15081 M-1600-F#8 G-7-219	122440-386-CN

Facility area	Facility number	Drawing numbers	Photograph numbers
	118-F-7	H-3-57210	122440-433-CN 122440-434-CN
100-H	118-H-1	H-3-57210 H-1-13484 H-1-14732 H-1-15397 H-1-4047 G-7-22	122440-351-CN
	118-H-2	H-3-57210 H-1-15397 H-1-14732 H-1-4047 G-7-22	122440-350-CN
	118-H-3	H-3-57210 H-1-4047 G-7-22	122440-368-CN
	118-H-4	H-3-57210 H-1-4047 G-7-22	122440-366-CN
	118-H-5	H-3-57210	122440-364-CN
100-K	118-K-1	H-3-57210 H-1-34161 H-1-25021 M-1600-K#1 G-7-220	122440-318-CN

Facility area	Facility number	Drawing numbers
200 East	218-E-1	H-2-124 H-2-31269 H-2-44501
	218-E-2	H-2-2479 H-2-44501 H-2-55534
	218-E-2A	H-2-2479 H-2-34761 H-2-44501 H-2-55534
	218-E-4	H-2-31269 H-2-34671 H-2-44501 H-2-55534
	218-E-5	H-2-2479 H-2-31269 H-2-34761 H-2-44501 H-2-55534
	218-E-5A	H-2-34761 H-2-44501 H-2-55534
	218-E-7	H-2-757 H-2-1938 H-2-44501
	218-E-8	H-2-31269 H-2-45501
	218-E-9	H-2-31269 H-2-44501 H-2-55534
	218-E-10	H-2-31269 H-2-44501 H-2-55534 H-2-58025 H-2-92004
	218-E-12A	H-2-32560 H-2-33276 H-2-44501 H-2-57849 H-2-75148
	218-E-12B	H-2-33276 H-2-44501

Facility area	Facility number	Drawing numbers
200 East (continued)	218-E-13	H-2-44500
	218-E-14	H-2-44501 H-2-55586 H-2-55587
	218-E-15	H-2-44501 H-2-58191 H-2-58192 H-2-58737 H-2-74239
200 West	218-W-1	H-2-123 H-2-2516 H-2-44511 H-2-31268 H-2-75149
	218-W-1A	H-2-2516 H-2-44511
	218-W-2	H-2-123 H-2-2503 H-2-31268 H-2-44511
	218-W-2A	H-2-32095 H-2-32102 H-2-36444 H-2-36841 H-2-44511 SK-2-1723
	218-W-3	H-2-3398 H-2-3399 H-2-31268 H-2-32095 H-2-44511
	218-W-3A	H-2-34880 H-2-37520 H-2-44511 H-2-75137
	218-W-3A-E	H-2-44511 H-2-75351

Facility area	Facility number	Drawing numbers
200 West (continued)	218-W-4A	H-2-31268 H-2-31715 H-2-31904 H-2-32144 H-2-32487 H-2-33564 H-2-33692 H-2-44511
	218-W-4B	H-2-33055 H-2-33971 H-2-34375 H-2-35279 H-2-35570 H-2-36243 H-2-36672 H-2-36678 H-2-37071 H-2-37077 H-2-37078 H-2-38022 H-2-38180 H-2-44511 H-2-68621 H-2-70151 H-2-72356 H-2-72398 H-2-72399 H-2-74638 H-2-74639 H-2-74640
	218-W-4C	H-2-34762 H-2-37437 H-2-44511 H-2-68597
	218-W-5	H-2-94677
	218-W-6	---
	218-W-7	H-2-1938 H-2-5170 H-2-51440 H-2-44511
	218-W-8	H-2-1938 H-2-2322 H-2-44511

Facility area	Facility number	Drawing numbers
200 West (continued)	218-W-9	H-2-34762 H-2-44511
	218-W-11	H-2-32487 H-2-34762 H-2-44511
	218-W-12	---
	218-W-13	H-2-33134 H-2-32495 H-2-44511

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