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INTERNAL TECHNICAL REPORT

Title: A HISTORY OF THE RADIOACTIVE WASTE MANAGEMENT COMPLEX AT THE IDAHO NATIONAL ENGINEERING LABORATORY

Organization: WASTE MANAGEMENT PROGRAMS DIVISION
RWMC OPERATIONS BRANCH

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A HISTORY OF THE RADIDACTIVE WASTE MANAGEMENT COMPLEX AT THE IDAHO NATIONAL ENGINEERING LABORATORY

1. INTRODUCTION

The Radioactive Waste Management Complex (RWMC) is located within the Idaho National Engineering Laboratory (INEL), formerly the National Reactor Testing Station (NRTS). The INEL covers 2315.5 km^2 of semiarid land in southeastern Idaho near the center of the eastern Snake River Plain. The U.S. Atomic Energy Commission (AEC), now the U.S. Department of Energy (DOE), established the NRTS in 1949 as a site for building and testing various types of nuclear facilities.

Major waste management developments, decisions, and practices at the RWMC after the site was selected fall into the following time periods: early disposal (1952-59), interim burial ground (1960-63), mid-to-late 60s (1964-69), and 1970-to date. These periods are presented as the major sections of this report. Appendix A contains a listing of terminology changes and an explanation of acronyms used throughout the report. Appendix B is a listing of conversion factors.

Information for this report was drawn primarily from existing records and reports. Available information on the earliest years was somewhat limited since much of the documentation concerning operation at the RWMC before 1970 was destroyed when the required retention period had been exceeded. Table 1 presents a chronological listing of the changes in waste management responsibilities of the government and contractor. Table 2 summarizes the known RWMC developments and facility additions by year.

TABLE 1. HISTDRY OF BURIAL GROUND ADMINISTRATION

Year	ID	Contractor
1952	Health Physics Division Site Survey Branch was responsible for operation of Burial Ground and environmental monitoring. Idaho Operations Office (ID) division of Engineering and Construction (ID-E&C) drew up burial plot plans.	National Industrial Maintenance Co. (NIMCO) was responsible for excavation, unloading, and burial work and Central Facilities maintenance (1949-53). E. B. Steele Co. was responsible for surveying.
Fall 1953		Lost River Transportation Co. was responsible for Central Facilities maintenance.
1953-1966 Energy		Phillips Petroleum Co. (PPCo) Atomic
		Division was responsible for Central Facilities maintenance and Idaho
Chemical		
		Processing Plant (ICPP); absorbed ID-
E&C.		
1953	Health and Safety Division (ID-H&S) was formed from ID Health Physics Safety Branch and Fire Department. Site Survey Branch still was responsible for Burial Ground and onsite radioactive waste disposal.	F. C. Torkelson Co. was responsible for surveying and architectural engineer contract for Site.
1960-1963 AEC.		PPCo became waste-receiving agent for
1961		PPCo assumed responsibility for health physics supervision at Burial Ground.
1962	AEC-ID was responsible for Burial Ground management.	PPCo Health and Safety was responsible for operation of Burial
Ground.		
1962		PPCo Nuclear Safety Committee was responsible for nuclear safety rules.

TABLE 1. (continued)

Year	ID	Contractor
1966		Idaho Nuclear Corporation (INC) (formed as a joint subsidiary of Aerojet-General Co. and Allied Chemical Corporation) was responsible for Burial Ground. Absorbed F. C. Torkelson Co., as INC Architect-Engineering Branch. CPP-HP made receiving agent for offsite waste.
1967	ID-H&S was reorganized into ID Health Services Laboratory (ID-HSL) and ID Operational Safety and Technical Support (ID-OSTS) Division; Environmental Branch of ID-HSL was responsible for technical direction of solid waste burial. Hazards Control Branch of ID-OSTS was responsible for health and safety surveillance.	
1969		INC reorganized; PPCo became a part owner. Nuclear and Operational Safety (NOS) Division (combined H&S Branch, Operations Surveillance Branch, and Nuclear Safety Committee) was responsible for independent internal review of burial operations.
1970	Waste Management Branch was formed in Nuclear Technology Division (NT-ID) and assumed responsibility for Burial Ground management.	NOS was responsible for all INC waste management and pollution control. In late 1970, that responsibility was transferred to Chemical Programs Division.

TABLE 1. (continued)

Year	ID	Contractor
1971 services		Aerojet Nuclear Co. (ANC) became contractor for operating the RWMC. Technical operation of the RWMC was transferred from Aerojet Safety Division to Waste Management Programs to ensure independent auditing capability.
1975	Energy Research and Development Administration (ERDA) replaced the AEC and assumed responsibility for radioactive waste management at the INEL.	
1976		EG&G Idaho, Inc., (EG&G) replaced ANC as INEL prime contractor.
1977	Department of Energy (DOE) replaced ERDA and assumed responsibility for radioactive waste management at the INEL.	

TABLE 2. BURIAL GROUND DEVELOPMENTS AND FACILITY ADDITIONS

Year	Facilities and Equipment Installed	Major Developments
1953	--	Original 5.2 ha of Burial Ground fenced
1954	--	Rocky flats waste shipped to RWMC Transuranic waste from Rocky Flats received visual survey Ground cover placed over filled trenches periodically
1957	--	Burial Ground expanded to 35.2 ha Pit disposal begun to accommodate large and bulky waste TRU waste placed in separate pits
1958	--	NRTS flood control project constructed on Big Lost River, adjacent to Burial Ground--including diversion dam and spreading areas
1960	--	HSL established ten monitoring holes drilled to the basalt adjacent to waste-filled excavations
1960-63	--	Procedures for acceptance of shipments and standardized forms adopted
1962	--	System of dikes and ditches constructed around Burial Ground Diversion dike for Big Lost River constructed by diking spreading area HP technician assigned duty to guide operation, witness disposal, and sign records showing disposal made
1963	--	Began random dumping of Rocky Flats waste in pits instead of stacking.

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1966	--	Minimum soil cover over buried waste increased from 0.6 to 0.9 m Minimum trench depth increased from 0.9 to 1.5 m Heavy metal plate used for compaction Fire protection improved Waste covering at end of week required
1969	--	Extensive dike system constructed to protect Burial Ground from runoff in local drainage basin Temporary grading and diking provided inside Burial Ground to control internal drainage Stacking of waste from Rocky Flats reinstituted
1970	--	RWMC expanded to 57.6 ha when 22.4-ha TSA was added Burial of TRU waste discontinued; TRU waste stored aboveground on asphalt, then covered with layers of plywood, plastic, and soil Diking around SDA completed At least 0.6 m of soil placed over bedrock at bottom of new pits and trenches
1971	Burial Ground trailer TSA change trailer Forklift truck, backhoe, and crane	RWMC land graded to provide major drainage channels for surface water Waste carried by ATMX cars, improved rail shipment carriers Stacking mechanized with hydraulic-cylinder unloader Computerized Waste Management Information System implemented Fire Protection Plan instituted Equipment and personnel permanently assigned to the RWMC

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1972	Dozer/scraper to cover Rocky Flats waste on ITSA pad	Waterproofing of ITSA pad upgraded
	Second access road for emergency use to west end of the RWMC	ITSA pad extended 76.2 m
		Upgrading of containers initiated, i.e., new steel drums painted white
		TDA pad established for surface disposal of waste with less than 10 nCi/g of transuranic nuclides
		Emergency Action Plan completed
1973	Mobile yard ramp and four forklift trucks	Training program for operators and supervisors at Burial Ground initiated
		TRU combustible and noncombustible waste packaged separately
		Environmental Surveillance Plan formulated
		Sampling of small mammals and soil outside SDA begun
		Measuring of temperature and humidity in ITSA storage configuration implemented
		Drainage of RWMC upgraded
		Machine compression test on ten 208.2-L steel drums performed
		Burial Ground subsurface water monitoring plan begun
1974	BORAX V building for storage of Waste Management material	Two 18 925-L water storage tanks installed under ground for fire-protection purposes
	ITSA exclusion fence	Plywood boxes covered with fiberglass-reinforced polyester (FRP), and steel drums lined with 0.23-mm polyethylene liners
	WMF-601	
	WMF-602 Decontamination Facility South	Initial Drum Retrieval (IDR) Program begun (1974-78)
	Decontamination Facility evaporation pond fenced	Most onsite waste transported in plastic bags for compaction

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1974 (cont)	Hydraulic, bale-type compactor installed in Equipment and Compactor Building for volume reduction of waste before disposal	Bioassay program initiated
	Perimeter electrical monitoring power around RWMC and evacuation alarm system installed	Radiation survey of grounds mechanized
	Railroad spur to TSA completed providing direct shipment of waste to RWMC	Computerized Transuranic-Contminated Waste Container Information System (TCWCIS) developed and implemented
	Air support structure placed over IDR	
	Second TSA storage pad	
1975	TSA air-support weather shield (ASWS)	Metal corrosion coupons placed with stored waste in TSA
	TSA instrusion alarm system	Soil level raised above SDA pits and trenches to exclude moisture accumulation (1975, 1976, 1978)
	362.9-kg-capacity front-end loader and hydraulic excavator	
	TSA-2 pad extended	
	TDA pad (Pad A) extended	
1976	Intermediate-Level Transuranic Storage Facility	Early Waste Retrieval project started
	WMF-603 water storage tank and pumphouse	Flora and fauna studies started
	Air-support weather shield for EWR project	
	TSA-R pad constructed and placed in operation	
	SDA sump pump installed	
	Movable Operating Area Confinement (OAC), including change booths, fire protection equipment, and air moving and filtering equiment used for retrieval in ASWS for EWR	

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1976 (cont)	Cherry picker Excavator 59-metric ton crane Front-end loader Water spray trailer Two flatbed trailers One air compressor	
1977	WMF-604 RWMC change and lunch facility	Cell monitoring instruments installed to measure temperature and humidity in TSA-1
	Soil vaults	
	Standby electrical power	
	TSA pad sweeper Dump truck Ten-wheel flat bed truck Earth tamper Water spray trailer Air compressor (breathing type)	
1978		Operating procedures standardized
	7570-L water truck 40.8 metric ton crane Earth scrapers Rough-terrain forklift	Offsite and onsite packaging criteria standardized and issued to replace Letters of Agreement with waste generators
	Additional vaults for ILTSF	Training guidelines and evaluation program established
		Health physics monitoring program improved
		Site characterization instrumentation program improved
		Core sampling for subsurface studies of 1972-78 initiated and continued
		Flora and fauna studies of 1977-78 improved
		Air monitoring of 1974-78 improved
		Additional soil stabilization and moisture exclusion initiated (0.6 to 0.9 m of soil cover over previously buried TRU waste)
		Fire testing of FRP boxes

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1979	Twenty 61-cm-dia. ILTSF vaults; five 40.6-cm-dia. ILTSF vaults	Bottom-discharge Cask Design Guidelines issued
	Radiation Analysis Laboratory (RAL) in WMF-601	Removal of basalt in disposal area initiated to increase disposal space
	Heavy Equipment Storage Shed (HESS), WMF-609	Fire testing of FRP boxes, plywood boxes, and metal boxes
	ILTSF pad area expanded	
	Dozer with ripper	
1980	Discrete sumps and drainage facilities on TSA-2	Testing of explosive fracturing of basalt in SDA--scale-model tests outside RWMC and in Pit 17
	Fifteen 61-cm-dia. and five 40.6-cm-dia. ILTSF vaults	Conceptual designs and estimates completed on large (54.4-metric ton) bottom-discharge cask
	New fire pumps and piping systems in WMF-603	Relocation of Air Support Weather Sheild to Cell 3, TSA-2
	1.3-m soil vault sleeve	Disposal of ANL-E low-level waste commenced
	Firehose cart with 304.8 m of reeled hose	
	Two 11.5-m^3 dump trucks	
	Front-end loader	
	ASWS block-lifting fixture	
	55.95-W turbine pump to replace original RWMC deep-well pump	
1981	Dry-pipe fire mains to TSA and SDA; and fire sprinkler systems in WMF-602, -603, and -609	First production-scale explosive rock fracturing; 2977 m^3 of basalt fractured and removed from Pit 17.

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1981 (cont)	Ultraviolet (fire) detection system installed in ASWS-2 and around Pit 16	Fire-retardant paint testing
		Thermal testing of ILTSF vaults
	Guardhouse (WMF-611) under construction	Water removed from ILTSF vaults before drying and resealing the vaults
	Production deep well pump installation and testing completed	SDA acid pit sampled; presence of waste radionuclides or other toxins not indicated by analyses of soil samples
	Five, 40.6-cm-diameter and twenty-two 61-cm-diameter ILTSF vaults installed with shield plugs and radiation-monitoring tubes	Monitoring potentially flammable gas in TSA cells
	Cylindrical concrete monuments to replace damaged old-style monuments	TRU waste shipments stacked in designated sections on ASWS-2
	Liquid Corrosive Chemical Disposal Area (LCCDA) closed	
	Weighing lysimeter data logger and weather station installed and tested	
	Water storage tank interior sandblasted and repainted	
	127-metric ton Manitowoc crawler-mounted crane	
	ASWS-3 deflated and stored	
1982	Motion-detection system installed in ASWS-2	RWMIS, TCWCIS, and SWIMS converted to NOMAD VP/CSS data base management system
	Guardhouse (WMF-611) completed	PWMC flooded by rapid snowmelt
	Decontamination Facility South (DFS) (WMF-602) decomtaminated and decommissioned then redesignated Operational Support Facility (OSF)	Flood-control upgrade
		Explosive rock-fracturing; 14 196.1 m^3 of basalt fractured and removed from Pit 17; 22 950 m^3 of basalt fractured in second FY 1982 blasting but not removed at end of FY 1982
	Radiography room and equipment installed in OSF for examination of drums and boxes of waste (a Waste Experimental Reduction Facility (WERF) project)	Hydrogen explosion testing (mock-up, 208.2-L waste drums)
		Thermal testing of ILTSF vaults

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1982 (cont)	Twenty-two, 61-cm-diemeter and ten, 40.6-cm-diameter ILTSF vaults installed; twelve, 121.9-cm-diameter ILTSF vaults procured for NWCF filters	New definition of TRU-contaminated material
		Soil sampling to detect trace elements or organics that could be transported by air to beyond the RWMC boundary
	Rotary snow-blower	Russian thistle samples
	7.3-metric ton, rough-terrain, extendable-boom, LOED forklift	Rock-fracturing tests using BRI-STAR and freezing water
	5.4-metric ton forklift	
	1.8-metric ton forklift	
	11.5-m^3, heavy-duty dump truck	
	49.9-metric ton, bottom-discharge cask	
1983	IH 11.5-m^3 dump truck	Explosive rock-fractfuring; 22,950 m^3 of basalt fractured in pots 18 and 19
	White 29.9-metric ton truck tractor	
	Hyster 2722-Kg forklift	Offsite and onsite packaging criteria were reviewed and combined into two DOE-ID documents
	Toyota 1814-Kg forklift	Quality Assurance Program Plans were prepared by each waste generator and approved for TRU waste shipments to the RWMC
	Kohler 50 Kw generator set	
	Jeep dolly	New drain culvers from north SDA external drain channel to main RWMC external drain channel installed. Explosive rock fracturing in main drain channel between RWMC and Adams Blvd. completed
	2-Trailers, 36-metric ton, flat deck	
	2-Trailers, 32-metric ton, folding deck	Environmental assessments performed for wind gaps dikes 1 and 2 raised approximately six feet
	Light generator trailer	
	Four 40.6-cm-diameter, twenty 61-cm-diameter and twelve 121.9-cm-diameter ILTSF vaults installed	

TABLE 2. (continued)

Year	Facilities and Equipment Installed	Major Developments
1983 (cont)	Visitor parking lot paved, exterior to Guard Post, WMF-611	
	New TSA/SWEPP access bridge installed	
	TSA-3 asphalt pad installed	
1984 thru July 1985	Soil vacuum, truck mounted	Explosive rock-fracturing; 24,092 m^3 of basalt fractured in pits 19 and 20. The broken rock was placed as rip-rap on flood control dike number-1 and 2 (July 1, 1984).
	2 trailers, 36-metric ton, flat deck	
	Railcar mover	RWMC Spill/Decon Plan approved
	SWEPP, 2.7 metric ton forklift (LP)	Automated TRU Waste Interim Tracking System developed and implemented
	Radiation Analysis Lab decommissioned	
	SWEPP and C&S buildings completed	Spreading Are Flood Control Dike No. 1 raised six feet, and Dike No. 2 eight feet
	The two south bays of the HESS enclosed	Productivity measurement system implemented and automated
	WVRF compactor filtered exhaust system modified to discharge outside the building	SWEPP operational August 1, 1985
	Bulk disposal crane pad constructed	Geotextile use in pit floor implemented
	SWEPP Scales (2268Kg)	

2. EARLY DISPOSAL PRACTICES (1952-59)

2.1 Waste Disposal Site Selection

The AEC recognized the need to develop a local disposal ground for the solid, radioactively contaminated waste that would be generated during the operation of nuclear reactors and associated facilities at the National Reactor Testing Station. The United States Geological Survey (USGS) was consulted in the selection of a disposal site on the NRTS. The disposal site was selected in 1951 according to the following criteria:[1,2]

a. An area of not less than 4 ha

b. Accessibility without extensive road construction

c. An area with not less than 4.6 and preferably 6.1 m of unconsolidated sedimentary overburden on the bedrock. (At that time the personnel selecting the site believed that trenches would be 3.7 to 4.6 m deep and that waste materials would be covered with at least 1.8 m of soil.)

d. Appreciable amounts of clay in the burial sediments, especially in the beds below a depth of 3.7 m. A USGS letter[1] stated that there should be at least several feet of sediment under the buried material to slow the downward percolation of gravitational water and to assist natural absorption of radioactive solids dissolved in circulating water. The letter stated that appreciable amounts of clay in the sediments would facilitate natural absorption.

e. Overburden sufficiently cohesive to stand a short period in vertical or nearly vertical walls

f. An area not directly up the groundwater stream from existing or potential reactor sites or other places where water production wells may be drilled.

g. Good surface drainage, leading away from existing or potential installations or water production sites.

A 40.0-ha area, located in the southwestern corner of the NRTS and characterized by fine-grained sediments deposited by the Big Lost River, was proposed for disposal operations. In May 1952, a 5.2-ha tract of this area was established as the NRTS Burial Ground for solid waste disposal.[3,4] At that time, AEC was also considering the area as a disposal site for solid waste generated at nuclear facilities in other parts of the country.[5] The Burial Ground site is located in Section 18, T2N, R29E, 3.2 km southwest of the Experimental Breeder Reactor-I (EBR-I) site, 8.1 km west of the Central Facilities Area, and 25.7 km southeast of Arco (see Figure 1).

2.2 Early Environmental Monitoring

Before the introduction of any radioactive material at the NRTS, extensive detailed information had been obtained between 1949 and 1950 on the natural background radiation. This environmental appraisal included evaluations of the effects of naturally occurring radionuclides in air, water, soil, and vegetation, and on predominant wildlife. The study established a base line against which quantities of radionuclides originating from reactor operations could be recognized easily and appraised.[6]

From the beginning of waste disposal, portable instruments had been used for direct monitoring, visual inspections, and surveys of the excavation areas. Although no routine air samples were taken in connection with the Burial Ground, an air-monitoring network throughout the NRTS and offsite had been maintained by AEC ID-HSL since the NRTS was first established by AEC-ID.[7]

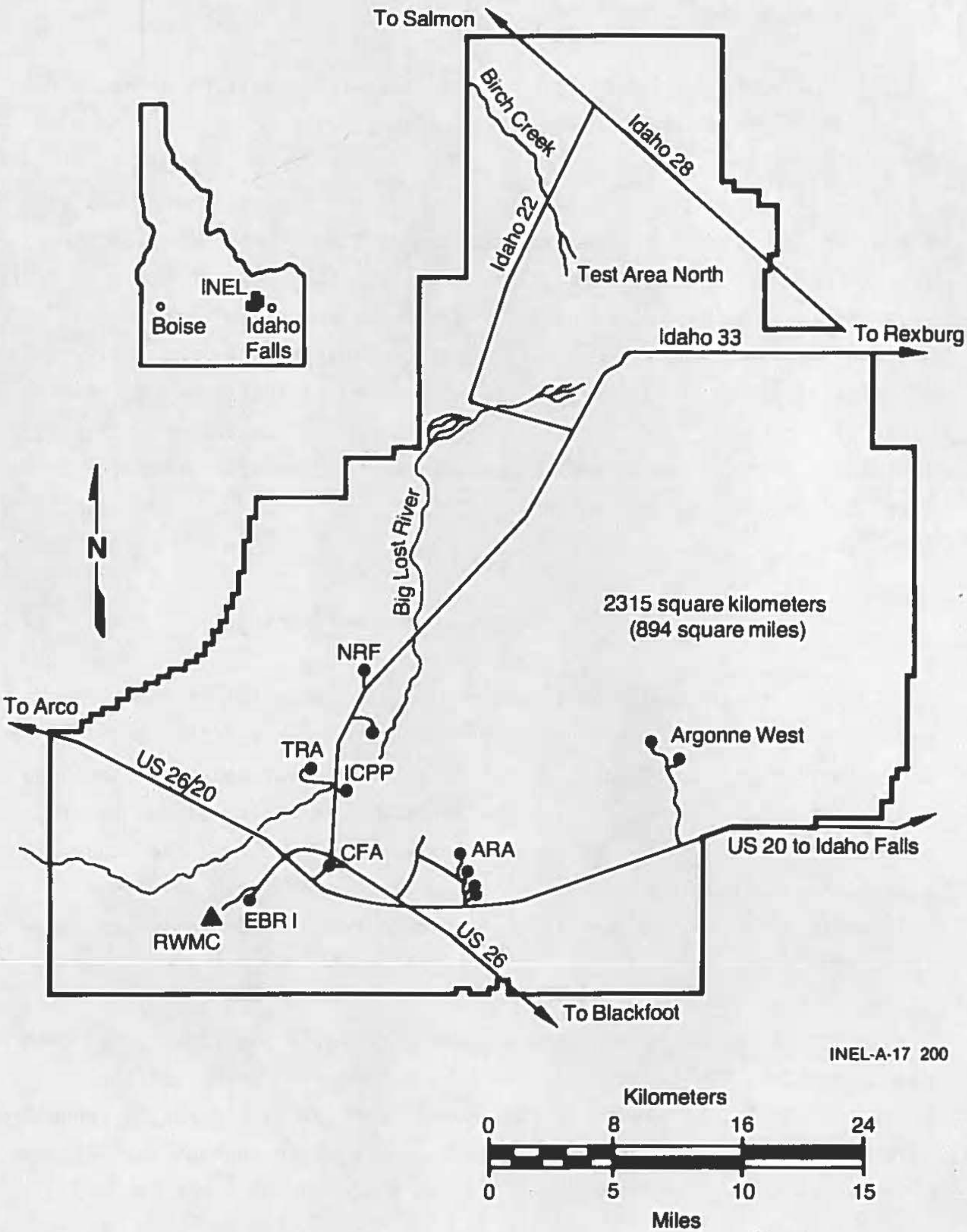


Figure 1. Location of Burial Ground (RWMC) at INEL.

2.3 Geology and Hydrology of the Burial Ground

During 1952, the USGS performed an investigation of the geology and hydrology of the larger 40.0-ha area.[3,5] A USGS report, published in 1953,[5] stated that the area was generally favorable for the disposal of limited quantities of short-lived radioactive waste and that its sediments would have greater ion-exchange capacity than sediments nearer the Big Lost River. The report noted that surficial sediment was more than 2.7 m thick over much of the site. AEC approved the site location since it met most of the original criteria for a suitable burial site.[3]

The 1953 USGS report also suggested that water in contact with contaminated material might carry contaminants downward to the water table. However, contamination was thought unlikely since percolating water would be subject to ion-exchange processes, and local precipitation would contribute little recharge water.

2.4 First Trench Burials

On July 8, 1952, the first trench was opened for the disposal of mixed-fission-product (MFP) waste generated at the NRTS. The MFP waste consisted mainly of contaminated paper, laboratory glassware, filters, and metal pipe fittings.[3] Although the Burial ground was designated for disposal of solid waste, one report[5] states that certain liquids in sealed containers were placed in the first trench.

Between 1952 and 1957, Trenches 1 through 10 were excavated to basalt.[8,9,10] These early trenches were approximately the same size, averaging 1.8 m wide, 274.3 m long and 3.7 m deep.[9] Spacing between these trenches ranged from 3.4 m up to 18.3 m.[10] Table 3 lists the opening and closing dates of trenches at the Burial Ground.

The Burial Ground was enclosed almost immediately with a barbed wire fence. Metal tags placed on the fence served as the sighting devices to mark trench locations.

TABLE 3. OPENING AND CLOSING DATES OF PITS AND TRENCHES[10]

Trench Number	Date Opened	Date Closed	Trench Number	Date Opened	Date Closed
1	07-08-52	10-01-54	40	10-07-65	01-13-66
2	10-01-54	12-21-54	41	01-04-66	10-04-66
3	12-22-54	04-22-55	42	05-09-66	01-16-67
4	04-22-55	11-21-55	43	10-20-66	06-01-67
5	11-04-55	03-29-56	44	01-13-67	03-24-67
6	03-22-56	09-04-56	45	02-28-67	09-27-67
7	08-14-56	12-20-56	46	09-25-67	03-14-68
8	12-13-56	05-07-57	47	02-28-68	08-05-68
9	01-17-57	09-06-57	48	08-08-68	05-02-69
10	07-19-57	02-07-58	49	11-18-68	06-30-69
11	02-11-58	07-25-58	50	07-01-69	11-01-69
12	01-03-58	01-16-59	51	10-30-69	04-08-70
13	01-09-58	04-24-59	52	03-04-70	07-04-70
14	04-16-59	07-30-59	53	07-01-70	10-12-70
15	07-31-59	10-16-59	54	09-23-70	05-04-71
16	10-17-59	04-12-60	55[a]	04-07-71	03-12-82
17	11-01-59	07-01-60	56	12-29-71	02-01-73
18	05-10-60	07-20-60	57	12-28-72	06-11-74
19	07-05-60	11-29-60	58	02-20-74	08-17-81
20	12-01-60	06-30-61			
21	12-13-60	01-10-61	Pit Number		
22	02-01-61	04-25-61	1	11-01-57	10-01-59
23	06-20-61	09-15-61	2	10-01-59	07-01-63
24	10-01-61	07-31-62	3	12-15-61	01-03-63
25	08-01-61	07-27-62	4	01-03-63	09-26-67
26	04-13-62	08-17-62	5	06-18-63	12-22-66
27	08-20-62	01-04-63	6	05-18-67	10-22-68
28	12-26-62	03-12-63	7	09-19-66	10-05-68
29	11-19-62	03-20-63	8	03-06-67	11-00-69
30	03-02-63	09-12-63	9	11-08-67	06-09-69
31	03-25-63	11-22-63	Acid Pit	01-01-54	01-01-61
32	04-01-63	11-18-63	10	08-07-68	07-08-71
33	10-11-63	08-11-64	11	04-14-70	10-16-70
34	03-18-64	08-27-64	12	07-02-70	09-12-72
35	08-28-64	01-19-65	12	07-20-71	07-29-74
36	12-01-64	07-24-65	14	07-01-74	03-31-76
37	12-24-64	07-01-65	15	06-25-75	07-05-84
38	05-15-65	09-16-65	16	05-22-68	Still open
39	07-20-65	11-05-65	17	08-20-82	Still open

a. Trench 55 was closed administratively 03-12-82 due to unknown conditions at the east end of the trench.

2.5 Disposal Procedures

A 1957 letter,[11] the earliest available description of the disposal routine, indicates that NRTS-generated solid waste was picked up twice a week. The operation of the Burial Ground was then the responsibility of the Site Survey Branch, Health and Safety Division, of AEC-ID, but actual burial operations were provided by the Central Facilities maintenance contractor.[4] (See Table 1.)

Routine solid waste was defined in terms of the personnel exposure caused by handling. If the health physicist who took radiation readings outside the metal container and in the truck cab determined that handling the waste would not cause personnel to exceed their daily exposure limits, the waste was handled as routine waste.[7]

Routine solid waste was packaged and disposed as follows:

a. Waste was placed in 0.8 by 0.8 by 0.9-m cardboard boxes and sealed with masking tape.

b. Cardboard boxes were placed in metal Dempster Dumpster containers, marked and used for radioactive waste only. Such containers were provided at the areas where waste was generated.[11]

These routine waste disposals were made under the supervision of a health physicist from the AEC-ID Site Survey Branch.

Nonroutine (high-radiation-level) waste that could cause excess personnel exposure was transported in special containers and transfer vehicles. As shown in Figure 2, a long-tongue trailer, pulled behind a pickup truck, was used to haul material contained in a 0.6 by 0.6 by 0.9-m wooden box or in a 113.6-L garbage can. NRTS contractors used a coffin and a lead open-top box container to shield the high-radiation-level waste. The nonroutine disposals were controlled by the Site Survey Branch of AEC-ID and were carried out under the supervision of a health physicist.

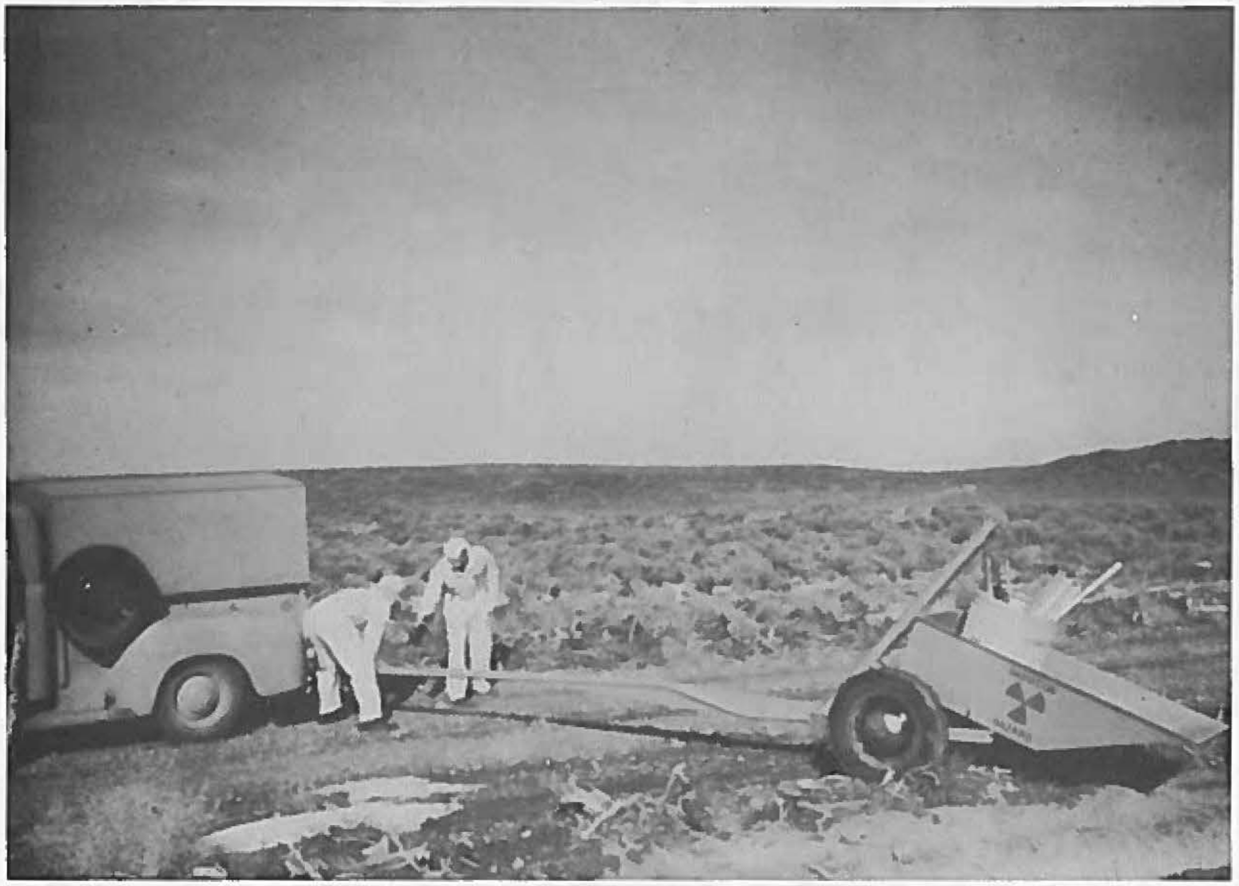


Figure 2. High-radiation-level waste disposal in 1950's.

At least up to 1957, no upper limit had been set on the level of radiation that could be handled; items of up to 12,000 R/hr were buried.[11]

Routine waste was dumped into the trenches (Figure 3) and probably not covered with earth until the end of the operating week.[5] Nonroutine waste deposited into the trenches was immediately covered with earth, but records of the earliest burials give no indication of the depth of earth cover or limits on radiation emitted.

Curie content and disposal location were recorded for the earliest disposals.[7] In those records the responsible personnel attempted to inventory each load, but completion of a form was not required as part of the disposal procedure.

In 1957, AEC-ID Manual, Chapter 0500-7, spelled out the responsibility and the organization involved in disposal of solid radioactive waste at the NRTS Burial Ground.[12,13] A 1959 supplement to the ID Manual, Chapter 0500-7, (a) made the organizations disposing of (or transporting) waste responsible for labor, equipment, and services in connection with the disposal operations, (b) required a standardized form to be filled out for each disposal, and (c) formally defined routine and nonroutine waste.[13] Organizations disposing of waste were responsible for safe packaging, personnel protective clothing, film badge and dosimeter monitoring, and equipping transport vehicles with "Radioactive Materials" signs on the front and rear. The organizations received permission to bury waste and obtained a key to the Burial Ground from the Site Survey Branch. With a health physicist present, waste was dumped in areas of the trenches clearly marked for disposal by signs on metal posts that were welded to truck wheelbases. The organization then returned the key and a completed "Waste Disposal Request and Authorization," Form ID-110, to the Site Survey Branch.

Waste was handled as nonroutine if it

a. Emitted over 500 mR/h at 0.9 m

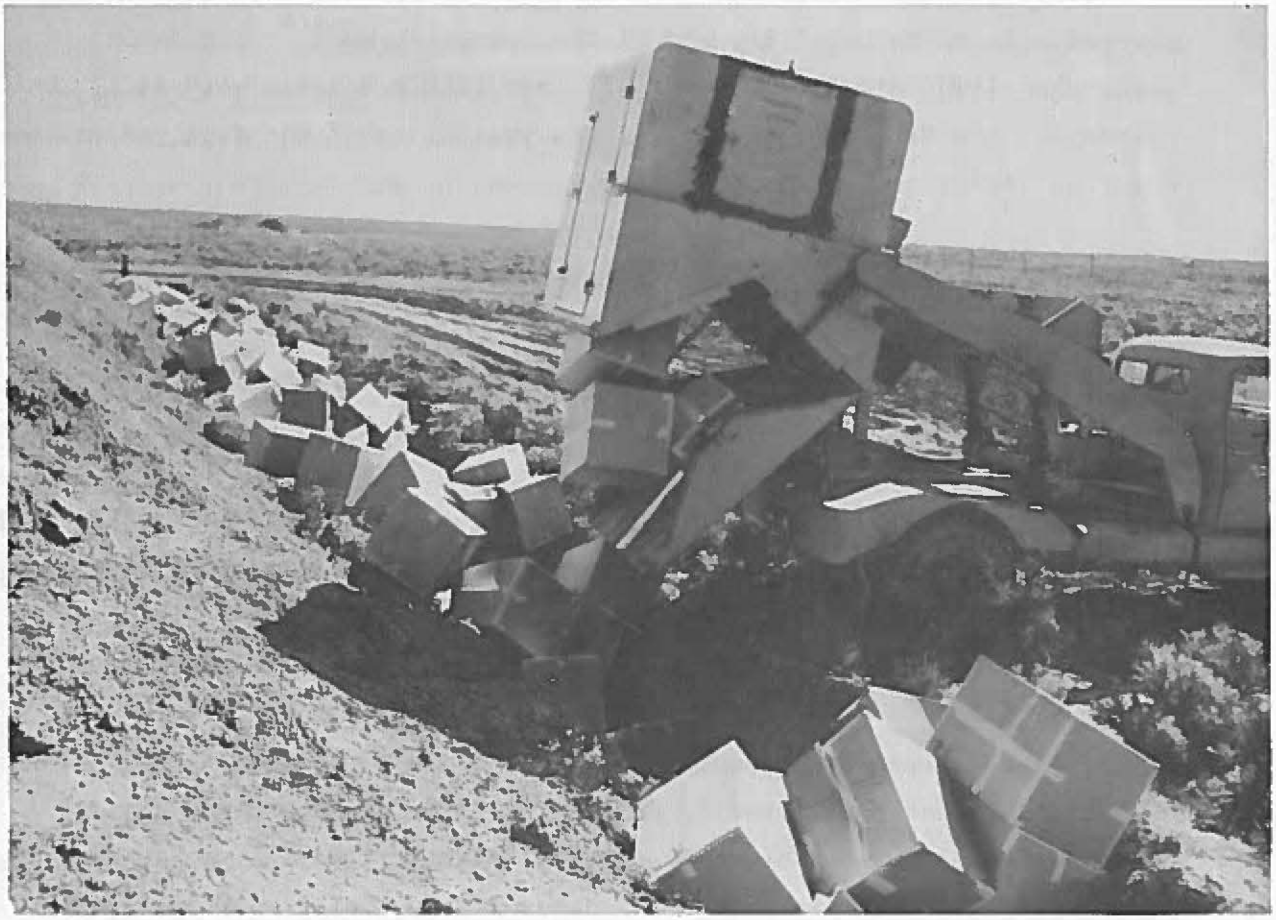


Figure 3. Dumping of boxes containing routine waste, 1950's.

b. Required special handling, special hauling, or shielded containers

c. Was source material (plutonium-238 or thorium), liquids, or slurries.

Arrangements to dispose of nonroutine material were made in advance with the Site Survey Branch; Form ID-110 was also submitted in advance to the Site Survey Branch for special approval and instructions.

2.6 Disposal of Rocky Flats Waste

In 1953, AEC decided that solid radioactive waste from its Rocky Flats Fabricating Facility near Golden, Colorado, would be sent for disposal to the Burial Ground, since waste burial in the Golden area was not acceptable.[14] Trucking quotations from Rocky Flats to either NRTS or Las Vegas were identical, but contacts at NRTS had communicated that they could accept the Rocky Flats waste, and the NRTS Burial Ground was selected for disposal of the Rocky Flats Waste.[15,16]

The first shipment of Rocky Flats waste was authorized in March 1954. This shipment was to be a trial run to provide (a) handling and shipping experience and (b) cost information to compare with alternative disposal methods, such as disposal at sea or disposal at other AEC installations.[15,17] At this time, a concern was expressed for reducing waste bulk, primarily to reduce shipping and handling costs. The memorandum authorizing this shipment stated that a final solution might be the establishment of a regional burial site for the western United States.[15]

The first drums from Rocky Flats arrived on April 22, 1954. Since this trial run proved that such shipments could be handled satisfactorily,[18] the AEC authorized the shipment of Rocky Flats waste to the NRTS.

The early waste shipments from Rocky Flats were not accompanied by papers describing the physical and radionuclide content. Instead, a memorandum from Rocky Flats was written at the end of each year summarizing the total radionuclide content and volume of the waste shipped to the NRTS. All shipments, however, were subject to Interstate Commerce Commission regulations.[19]

Between April 1954 and November 1957, the transuranic (TRU) contaminated waste from Rocky Flats was interspersed with NRTS mixed-fission-product waste in Trenches 1 through 10.[9]

2.7 Burial Ground Expansion

Since the 5.2-ha Burial Ground was nearly filled by 1957, it was then expanded to its present size of 35.2 ha, encompassing most of the 40.0 ha surveyed by the USGS in 1952. The expansion also enclosed an acid pit that had been used for disposal of radioactive laboratory acids since January 1, 1954.[4,10,14]

2.8 First Pit Disposals

Excavation of pits began in 1957 to accommodate large, bulky items being shipped from Rocky Flats. The amount of waste from Rocky Flats was rapidly increasing at that time. Trenches were used for disposal of the MFP waste; but MFP waste too bulky to fit into the trenches was also placed in pits.[9] Figure 4 illustrates the pit and trench locations at the Burial Ground.

Pit 1 was opened November 1, 1957,[10] and was located in the northeast corner of the original 5.2-ha site. (Card[9] indicates that the pit was opened earlier, on September 26, 1957.) Table 3 presents the opening and closing dates of the pits and trenches at the Burial Ground.

Tractor-drawn scrapers excavated the pits until the basalt was exposed. Pit dimensions range from 15.2 to 91.4 m wide, 76.2 to 335.3 m long, and 1.5 to 4.6 m deep.[3,8]

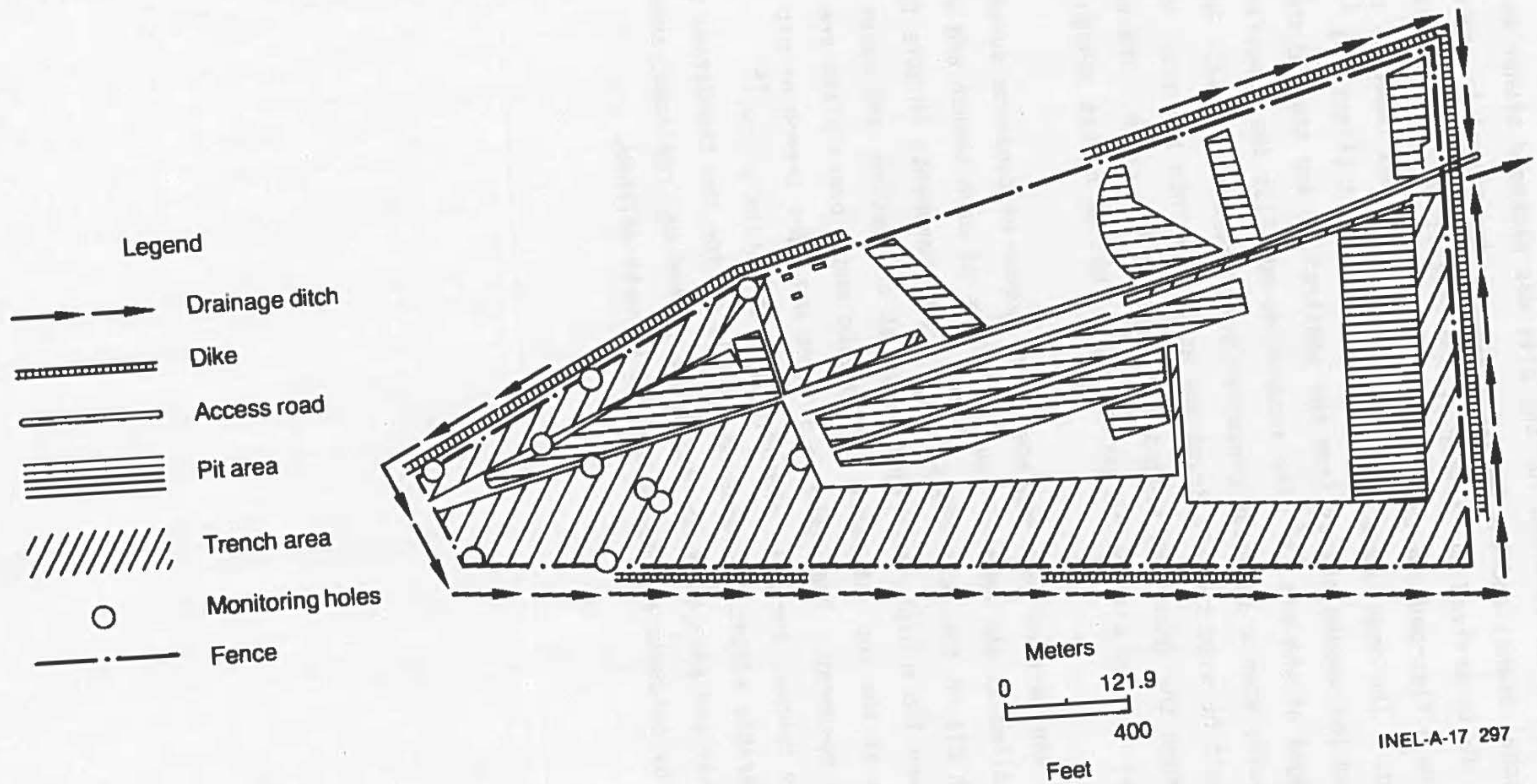


Figure 4. Plan of NRTS Burial Ground.

Rocky Flats waste destined for the pits was packaged either in 113.6-L or 208.2-L steel drums, and the bulkier items were packaged in wooden crates.[8,17] Waste arrived by railcar at the Central Facilities Area, was transferred to a flat-bed semitrailer truck, and then was taken to the Burial Ground.[5] The drums were hand-stacked in the pit (Figure 5).[17] A crane lifted the wooden crates from the semitrailer and stacked them around the edges of the pit.[6,9] The records do not list the specific location of boxes when a shipment contained both boxes and drums. The crane also could be used to lift drums one at a time into the pit. Workers manually arranged the drums and rigged and unrigged the crane. The waste in the pits was covered with earth periodically, but on no set schedule.

The metal tag markers were replaced by a system of concrete survey monuments installed at the ends of the centerline of each trench and at the corners of each pit in the late 1950s.[17,20] These monuments (Figure 6), still in use, are 1.8 m high, 40.6 by 40.6 cm at the bottom, and taper to 20.3 by 20.3 cm at the top. A metal lifting lug and a brass plate are secured to each monument. The plate is stamped with the trench or pit number, the date opened, the date closed, and a direction arrow.[14] Although considerable effort was made to clearly define the boundaries of the early trenches and pits when the metal tag system was replaced, some of them now marked by concrete monuments may not be well defined.

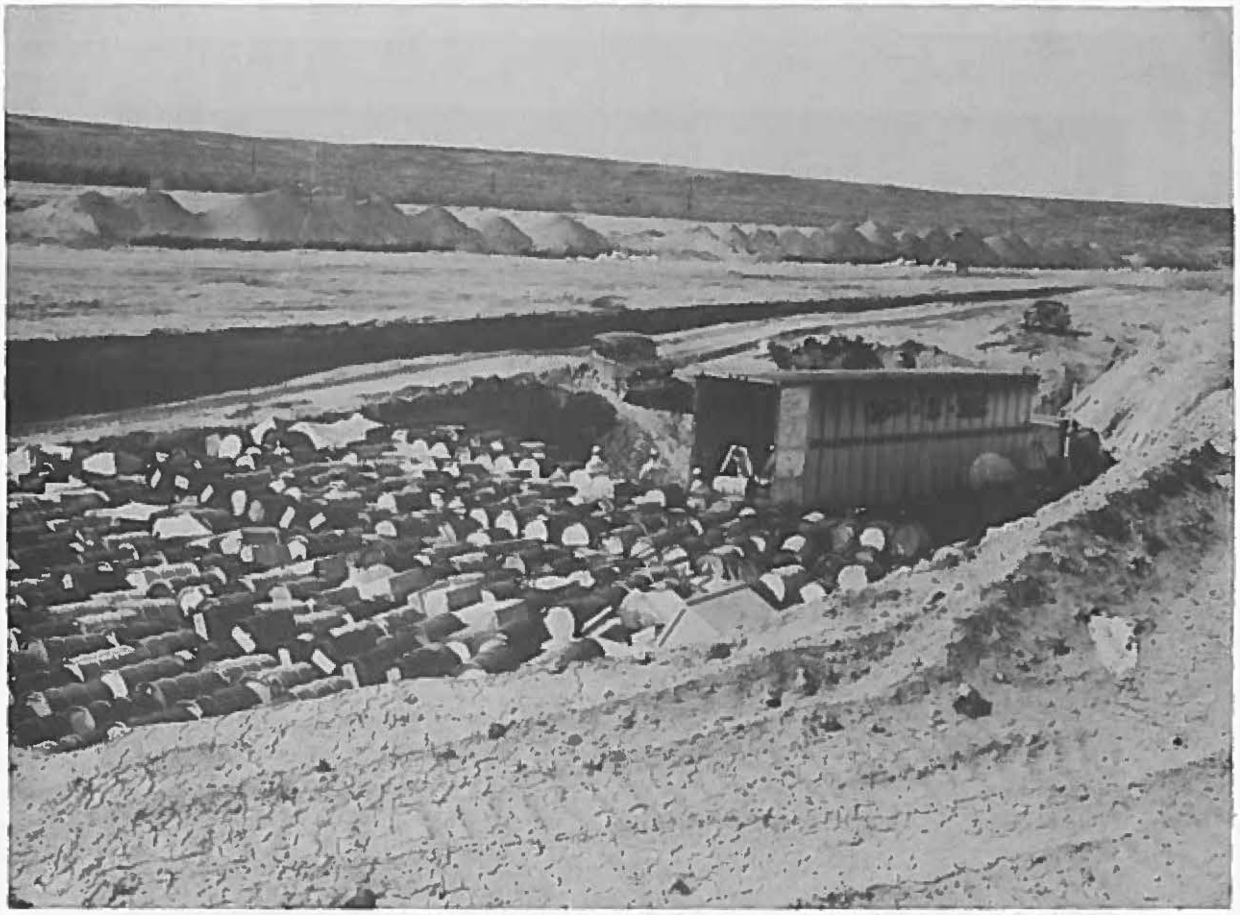


Figure 5. Hand stacking of drums, 1950's.

Figure 6. Concrete survey monument marking trench location.

3. INTERIM BURIAL GROUND (1960-63)

During the 1950s, the rate at which private industry (AEC licensees) generated radioactive waste was increasing. Since no commercially operated burial ground existed for this waste, most of the licensees used the services of seven firms that disposed of packaged solid waste in AEC-approved areas off the U.S. coast.[21] In late 1959, the AEC decided that land burial had definite advantages (particularly economic) over sea disposal. In January 1960, the AEC announced its intention to establish regional solid waste burial grounds that would be privately operated on state or federal lands. And, since time would be required to evaluate the geology, hydrology, and topology of proposed regional burial grounds, the AEC decided to establish an interim burial ground program.[21]

In May 1960, the AEC designated the Idaho NRTS and the Tennessee Oak Ridge National Laboratory (ORNL) as the interim burial grounds.

3.1 Interim Burial Ground Program Policies and Procedures

The information in the following discussion pertains only to offsite waste received during the Interim Burial Ground Program. Onsite waste policies during this period are discussed in later subsections. Most of the information on the Interim Burial Ground Program was taken from Reference 21.

At the request of the AEC, ORNL and NRTS coordinated their burial policies and procedures, which included the following:

a. Only solid waste was accepted.

b. Conformance to existing federal regulations was required for all shipments and packaging.

c. To apply for service, the customer filled out an order form and a waste shipment data sheet and returned them to the burial ground management; waste could not be shipped until the customer received approval.

d. The waste was accepted free on board (f.o.b.) at the burial site; the generator was responsible for all packaging and shipping.

e. Any unusual handling expense, such as for extra heavy packages or special services, was charged to the customer.

f. The customer paid the full cost of any decontamination or special handling required because of the shipment's failure to meet AEC and other applicable health and safety standards.

g. The ORNL and the NRTS also established formal procedures for dealing with improper or problem shipments.

During the Interim Burial Ground Program, the AEC established and maintained a record of all radioactive waste burials in the U.S. At first, each AEC operations office was required to submit a monthly burial summary to the AEC Headquarters, Division of Production; later this summary was required every six months.

In May 1963, the AEC issued a press release withdrawing its services at the interim burial grounds for radioactive waste shipped on or after August 12, 1963, because other suitable burial sites had been established by private industry. (Records of waste buried at the NRTS Burial Ground during this program are in EG&G Idaho, Inc., Waste Programs Division files stored with Records Management.) From then on, the AEC General Manager's approval was required for burial of any licensee waste at the NRTS. Rocky Flats waste, however, was still received, mainly because privately operated burial grounds were not allowed to receive classified waste or material from which sensitive information could be derived by sampling or observation.[22]

3.2 Transfer of Burial Ground Operation

During the Interim Burial Ground Program, operation of the NRTS Burial Ground was delegated to the NRTS operating contractor. In October 1962, the responsibility for both managing and operating the Burial Ground was formally transferred from the Site Survey Branch, AEC-ID, to the Phillips Petroleum Company (PPCo), which had been acting as the AEC-ID agent in operating the Burial Ground. PPCo then assumed responsibility for health physics surveillance within the Burial Ground and handled special arrangements for disposal directly.[23]

3.2.1 Standard Practice

After the formal transfer, PPCo published a written standard practice to further formalize burial operations involving NRTS waste.[24] The standard practice outlined disposal operations as described below.[25]

3.2.1.1 Disposal of Routine Waste. Routine, low-radiation-level, solid waste, emitting less than 500 mR/h, was to be boxed in cardboard cartons, placed in Dempster Dumpsters, transferred to the Burial Ground, and dumped into trenches. Routine disposal was limited to a 3 by 3 by 6.1-m bulk of less than 9.07 metric tons. Trenches were to be excavated 1.5 m wide, at least 0.9 m deep on 4.9-m centers. Trenches were to be backfilled such that radiation 0.9 m from the surface was less than 1 mR/h. Partly filled trenches were barricaded at the 60 mR/h point to limit access and control radiation exposure. After each trench or pit was filled and backfilled with at least 0.9 m of dirt, the location was permanently marked with a concrete monument.

3.2.1.2 Restrictions. Nonroutine waste that required handling with special equipment was limited to 45.4 metric tons in one unit. A health physicist was on duty at the Burial Ground to guide the operation, witness the disposal, and sign the disposal records.

No liquid waste was to be accepted for disposal at the Burial Ground. Fissile material was closely supervised within the following guidelines.

a. All fissile material was to be identified, and the maximum amount was to be stated on the disposal form.

b. Less than 300 g of ^{235}U or 200 g of ^{239}Pu could be disposed of in units such that there were no more than 400 g of ^{235}U or 267 g of ^{239}Pu per 0.028 m^3.

c. Quantities greater than 300 g of ^{235}U or 200 g of ^{239}Pu were to be isolated from the rest of the waste material and buried only after approval by the PPCo Nuclear Safety Committee.[25]

On January 2, 1964, PPCo updated its standard practice to incorporate Forms ID-136 and ID-137 used during the Interim Burial Ground Program.[4]

3.2.2 TRU Waste Disposal

Beginning in November 1963, Rocky Flats waste was no longer stacked but was dumped in pits to reduce labor costs and minimize personnel radiation exposures[26] (see Figure 7). Random dumping continued until 1969.

3.3 Incidents at the NRTS

Two NRTS incidents during this period impacted waste management practices--an accidental criticality excursion at the Army Stationary Low Power Reactor (SL-1) in 1961 and a localized flood in 1962.

3.3.1 SL-1 Accident

An accidental criticality excursion occurred on January 3, 1961, at SL-1 located at the Army Reactor Area (now the Auxiliary Reactor Area

Figure 7. Dumping of drums (1963-69).

ARA-II). To accommodate the contaminated materials resulting from the accident, a separate burial ground (the SL-1 Burial Ground) was opened on May 23, 1961.[27]

Although most of the SL-1 waste was disposed in the special burial ground, one reference[9] notes that some waste from the SL-1 incident was deposited in Pit 1, which was reopened in October 1961 for that purpose. Data in the Radioactive Waste Management Information System (RWMIS) do not support the contention that Pit 1 was reopened to receive SL-1 waste. The disposal locations in RWMIS are one-dimensional, expressed as a distance from one point. Because SL-1 Pit 1 is long and narrow, like a trench, a disposal location would be expressed as a distance from one end. Burial Ground Pit 1 locations require north/south and east/west coordinates. Furthermore, the health physicist who worked at the Burial Ground during this time has stated that Pit 1 was not reopened.

The SL-1 Burial Ground was established 0.4 km from the reactor location, approximately 7.2 km north of the NRTS southern boundary and 14.5 km west of the southeastern boundary. The 1.6-ha site is fenced and contains one trench and two pits about 152.4 m long.[28] The SL-1 Burial Ground was closed July 27, 1972, and has since been surveyed semiannually.[27] The Waste Programs Division, RWMC Operations (WP-O) Branch is presently responsible for maintenance of the SL-1 Burial Ground.

3.3.2 1962 Flood

In February 1962, approximately 4.6 cm of rain fell on 20.3 cm of snow in three days. The upper foot or so of undisturbed ground was frozen, causing much more run off than normal from the area surrounding the Burial Ground. Pits 2 and 3 and Trenches 24 and 25 were open and were filled with water.[3] Figure 8 is a photograph of the 1962 flood.

The flood conditions and subsequent actions are described in detail in References 7 and 14. Some of the low-radiation waste boxes and barrels floated around in the flood water. After some boxes were broken, the radioactive contents, such as gloves and sample bottles, became distributed

Figure 8. 1962 "Chinook"-caused flood at Burial Ground.

in undisturbed areas within and adjacent to the RWMC. A radiation survey was immediately initiated. All contaminated items found outside a designated burial location were collected and redeposited in a pit or trench. All detectable surface contamination was confined to areas in and around the Burial Ground. Water samples from monitoring holes immediately adjacent to the trenches indicated no significant migration of radionuclides through the soil as a result of the flooded conditions. No general contamination spread was detected on the ground surface. After this local flooding, a diversion drainage system was constructed around the perimeter of the Burial Ground.

3.4 Environmental Monitoring

Two major improved environmental monitoring systems were initiated during the Interim Burial Ground Program. These remain part of the current environmental surveillance plan (see Section 5.4.9).

The first was subsurface water monitoring. In 1970, the USGS drilled ten monitoring holes to the basalt surface at the request of the Site Survey Branch. These holes were drilled in the western section of the Burial Ground, which was essentially filled by 1960.[29,30] The USGS monitored these holes occasionally and could also check them after flooding or other incidents that potentially affect subsurface water, e.g., the 1962 flood described previously.

The second improvement was in radiation monitoring. In 1960, 35 film badges were evenly spaced around the perimeter fence of the Burial Ground to monitor the direct radiation levels.[7]

4. WASTE BURIAL (1964-70)

The period between 1964 and 1970 was characterized by increased environmental assessments of NRTS radioactive waste disposal practices. The late 1960s saw the passage of environmental laws, culminating in the National Environmental Policy Act of 1969. After a fire occurred at the Rocky Flats plant on May 11, 1969, and the waste from the fire cleanup was shipped to Idaho, environmental concern focused on the NRTS.

4.1 Environmental Concern

The original USGS survey of the NRTS suggested the possibility of waste disposal operations contaminating the Snake River Plain aquifer underlying the NRTS but considered this possibility unlikely because of the arid environment. During the Interim Burial Ground Program, a similar concern had been voiced.

By the mid-to-late 1960s, several individuals and groups began to question the wisdom of disposing of TRU waste over the aquifer. In 1966, the National Academy of Sciences Committee on Geologic Aspects of Radioactive Waste Disposal questioned the concept of an arid environment protecting the aquifer from contamination. After visiting the NRTS in June and July of 1960 and again in May of 1965, the Committee noted that ultimate leakage of plutonium wastes from corroding steel drums was inevitable and expressed concern about continued waste disposal above the aquifer.[3,31]

4.1.1 Environmental Studies

Many studies by the AEC, other federal agencies, and the State of Idaho then followed. In October 1968, the Federal Water Pollution Control Administration surveyed the Burial Ground to determine whether additional controls were necessary to improve water quality as set forth by Executive Order 11288, "Prevention, Control, and Abatement of Water Pollution by Federal Activities."[32]

In 1969, after the waste from the Rocky Flats fire had been sent to the NRTS Burial Ground, Idaho Senator Frank Church requested that four federal agencies (the USGS, the Bureau of Radiological Health of the U.S. Public Health Service, the Federal Water Pollution Control Administration, and the Bureau of Sport Fisheries and Wildlife) conduct a joint review of the Burial Ground.[33]

The AEC Division of Operational Safety reviewed the NRTS Burial Ground in October 1969.[34] The AEC also established a General Manager's Task Force on AEC Operational Radioactive Waste Management to develop long-range policies, standards, and criteria for management of AEC waste.[35] This task force also examined sorting, compaction, and incineration of TRU waste.[36] The following were the general conclusions of the numerous surveys:[32, 33, 34, 35, 36, 37]

a. The burial of radioactive waste had not resulted in a health or safety problem in offsite areas.

b. The burial of long-lived radioactive waste, specifically plutonium, over the Snake River Plain aquifer was inadvisable, and provisions for segregating and removing such waste should be made, if such removal would not create a greater hazard than leaving the waste in place.

c. A minimum 0.6-m underburden in trenches and pits should be established.

d. The environmental monitoring program near the Burial Ground was not adequate to determine whether or not migration of radioactive material had taken place; deep observation wells should be drilled to monitor effects on water quality.

e. Flood control measures were not adequate.

f. Trenches and pits should be covered with at least 0.9 m of soil.

g. The volume of TRU waste could be substantially reduced through compaction.

4.1.2 Cessation of TRU Waste Burial

During 1969, the burial of TRU waste was reevaluated. In December 1969, J. R. Horan, ID-Health Services, recommended the suspension of burying intermediate-level waste from the Rocky Flats Plant during the winter or until the environmental hazard could be evaluated. He also noted there was evidence from experiences at other facilities that segregation of plutonium-contaminated waste was advisable.[38] A January 1970, letter from W. L. Ginkel, Manager of AEC-ID, to the manager of the Rocky Flats Plant stated that Rocky Flats waste would not be buried at the NRTS Burial Ground during the winter and spring because waste-handling techniques were being reevaluated and because of potential flooding.[39] After January 16, 1970, the waste was stacked aboveground.

4.1.3 Investigation of Alternative Sites

In 1969, AEC-ID began investigation of alternative burial sites at the NRTS. At the request of the AEC, the USGS investigated 17 NRTS sites as potential burial grounds.[35,40] In November 1969, a preliminary report recommended nine sites on the NRTS for further investigation.[40,41,42] Expansion of Burial Ground boundaries was also studied. In 1971, a report of an archaeological survey of the area surrounding the Burial Ground recommended that the area west and north of the existing Burial Ground not be disturbed in any expansion because of potential archaeological sites.[43] Minimal action has been taken beyond these studies in establishing additional sites or expanding the Burial Ground.

4.2 Changes in Disposal Procedures and Facilities

Several changes in disposal practices and facilities were initiated between 1964 and 1970. These changes included the following:

a. Increasing the minimum soil cover of buried radioactive waste from 0.6 to 0.9 m--1966[4]

b. Increasing the minimum trench depth from 0.9 to 1.5 m--1966[3]

c. Dropping a heavy steel plate on the waste dumped into trenches to compact it--1966[20,44]

d. Depositing at least 0.6 m of soil underburden in trenches and pits--1970 (this was done mainly in response of the Federal Water Pollution Control Administration Study).[32]

4.2.1 1966 Fires

Covering of waste in trenches at the end of each working week was enforced after two fires occurred at the Burial ground on September 8 and 9, 1966. The fires originated in Trench 42 where waste has been deposited in 0.6 by 0.6 by 0.9-m cardboard boxes. Trench 42 had been excavated on May 9, 1966, and waste was emplaced in July. One letter indicated that a wait for compaction may have delayed the backfilling of the trench. (Backfilling was a requirement of the AEC-ID Manual Chapter 0500-7, B-2-d of June 20, 1966.) Also, the amount of waste had increased significantly (34%) during August, and most heavy equipment operators were working at other facilities during the last half of the month.[44]

An apparent cause of the fires was the inadvertent inclusion of alkali metals with the low-radiation-level waste.[45] The AEC-ID Fire Department responded to a two-way radio alarm and extinguished the fires with water and bulldozing soil over the burning debris. Neither property damage nor detectable spread of contamination occurred.[14]

In October 1966, it was proposed that all waste dumped during the week be compacted and at least thinly covered with earth on Friday afternoon.[9,44] Sections considered completely filled were to be covered with 3 ft of soil. This backfilling of exposed material in trenches and pits on the last working day of the week became a standard procedure, and a firefighting plan also evolved.[4,8]

4.2.2 1969 Flooding

During a two-day January thaw in 1969, rainfall plus melting snow again inundated the Burial Ground. In addition to localized water, runoff from outside the Burial Ground flowed into it. Water filled Pit 10, considerable amounts entered Trenches 48 and 49, and some possibly entered Pit 9, which was partly open.[3] The 1969 flooding, shown in Figure 9, was partially caused by large snowdrifts that blocked the existing drainage, which had been established as a result of the 1962 flood. The runoff topped the old dikes and flowed through the Burial Ground.

After this flood, dikes around the Burial Ground were raised, and exterior drainage ditches were enlarged. New dikes and ditches were designed to withstand a major local runoff, even in the presence of deep snowdrifts. The ditches were made large enough so that, if necessary, heavy equipment could be used to clear snowdrifts.[14]

4.3 Environmental Monitoring

4.3.1 Monitoring at the Perimeter

In 1966, the 35 film badges used to monitor radiation at the perimeter of the Burial Ground were replaced by thermoluminescent dosimeters.[7] In November 1968, the number of TLD monitoring stations was reduced to 18.

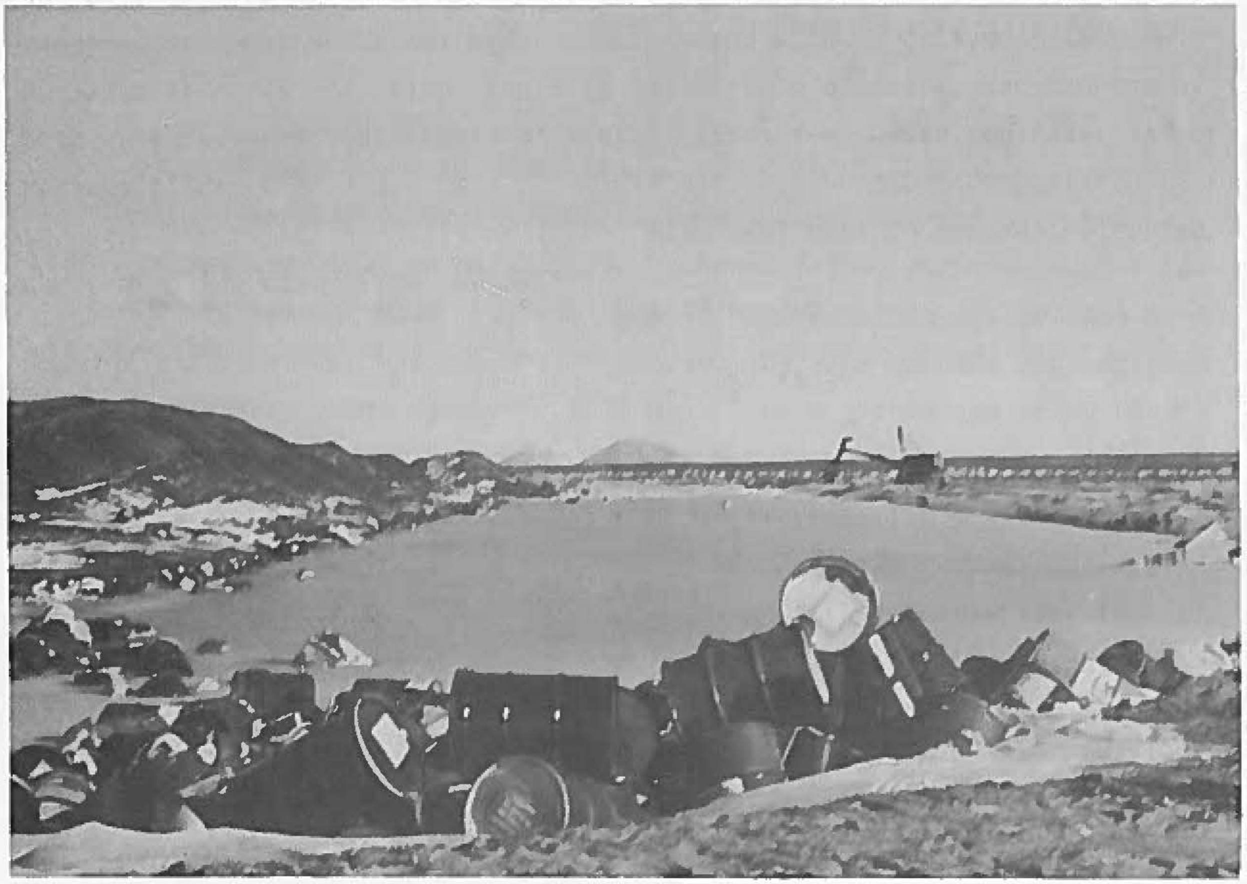


Figure 9. 1969 "Chinook"-caused flood at Burial Ground.

4.3.2 Subsurface Water Monitoring

In 1969, the USGS began a series of studies to detail the geology, hydrology, and available moisture and to determine the potential for migration of radionuclides from the buried waste.

Water samples taken from the subsurface monitoring holes after the spring thaw indicated the presence of cesium-137. Samples taken from new holes within 0.3 m of those holes failed to explain or confirm the presence of the cesium detected in the original monitoring holes.[30]

Two field investigations conducted by the Health Services Laboratory (HSL) in 1969 and 1970 showed that very limited leaching of radionuclides from the waste and migration of some fission products as well as plutonium isotopes and daughter products had occurred. An HSL report inferred that these conditions resulted from inundation of the waste as a result of poor drainage of snow-melt runoff. The concentrations and distances involved were insignificant and were not considered cause for concern for the aquifer.[30]

5. WASTE MANAGEMENT (1970-85)

On March 20, 1970, the AEC issued Immediate Action Directive (IAD) No. 0511-21, "Policy Statement Regarding Solid Waste Burial." This policy required segregation of all waste contaminated with long-lived transuranic nuclides in a concentration greater than 10 nCi/g of waste, and storage of that waste to permit retrieval of contamination-free waste containers after periods of up to 20 years.[14,46,47] In addition, the AEC made public, through letters to the State of Idaho, its commitment to remove the buried and stored TRU waste from the NRTS.[33]

5.1 Segregation of TRU Waste

During the first half of 1970, several methods were considered for the NRTS response to the new AEC directive on segregating TRU waste. These included (a) expansion and modification of the existing disposal operation, (b) above- or below-grade storage, and (c) storage at another site in natural or engineered facilities.[14] Above-grade storage was chosen, and the Burial Ground was expanded to its present 57.4 ha.[48]

DOE Order 5820.1, "Management of Transuranic Contaminated Material," dated September 30, 1982, changed the definition of TRU-contaminated material to read:

> Without regard to source or form, materials that at the end of institutional periods are 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

5.1.1 Temporary Aboveground Storage

While the decision to store TRU waste aboveground was being made, incoming Rocky Flats waste remained in a temporary aboveground storage established in January of 1970. On June 1, 1970, ID security personnel discovered a fire in the temporary aboveground storage. The fire was started by hot sunlight shining on a black drum containing depleted uranium turnings. The Fire Department responded immediately, but attempts failed to extinguish the fire in the waste stack. An equipment operator, using a crane, lifted and isolated the burning drum from the stack. A bulldozer then covered the drum with soil, extinguishing the fire. The air and direct radiation were monitored constantly, and the contamination spread was very low. Efforts were initiated to protect the other drums from any possible ignition by cooling them with a fine water spray. The upper surfaces were later coated with white paint to reduce the absorption of heat from the sun. Immediately after this fire, all drums were moved from temporary aboveground storage to a location where they could be covered with soil.[14]

5.1.2 Transuranic Storage Area (TSA) Pad 1

Construction of the Transuranic Storage Area (then known as the Idaho Transuranic Storage Area (ITSA)) was completed in October 1970.[7] The first Transuranic Storage Area (TSA) pad was 45.7 m wide by 121.9 m long and was surfaced with 10.2 cm of blacktop paving. (The length of the pad was extended to 222.5 m in 1972.) The paving was graded toward the centerline of the pad and sloped toward the north end to provide drainage.

The first waste was stored on TSA-1 November 9, 1970.[4] The pad was divided into 45.7 by 54.9-m cells with a 0.9-m-thick earth firewall isolating each cell.[14] In 1971, waste drums were stacked horizontally, nine drums high at the centerline of the pad and to a lesser height at the ends of each row, with crates lining the sides and down the center of the ITSA pad.[49] Begining December 22, 1972, in Cell 5, the drums were sacked vertically.[50] Containers were stacked 4.6 m high except within 9.14 m of the edge where the stack was limited to 3.7 m. A sheet of 1.3-cm-thick fire-retardant plywood was placed between every layer of drums to stabilize the stacking surface and increase overall rigidity.[14,50,51] The paved area was surrounded on three sides by a 3.7-m-high soil berm. A 1971 reference states that as the TSA pad was filled, the stacked waste was covered with a minimum of 0.5 m of earth from the surrounding berm.[49] However, a later report states that the final cover consisted of 1.6-cm-thick plywood, a tough nylon-reinforced polyvinyl cover, and 0.6 to 0.9 m of soil, placed over the containers in that order. The soil was then seeded to a sod building grass.[14] Figure 10 shows the cell arrangements and overview of the TSA pads, and Figure 11 shows an overview of the TDA.

Several changes were made in the TSA and in storage methods before TSA-1 was closed to receipt of waste on October 17, 1975. (Table 4 gives opening and closing dates of pad storage.) These changes described in the NRTS monthly reports and other documents are outlined below.

a. Buildings--The first buildings (a Burial Ground trailer and a TSA clothing-change trailer) were installed at the Burial Ground site in 1971.

b. Operations--

1. In 1971, a hydraulic-cylinder unloader on the forklift pallet eased handling and cut labor costs and personnel injury hazards.[4]

2. In 1972, large earth-moving equipment was used to cover TRU waste.

3. By October of 1973, unloading and stacking of waste containers was accomplished in one mechanical operation with a telescoping-mast forklift. A mobile yard ramp, also obtained in 1973, was used for unloading palleted waste containers from trucks by forklift.[51]

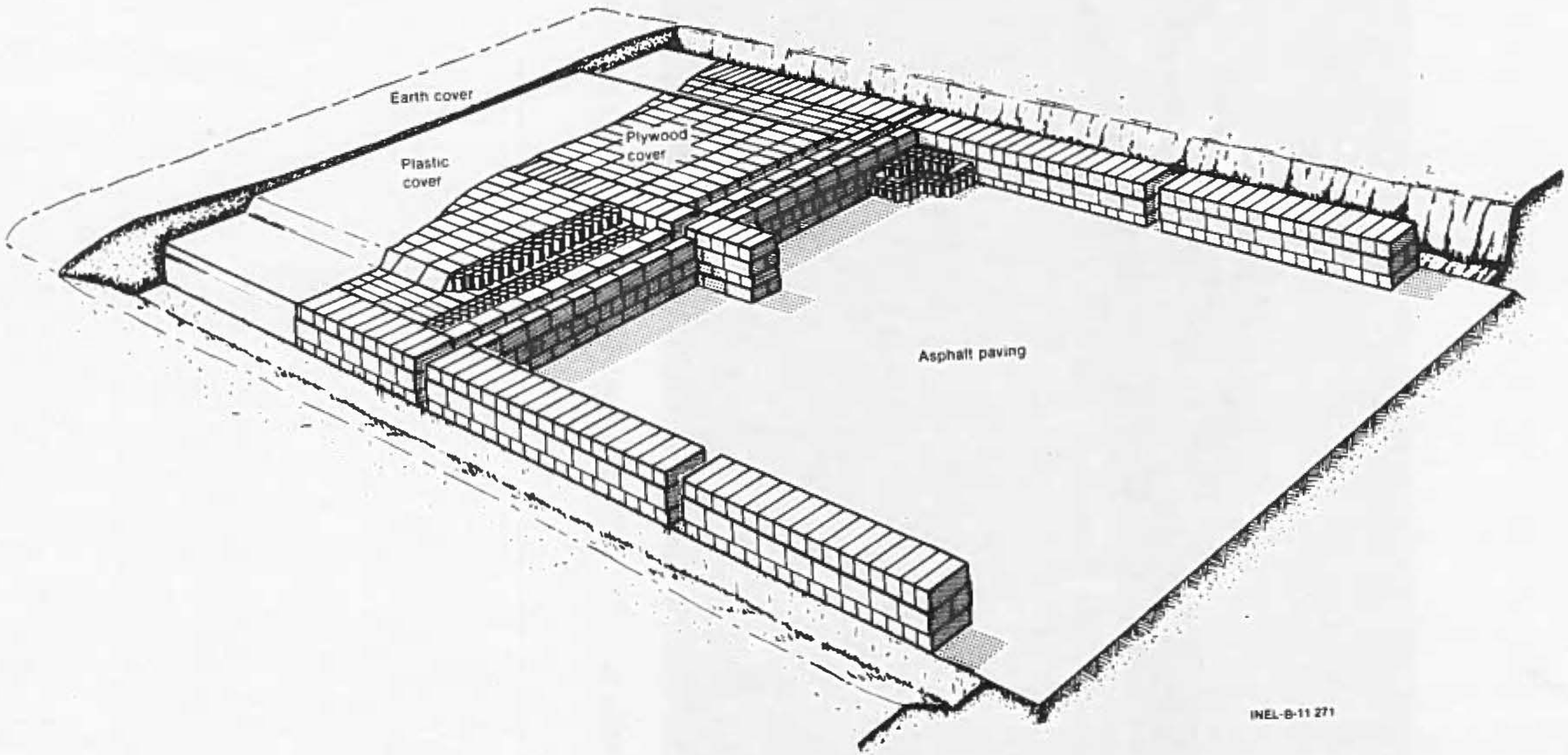


Figure 10. Transuranic Storage Area overview.

Figure 11. TDA pad before it was covered with soil.

TABLE 4. PAD OPENING AND CLOSING DATES

	Date Opened	Date Closed
TSA-1		
Cell 1	11-01-70	05-18-71
Cell 2	05-19-71	12-17-71
Cell 3	12-15-71	06-05-72
Cell 4	06-05-72	01-15-73
Cell 5	12-22-72	06-20-73
Cell 6	05-24-73	11-07-73
Cell 7	11-07-73	01-23-75
Cell 8	04-24-74	10-25-75
TSA-2		
Cell 1	09-00-75	12-00-77
Cell 1A	07-00-80	07-00-80
Cell 2	12-00-77	06-09-80
Cell 3	08-00-80	still open
TDA Pad	09-26-72	11-17-78
TSA-3	08-01-85	still open

4. A railroad spur was completed in 1974 for transporting Rocky Flats waste directly to the TSA, thus eliminating the transfer to trucks at CFA.[14] A railcar transfer yard was added at the southeast corner of the TSA (Figure 14.a) to facilitate railcar transfer to and from the RWMC.

5. Early in 1975, segregation of combustible and noncombustible TRU waste began for storage in Cell 8.

6. In 1976, an assay system as procured for determining the Pu content in drums.

c. Weather-proofing--

1. During 1972, TSA containers were improved. Plywood boxes were covered with fiberglass, and the steel drums were lined with 0.25 mm polyethylene.[48]

2. In 1973, a protective polyvinyl sheet was installed as a winter cover over the stored waste on the TSA pad.[51]

3. In 1974, rust and bare metal on TRU drums were treated before storage.[51]

d. Security--

1. In 1974, an exclusion fence was installed to control access to the TSA pad.

2. In 1975, an intrusion-detection security alarm system as installed for the TSA.

e. Monitoring--

1. In 1973, temperature and humidity of the atmosphere surrounding the drums were first measured.[51]

2. When the exclusion fence was installed in 1974, special ballast with low alpha value was used for the railroad track bed inside the fence to ensure low background radiation for monitoring.

5.1.3 Transuranic Disposal Area (TDA)

The Transuranic Disposal Area (originally designated the Engineered Waste Storage Area) pad was constructed in September 1972, in an area not suited for pits or trenches because of near-surface basalt outcroppings.[33] This area was established to dispose of waste that was not transuranic but did contain less than 10 nCi/g of transuranic alpha emitters in a single container and had a dose rate of less than 200 mR/hr at the container surface.[14,27]

The initial pad was a 36.6 by 51.8-m asphalt pad surrounded by an earth berm sufficient to give a 0.9-m cover and 3:1 final slope.[52,53] A southern extension added in 1973 measured (36.6 by 50.3 m), and the direction of stacking waste was reoriented to be compatible with future extensions.[51] The pad was again expanded in 1976 in a western extension to give total overall dimensions of 73.2 m wide by 102.1 m long.

Boxes were stacked around the periphery, and drums were stacked horizontally in staggered layers. Waste on the pads was covered with earth so that no more than two rows of drums or one row of boxes was exposed at any time. The final cover was at least 0.9 m of earth, with a slope no greater than 3:1, and was seeded with sod-building grass.[14,27] This disposal method was used to permit year-round disposal operation as well as segregation of this type of waste material for future retrievability if desired.

The TDA was entirely covered in November 1978, and closed to further use. Closure was completed by covering the remaining exposed metal waste containers with plywood and covering the entire stack with polyethylene and soil in a manner similar to the TSA pads (Figure 11).

During the last quarter of FY 1979, a reentry was conducted into TDA in the area of the oldest waste containers to evaluate their future retrievability. Visual observation indicated that the 208.2-L drums (Figure 12) and wooden boxes were deteriorated sufficiently to preclude easy retrieval of any containers. Preliminary analyses of soil and air samples revealed minimal radioactive leakage from the waste containers. Soil moisture and temperature probes were installed in the excavated area before closure.[54]

DOE officially authorized closure of TDA on July 5, 1979. Additional transuranic-contaminated waste (less than 10 nCi/g) will be buried within the RWMC, but must be segregated in other clearly marked areas.[55,56]

A plan to stabilize the waste on the TDA was submitted to DOE-ID in January, 1985. Engineering design and modeling for the stabilization methodology recommended in the plan is scheduled for completion in FY-1985.

5.1.4 TSA-2

The second TSA pad, opened in September 1975,[10] is constructed like Pad 1 and has the same dimensions. An air-support weather shield (ASWS) erected over the southern portion of TSA-2 in October 1975, permitted all-weather operations (see Figure 13). The ASWS is equipped with (a) a backup blower system with its own auxiliary power plant to maintain the supporting internal pressure should the primary blower system fail, (b) a heating system to heat the air and prevent snow from accumulating on the shield, (c) an air-lock entry with double doors for vehicle access, (d) a separate doorway for personnel use, and (e) an emergency-exit doorway for personnel.[14]

In 1976, a drum monitor was procured to help preclude inadvertently creating a critical assembly caused by bringing together two or more overloaded drums containing plutonium in excess of the imposed limits.[27] Cell-monitoring instruments to measure temperature and humidity were added to this pad in 1977. Figure 14 is a photograph of storage on TSA-2 under the ASWS in 1981. Waste containers are stacked vertically 4.6 m high,

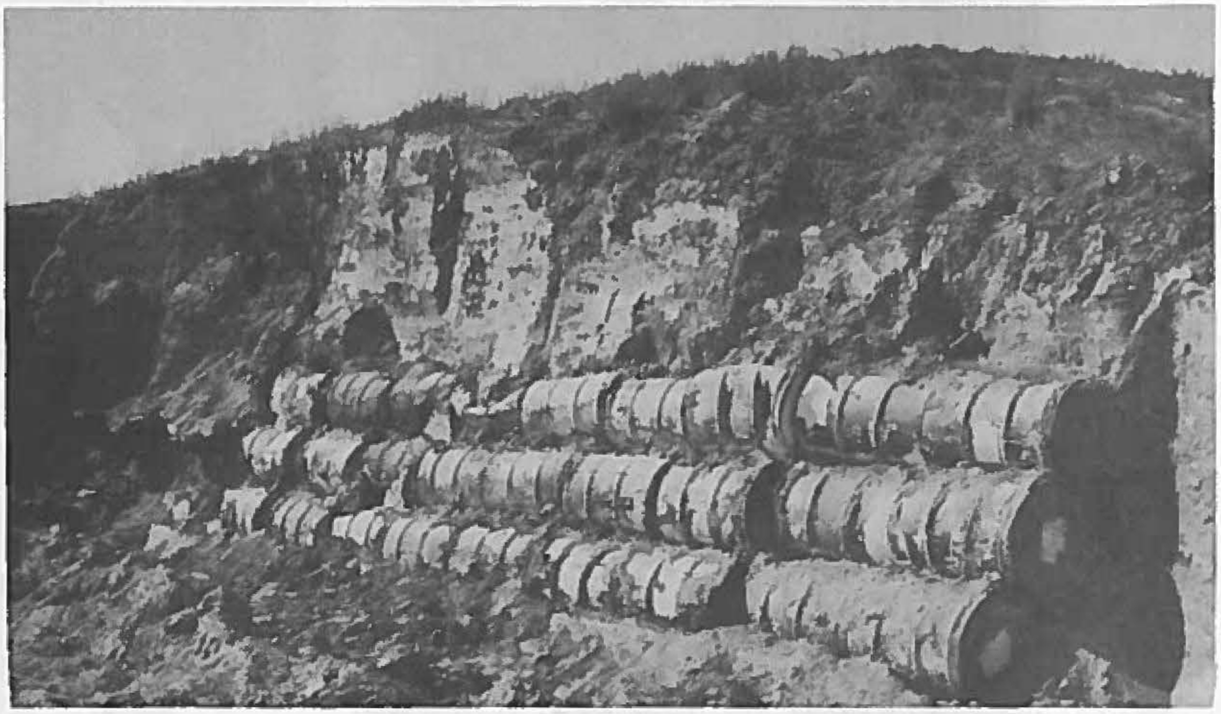


Figure 12. TDA penetration exposing 208.2-litre drums.

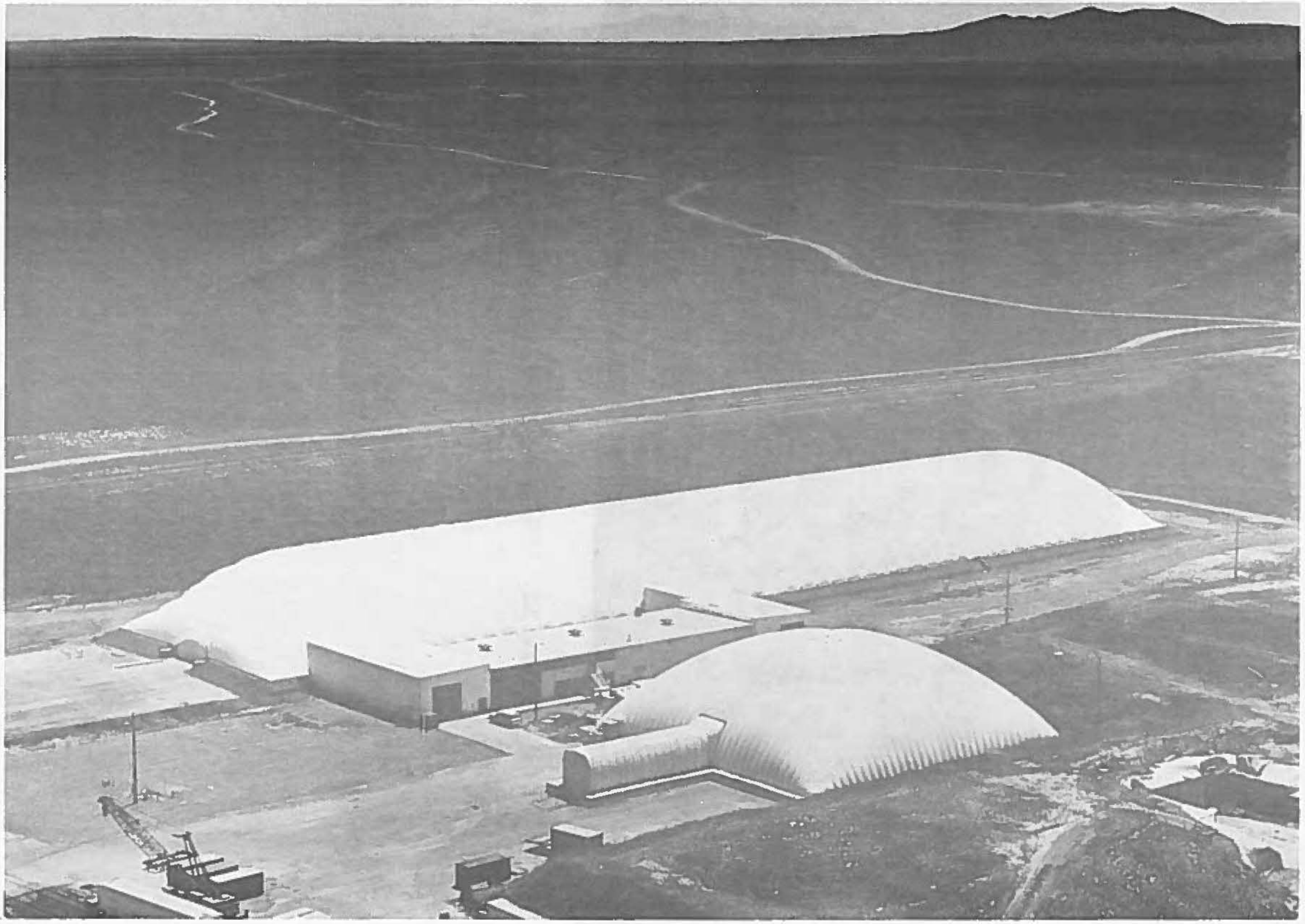


FIGURE 13. TSA-1, TSA-2 AND ASW[illegible] WEPP, AND C&S ASWS

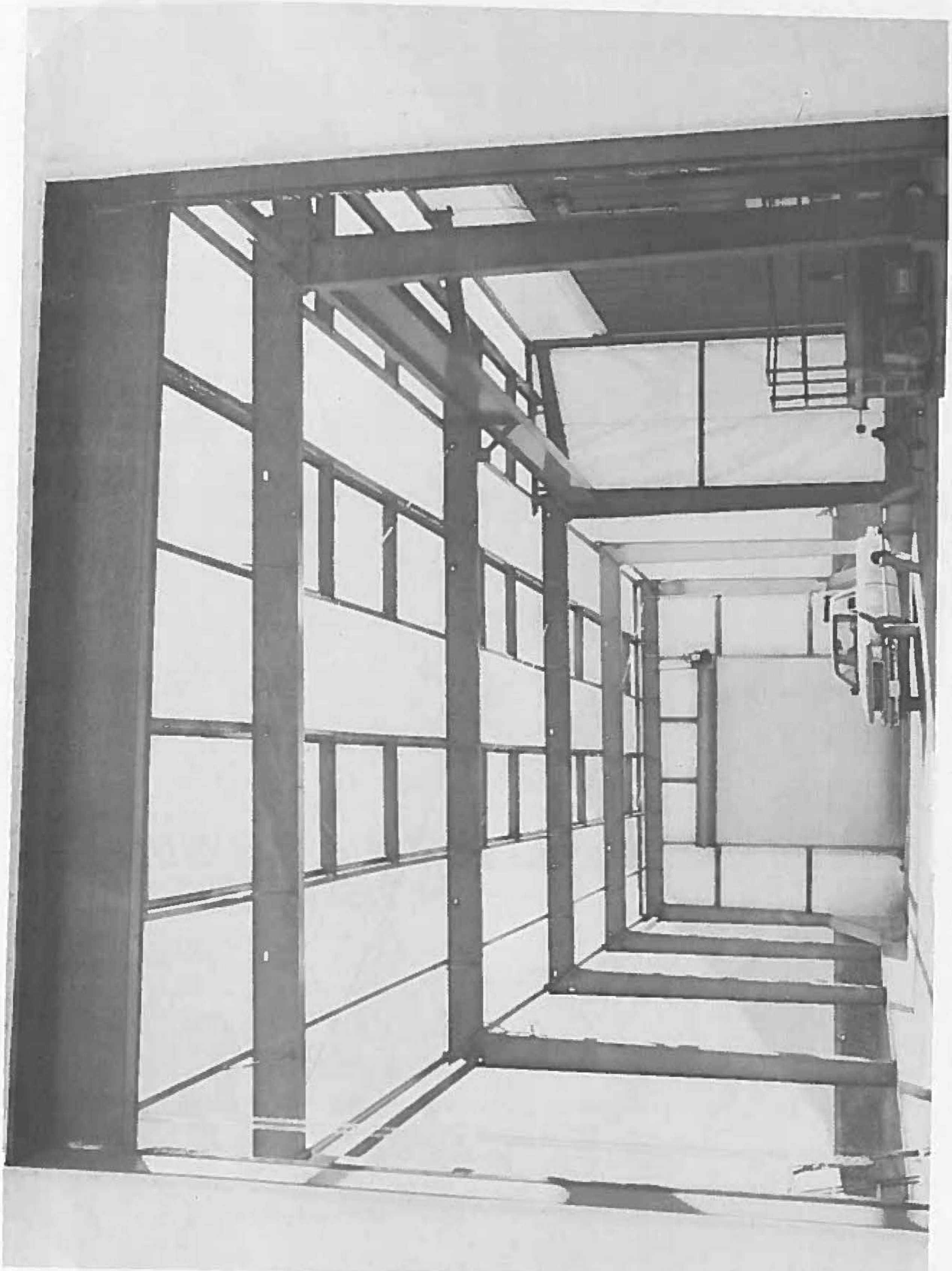


FIGURE 13a. C&S BUILDING EQUIPMENT AIRLOCK

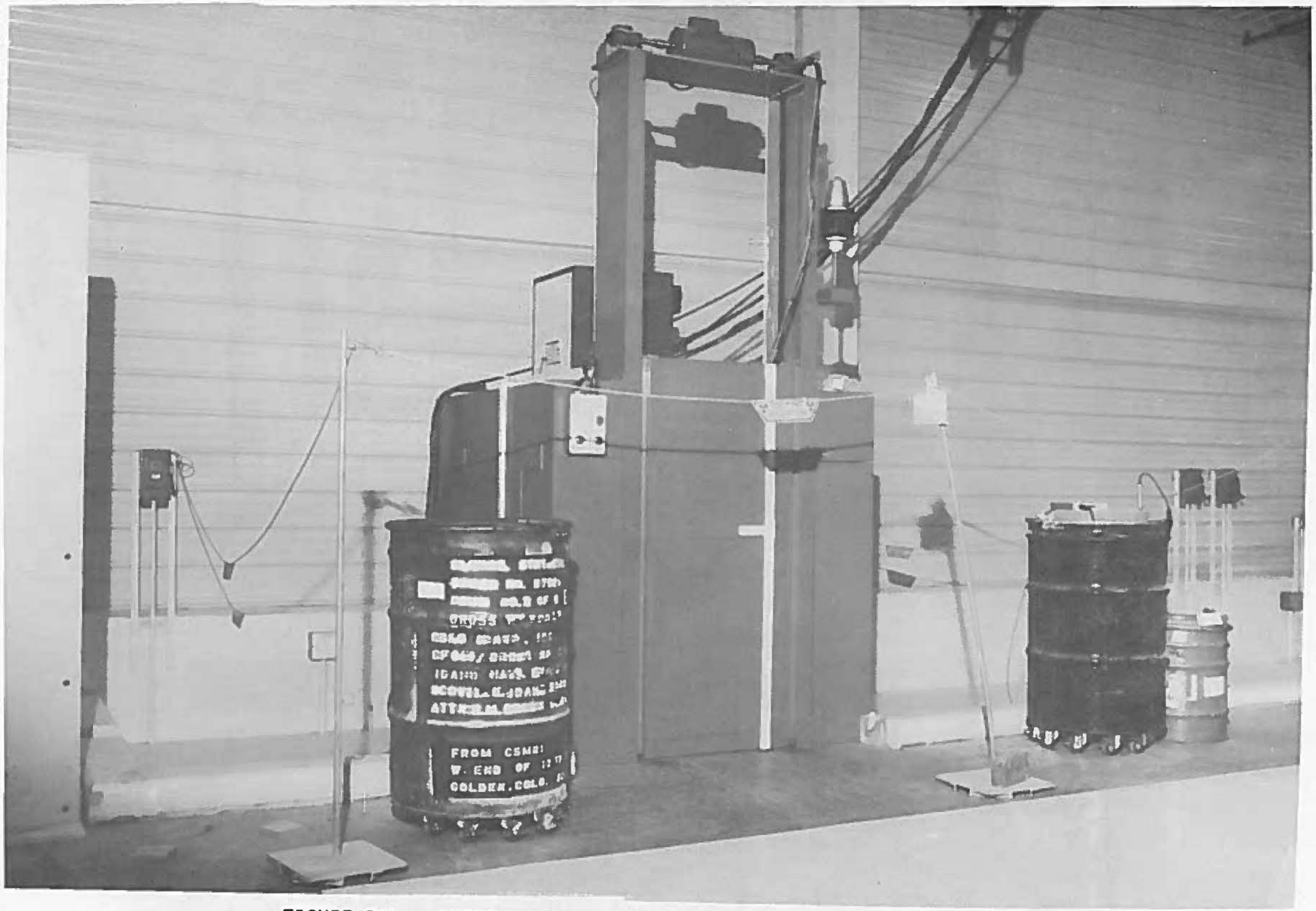


FIGURE 13b. CONTAINER ASSAY SYSTEM

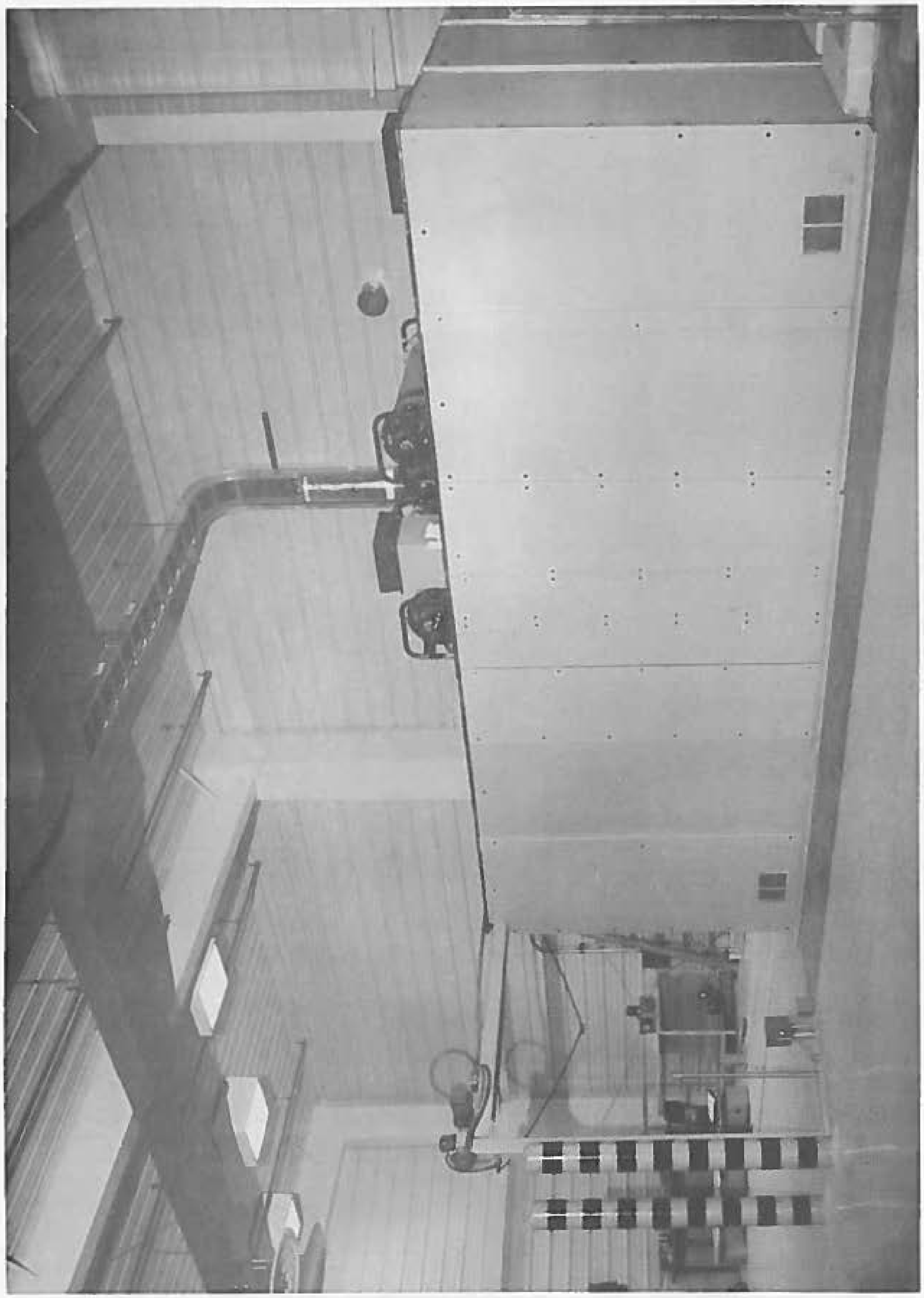


FIGURE 13c. REAL-TIME RADIOGRAPHY

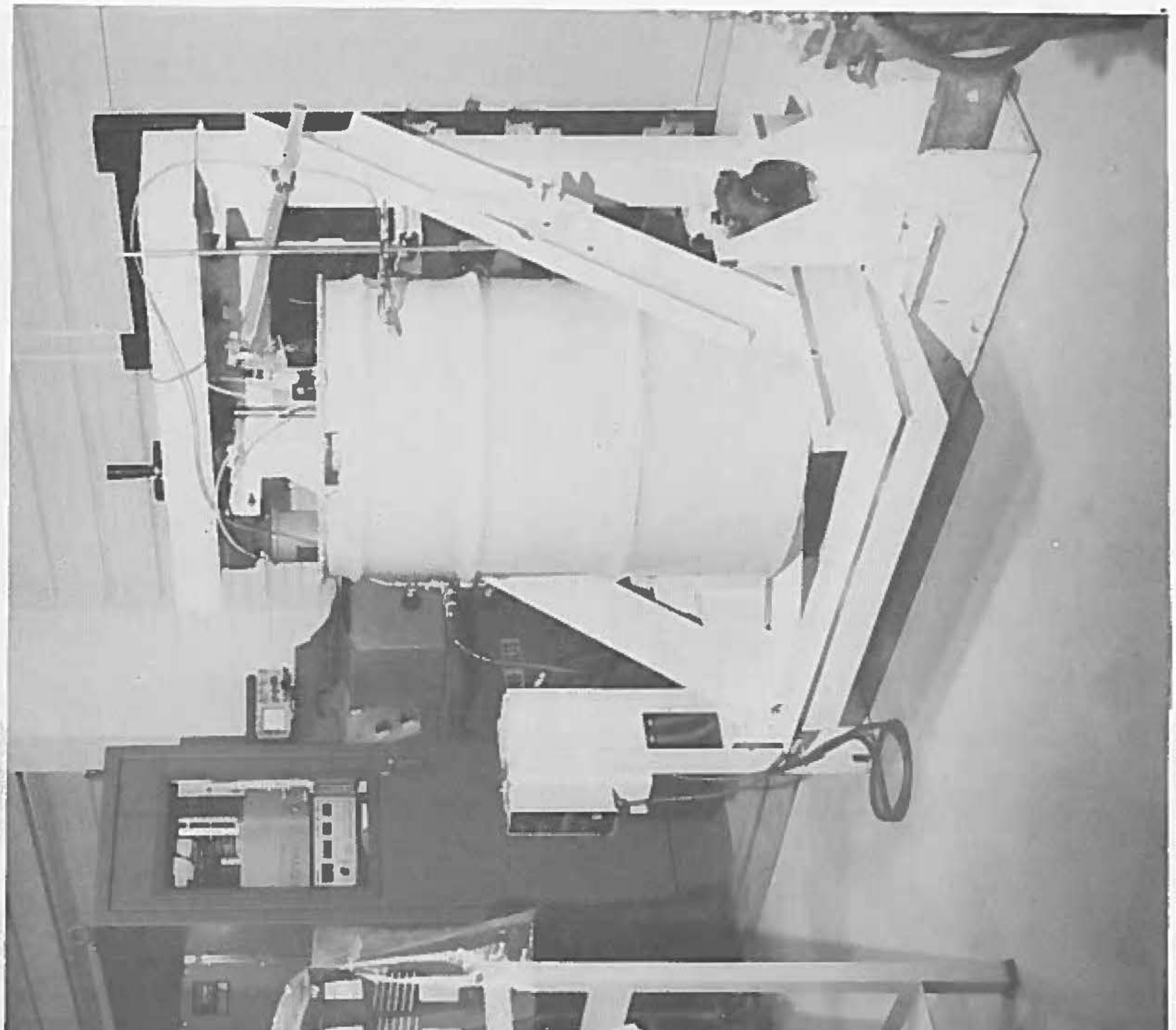


FIGURE 13d. CONTAINER INTEGRITY SYSTEM

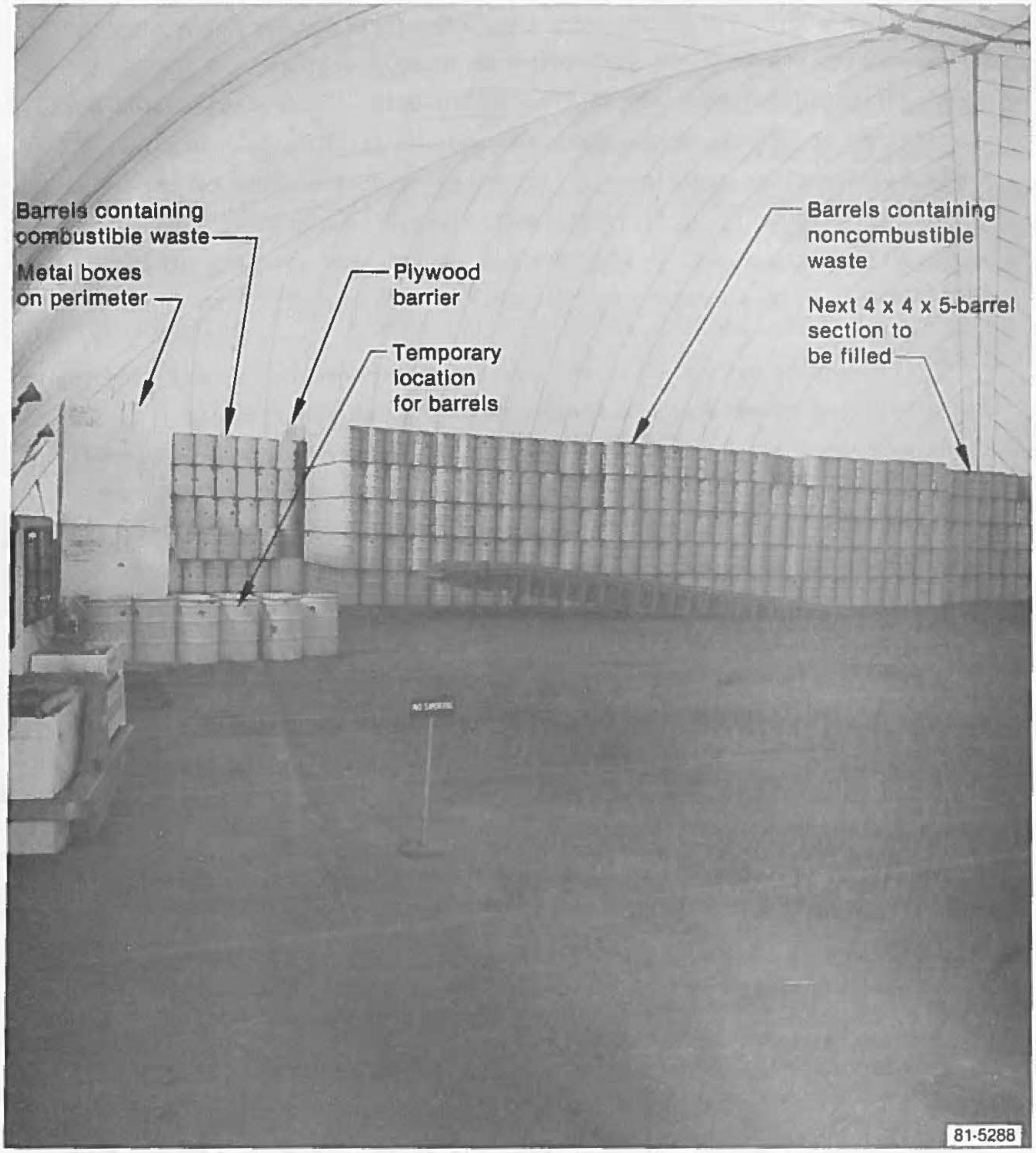


Figure 14. Waste stack in ASWS-2 on TSA Pad-2.

except that within 9 m of the edge they are stacked about 3.7 m high to allow sloping of the final soil cover to improve drainage. A 0.6 to 1.2-m earth firewall isolates each 45.7 by 30.5 m cell. Fiberglass-coated boxes are stacked to define the boundary and provide for side load-bearing surfaces; the other containers fill the cell spaces bounded by the boxes. A sheet of 0.6-cm-thick, fire-retardant plywood is placed between every layer of drums to stabilize the stacking surface and increase overall rigidity.

After each cell is filled, the ASWS is moved forward (north), and the containers are covered with a final covering which consists of: (a) a sheet of 1.5-cm-thick plywood, (b) a 0.05-cm nylon-reinforced polyvinyl plastic cover, and (c) 0.9 m of soil. Earth-moving equipment can be operated atop the soil cover on the stacked containers. The soil is then seeded to a sod-building grass.

It was determined that there was sufficient space in the present ASWS to accommodate, without moving the structure, the predicted number of TRU waste drums until SWEPP becomes operational. This accommodation could be achieved by increasing the drum stack height to six high and storing the M-III bins and RFP boxes on the TSAR. An evaluation substantiated that the drum stack height could be safely increased to six drums high. This change was initiated in late 1983 to avoid the costs of moving the ASWS and covering the waste.

5.1.5 SWEPP (TSA-3)

The Stored Waste Examination Pilot Plant (SWEPP) 47-m by 18-m metal examination building and the 198-m by 46-m Certification and Storage (C&S) Air Support Weather Shield (ASWS) were erected in FY-1984 on the 285-m by 45-m TSA-3 pad (completed in 1983, Figure 13).

SWEPP consists of two buildings (Figure 13): The SWEPP Building and the certified and segregated storage building (Figures 13 and 13a). The purpose of the SWEPP process is to determine whether the stored TRU waste meets the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria.

The equipment for nondestructive examination (Figure 13b, c, and d) is located in the SWEPP Building; this equipment includes real-time radiography (RTR) and the container integrity (CI) and assay systems.

The RTR, a movie image of the waste container contents, is provided via X-ray and T.V.

The CI system ascertains, through ultrasonic testing, the condition of the waste containers. The drums tested must meet Department of Transportation Type A specifications. If they do not, they are overpacked into new Type A containers.

The assay system is designed to measure fissile content, thermal power content, and total TRU content by using the differential die-away technique (i.e., active neutron interogation and passive neutron counting).

FY-1985 was devoted to installation and checkout of examination and facility equipment, initial operating staff acquisition and training, preparation of maintenance and operational documentation, and facility startup activities. SWEPP startup was initiated August 1, 1985.

5.1.6 TSA-R

TSA-Retrieved (TSA-R) is a 45.7 by 132.6-m asphalt pad built in December 1976, as a southerly extension of TSA-1. TSA-R provides 20-year retrievable storage of TRU waste retrieved during two projects conducted between 1974 and 1978. These two projects, Initial Drum Retrieval (IDR) and Early Waste Retrieval (EWR), are discussed later in this section.

Waste was repackaged in 314.2 L drums, DOT 7A steel bins, or metal cargo carriers. The pad was filled using DOT 7A steel bins stacked two high around the perimeter, with cargo carriers stacked two high in the middle.

The TSA-R pad was closed in FY 1979 following an ultrasonic test program conducted by the TRU Waste Systems Project on previously retrieved drums. The waste containers on the pad were covered with 10.2 cm by 30.5 cm by 4.9-m planks, 6-mm-thick plywood, polyethylene sheeting, and 0.6 m (2 ft) of soil. Temperature and moisture probes in the storage cell were placed by the WP Environmental Science Project before closure. Figure 15 shows the TSA-R pad being covered with earth.

The portion of the TSA-R pad that does not contain retrieved waste is at present used for temporarily storing waste in DOT 7A fiberglass-coated boxes from Rocky Flats and Mound Laboratory. The boxes were moved to TSA-2 (usually within a year) as needed for the perimeter walls of each cell and to fill space between cells.

5.1.7 Intermediate-Level Transuranic Storage Facility (ILTSF)

Construction of the Intermediate-Level Transuranic Storage Facility (ILTSF), an area designed to store intermediate-level TRU waste, began in late 1975. Waste is designated intermediate level if it emits beta-gamma radiation at levels high enough to require special handling and shielding[37,57]--specifically limited to between 200 mR/hr and 4500 R/hr at the container surface. At the close of FY 1982, the upper radiation limit was being revised to 100 R/h in the RWMC packaging criteria to agree with WIPP-DOE-069, Rev. 1, "TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant." The ILTSF provides below-grade storage in carbon-steel-pipe vaults for this intermediate-level TRU waste until shipment to a permanent federal repository is possible.[57]

Work associated with installing the initial storage vaults was completed in May 1976. The pad was extended to a length of 107.3 m in the fall of 1976.[57] Initially an experimental installation, the ILTSF is now an established operating facility.

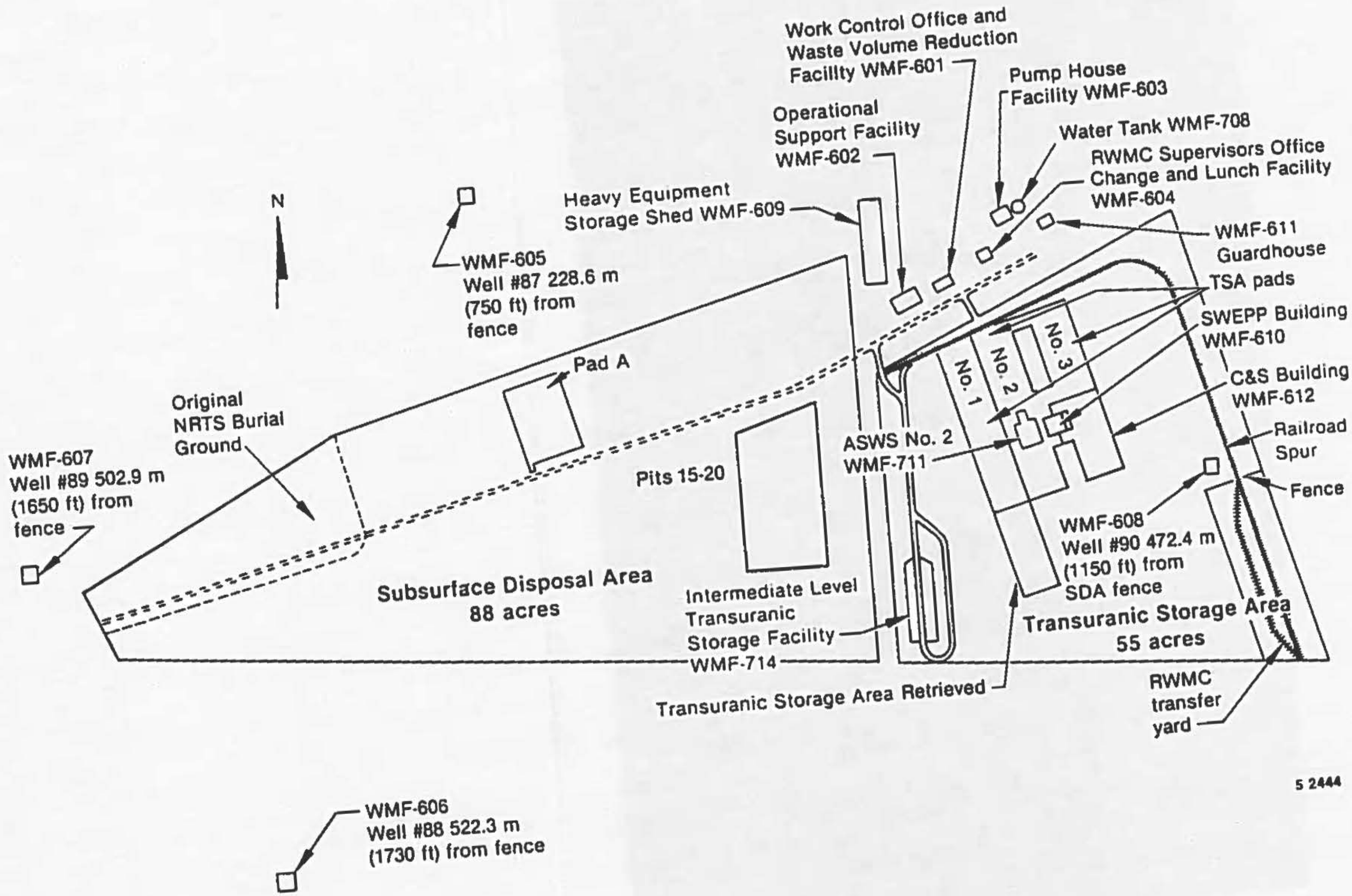


FIGURE 14a. TSA ACTIVE STORAGE AREAS

Figure 15. Covering of the TSA-R pad.

The original ILTSF contained 26 steel pipe vaults: twelve 61-cm-diameter vaults and fourteen 40.6-cm-diameter vaults.[56] Sixteen additional 61-cm-diameter vaults were installed in 1977, and fifteen more were installed in 1978. Also in 1978, all vaults were modified to improve the closure seal. Some of them were modified so that samples could be taken of inside air, moisture, and temperature. The vaults installed in 1978 were 9.1 m deep. This depth required drilling emplacement holes about 3.7 m into the basalt. In FY 1980, fifteen 61-cm and five 40.6-cm vaults were installed at the ILTSF--all of them about 4.6 m long. The length of all future vaults will be limited to 4.6 m due to the cost of drilling into the basalt. In FY 1981, five 40.6-cm-diameter and twenty-two, 61-cm-diameter ILTSF vaults with shield plugs and radiation-monitoring tubes were installed. Twenty-two, 61-cm and ten, 40.6-cm-diameter ILTSF vaults were installed. Twelve, 121.9-cm-diameter ILTSF vaults were designed and procured (for installation in FY 1983) for temporary storage of New Waste Calcining Facility (NWCF) filters. These twelve 121.9-cm diameter vaults plus twenty 61-cm-diameter and four 40.6-cm-diameter vaults were installed during FY-1984. A second 31.7 m by 106.7 m ILTSF pad was completed in July 1985.

A removable concrete plug in each vault provides shielding.[14,27] The vaults are embedded in a compacted embankment 9.1 m wide, 106.7 m long, and 1.5 m high. The vaults extend about 10 cm above a 5-cm-thick asphalt pad. The height of the pad provides adequate soil depth above the basalt for the vaults and prevents accumulation of water around the vaults. The asphalt surface allows use of heavy machinery during waste unloading and retrieval operations.[58] Free-air transfer is the method used for transferring waste into the 61-cm-diameter vaults (Figure 16), while a bottom-discharge cask is used for transferring waste to the 40.6-cm- diameter vaults.

5.2 Receipt of Offsite TRU and Low-Level Waste

Rocky Flats has been the main source of TRU waste shipped to the INEL. Since the termination of the Interim Burial Ground Program, no other offsite waste has been received without specific AEC authorization. Authorization, established through Letters of Agreement, has been given to

Figure 16. Free-air transfer to ILTSF vaults.

receive transuranic waste from Bettis Atomic Power Laboratory, Pittsburgh, PA, (since 1973); Argonne National Laboratory-East, Chicago, IL, (since 1974); Mound Laboratory at Miamisburg, OH, (since 1975); and Battelle Laboratories in Columbus, OH (since 1978). The Letters of Agreement establish receipt criteria for each shipper.[59,60,61,62] A similar Letter of Agreement was negotiated with Rocky Flats in 1975.[63] Before 1975, receipt criteria for Rocky Flats waste were not formally written; only since about 1970 has Rocky Flats supplied information on content and curie level of its waste along with each shipment. Before that time, Rocky Flats provided a year-end memorandum summarizing the radionuclide content and volume of waste that had been shipped to the INEL during that year. A special Letter of Agreement was negotiated in 1977 with Argonne-West for receipt of intermediate-level TRU waste.[64]

In October 1979, DOE announced a policy change to discontinue the use of commercial burial sites for disposal of low-level radioactive waste generated by DOE contractor operators and to dispose of that waste instead at DOE disposal sites. This policy was adopted to relieve pressure on the three commercial low-level waste disposal sites resulting from reduced capacity at those sites. After discussion with the State of Idaho,[65,66,67,68] disposal of low-level waste from ANL-E was begun in September 1980.

In 1978, formal packaging criteria for radioactive waste receipt were established, and these criteria have replaced the Letters of Agreement.[69] Packaging criteria for acceptance of low-level waste from DOE facilities other than the INEL were issued in FY 1980 to support the receipt of ANL-E low-level waste. These criteria are updated periodically[69, 69a and 69b]; the most recent update was March 1985.[115]

5.3 Retrieval of Waste

The first information on conditions of the waste came not from a formal study, but from an attempt to recover some experimental equipment in the fall of 1969. Although the equipment was not found, waste buried for 10 to

15 years was uncovered. Barrels were found undamaged and well preserved, but boxes and other similar packaging material had deteriorated.[4]

5.3.1 ACC Retrieval Study

In 1971, the AEC requested Allied Chemical Corporation (ACC) to perform a probe test of buried waste to determine (a) the condition of waste and containers, (b) soil migration of the Pu contaminants, (c) difficulties of controlled contamination spread during retrieval, and (d) cost of retrieval. Waste from Pits 2, 5, 10, and 11 was examined--some of it buried for more than 10 years. Some barrels were in excellent condition while others were corroded. It was obvious that damage during original dumping operations was extensive and had resulted in many open barrels. Plywood boxes and cardboard cartons were deteriorated to the extent that they had no containment value.[70]

5.3.2 Initial Drum Retrieval Project

The Initial Drum Retrieval (IDR) project was initiated in FY 1974 with the following objectives:

a. To demonstrate the safe retrieval of drums buried at the RWMC between 1968 and 1970

b. To gain experience in handling and repackaging these drums for interim storage

c. To develop and use the most economical storage container for retrieved waste. A total of 20 262 drums were repackaged and stored.

Retrieval operations began in July 1974, and were completed in June 1978. The retrieval was limited to Pits 11 and 12 after probes into Pits 6, 9, and 10 uncovered high levels of contamination and badly deteriorated containers. Personnel wearing anticontamination clothing retrieved the waste under an air-support weather shield. During the 3-1/2 years of these operations, retrieval personnel experienced no serious injury, and they received no significant increases in wholebody dose of radionuclides.[71]

Cargo carriers were selected and procured for storing IDR drums because they offered the advantages of a transportable overpack and were the most economical of the proposed storage containers.

Finds of the project were as follows:[71,72]

a. Of the drums retrieved during the entire project, 91.5% had good integrity.

b. Virtually all drums from Pit 11 showed visible rusting on the surface.

c. About 6.1% of the Pit 11 drums had external alpha contamination, which was easy to control and showed no tendency to spread to other areas.

d. None of the Pit 12 drums had external contamination, and they were in much better condition than those from Pit 11--probably due to a shorter time underground.

e. About 2.4% of the drums were breached (small holes); of these drums, one-third leaked free liquid, which was usually uncontaminated.

Conclusions in the final report[71] were that any retrieval operation could be performed in a manner similar to that used in the IDR project, provided the drums had been stacked in an orderly manner and had been buried in the ground for less than ten years. The boxes were deteriorated badly enough to require repackaging; they were not retrieved in this project.

5.3.3 Early Waste Retrieval Project[73,74,75]

The purpose of the Early Waste Retrieval (EWR) project initiated in FY 1976 was to develop methods and equipment for the safe retrieval of TRU waste that had been buried for 22 to 24 years. Safety considerations were to include evaluating personnel exposure risks and minimizing spread of contamination to the environment during retrieval of uncontained waste and waste in deteriorated containers.

Retrieval activities began May 4, 1976, and terminated September 29, 1978. Total waste retrieved from Pits 1 and 2 and Trenches 5, 7, 8, 9, and 10 amounted to 170.6 m^3. This included 457, 208.2-L drums, 34.43 m^3 of loose waste, 24.3 m^3 of contaminated soils, and 17.2 m^3 of waste generated by retrieval operations. About 67% of the drums retrieved were severely breached. Free liquid leaked from about 6% of the drums, and 5% had external alpha contamination.

All retrieval activities were performed inside the Operating Area Confinement (OAC), a self-supporting building constructed of lightweight metal panels. An air-support weather shield provided weather protection for the DAC. The OAC prevented the spread of contamination to the environment and provided operational safety for personnel. Figure 17 shows EWR operations inside the OAC within ASWS-3.

All personnel entering the OAC were required to wear anticontamination clothing and a bubble suit. An air compressor in the OAC supplied clean air to the bubble suits. EWR personnel were periodically rotated to other assignments within the RWMC. The average exposure reading for the entire RWMC crew was steadily reduced during the time of the EWR project--1500 mR in 1976, 990 mR in 1977, and 730 mR in 1978. The established operating and safety procedures and improvements in techniques and materials prevented spread of contamination and reduced the amount of contaminated soil and waste generated from retrieval operations.

Figure 17. EWR operations inside OAC.

All waste was wrapped in plastic before repackaging. The loose waste, breached drums, and contaminated soil were placed in new drums. Waste generated during operations was repackaged in drums (also compacted in 1978). DOT 7A steel bins (MIII) were used as overpack containers for the repackaged waste.

On termination of retrieval operations, (a) all equipment was decontaminated and removed from the OAC, (b) the excavation was backfilled with clean soil, (c) the OAC was decontaminated, and (d) the facility was placed into a standby mode.

In June 1981, ASWS-3 was deflated and stored. The anchor blocks were covered in place when the area was backfilled. The blocks can be retrieved easily if a need for them is identified in the future.

5.3.4 TSA Reentry Study

Cells 1 and 6 of TSA-1 were opened in a TSA Reentry Study conducted in 1978 to determine if the stored TRU waste containers were undergoing significant deterioration since storage.[76] The waste in Cell 1 had been stored in late 1970 and early 1971 and was the earliest waste stored aboveground. The drums in this cell were stacked horizontally. The waste in Cell 6, however, was stored during 1973. Cell 6 was chosen since it was the first cell in which all the drums were stacked vertically, the method currently used at the RWMC.

All drums were found to be in good condition, but drums from Cell 1 generally appeared in better condition than those from Cell 6. (Both of these areas were filled without an ASWS.) The difference in the condition of the drums was attributed to (a) Cell 1 drums being stacked horizontally rather than vertically, allowing less flat surface to be exposed to the weather, and (b) drums in Cell 1 being painted with black bituminous-base paint instead of white alkalyd paint as those in Cell 6. The bituminous paint appeared more resistant to a moist environment.[76] The storage method was considered acceptable and responsive to requirements of 20-year interim storage, especially since storage now takes place under an air support weather shield.[76]

One-hundred-thirty-five DOT 17C drums retrieved from Cells 1 and 6 were subjected to ultrasonic testing during FY 1979 to provide additional data for evaluating container life in the TSA storage. The results of the testing showed the thickness of the drums to be within original tolerances. The data obtained from the testing of these retrieved drums indicate that they will meet and probably exceed the 20-year storage criteria. This study recommended continuance of the present storage practice and unchanged environmental conditions in the storage cells.[77]

Cell 5 of TSA-1 was opened June 1984 for inspection of the waste containers and development of SWEPP certification procedures. Findings will be documented upon completion of the project.

5.4 Changes in Waste Management Practices

Changes in waste management practices at the RWMC since 1970 are described in the following sections.

5.4.1 Waste Information Systems

The Waste Information Section operates six waste information systems for DOE. This section and the Waste Information Systems were transferred to the National Low Level Waste Management Programs Branch February 13, 1984.

5.4.2 Waste Storage Practices

Waste storage practices on TSA pads were changed in FY 1981 to delay by at least a year the time when TSA air-support weather shield (ASWS-2) is filled and must be moved. Metal boxes stacked two high and fiberglass-coated wooden boxes stacked three high comprise the perimeter to stabilize the waste stack under ASWS-2 (Figure 14). Within the perimeter, metal barrels are stacked in 4 x 4 x 6-barrel arrays to fill one section of the grid at a time. The purpose of filling one section at a time is to facilitate retrieval of a specific barrel or shipment if that becomes necessary. Since a section holds 96 barrels, and a shipment usually contains approximately 70 barrels, two sections, at most, would have to be opened to retrieve a particular barrel or shipment. Figure 18 illustrates the new grid pattern being used in ASWS-2 on TSA-2, and Figure 19 illustrates the new grid on TSA-R.

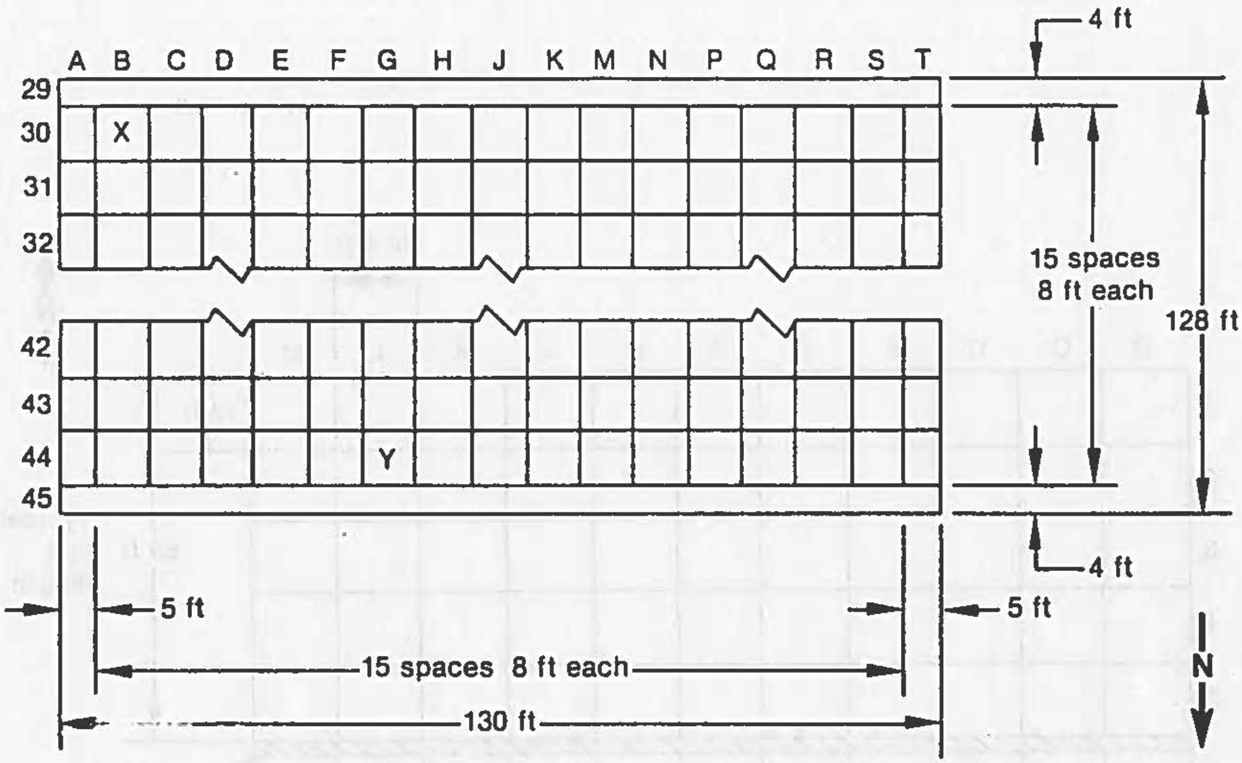
5.4.3 Space Utilization

A 1970 letter pointed out that the Burial Ground would be filled in a few years unless a plan for maximum utilization was developed and implemented.[80] The problem was examined in 1971, and a resulting space utilization plan proposed closer spacing of the trenches and using space between old trenches. It also pointed out the advantages to be gained through compaction.[81]

A life-expectancy study of the SDA began in 1979 and has been documented annually.[82,83,84,85,85a] The study predicts the useful lifetime of the SDA based on 10-year forecasts provided by waste generators, current waste-handling practices, and the known available space in the SDA. The study concluded that space could be fully used as early as 1996. The resulting changes in space utilization are addressed in the following subsections.

Table 5 summarizes the waste buried or stored at the RWMC from 1952 through December 1983.

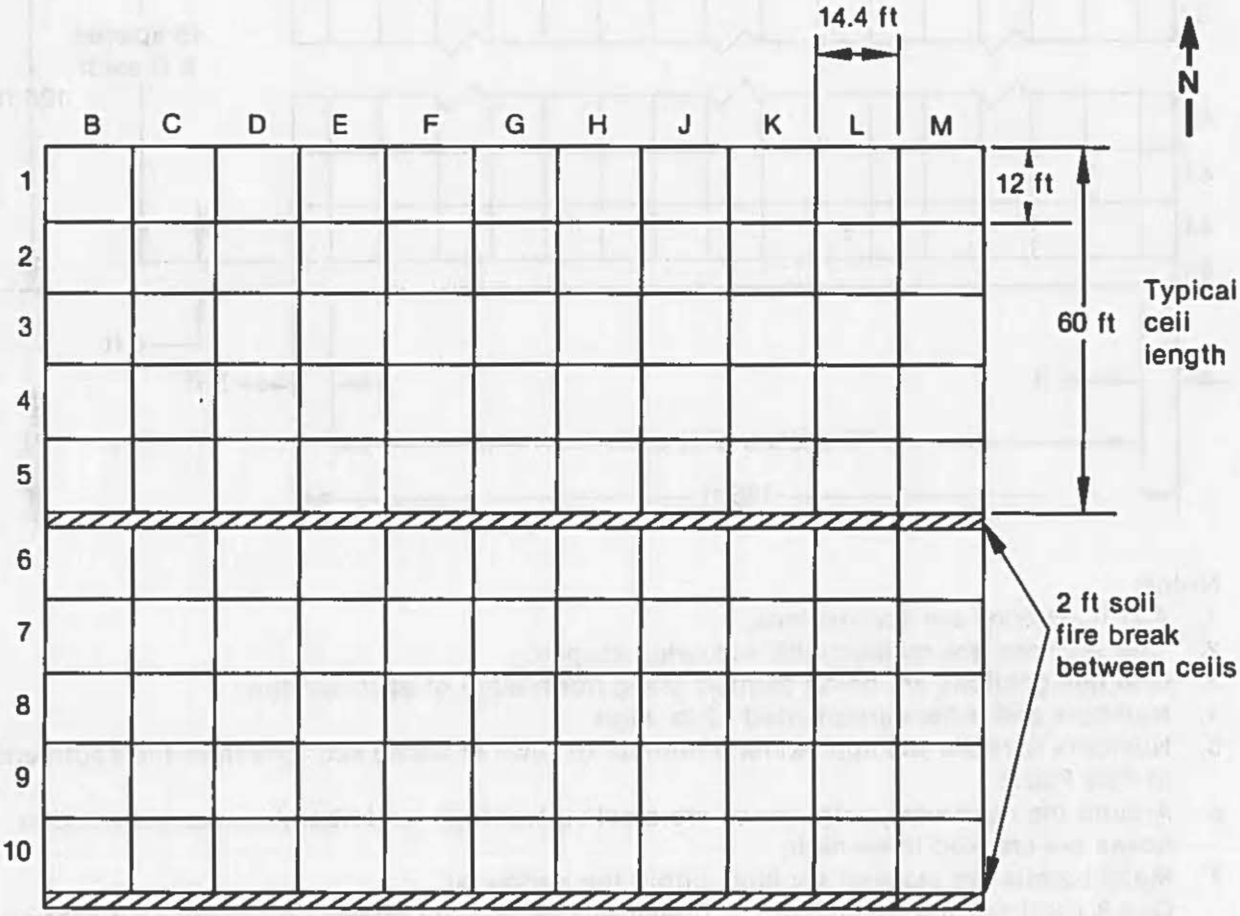
5.4 3.1 Compaction. Waste volume had always been a concern because of shipping and handling costs and because of the need to conserve space at the Burial Ground. By 1966 (and possibly as early as 1962), the gamma-emitting routine waste at the NRTS was compacted by dropping a heavy steel plate on it.



Notes:
1. All dimensions are approximate.
2. Grid sections are marked with 4-in.-wide stripes.
3. Grid designations are being painted along north edge of each section.
4. Numbers and letters are painted 12 in. high.
5. Numbers indicate the approximate number of rows of waste sections from the south end of TSA Pad 2.
6. Around the perimeter,metal boxes are stacked two high, and fiberglass-coated wooden boxes are stacked three high.
7. Metal barrels are stacked six high within the perimeter.
   One 8 x 8-ft section is filled (4 x 4 x 5-barrel array) before proceeding to the next section.
8. X is Section 30B. Y is Section 44 G.

INEL 4 0498

Figure 18. Storage grid system used in ASWS-2 on TSA Pad-2.



Notes:
1. All dimensions are approximate.
2. Grid sections are marked with 4-in.-wide stripes.
3. Grid designations are being painted along south edge of section.
4. Numbers and letters are painted 12 in. high.
5. The cell will be closed annually, with approximately 60 ft of stored waste between soil fire breaks. Cells will be closed and fire breaks emplaced when weather and conditions permit.

INEL 4 0495

Figure 19. Storage grid system used on TSA-R pad.

TABLE 5. SOLID RADIOACTIVE WASTE DISPOSED OF OR STORED AT THE RWMC FROM 1952 THROUGH 1983

Calendar Year	Buried LLW Volume (m^3)	Buried LLW (Ci)[a]	Buried TRU Volume (m^3)	Buried TRU (Ci)[a]	Stored Tru Volume (m^3)	Stored Tru (Ci)[a]
1952-60	18 475[b]	60 920	10 545	11 300	--	--
1961	6 091[b]	155 650	2 439	3 650	--	--
1962	5 730[b]	115 320	2 755	3 780	--	--
1963	5 445[b]	251 480	3 357	10 520	--	--
1964	3 132	146 330	3 764	12 270	--	--
1965	4 076	685 890	3 454	17 010	--	--
1966	4 634	859 010	4 859	65 290	--	--
1967	3 820	836 130	5 826	41 670	--	--
1968	3 947	268 810	9 791	32 690	--	--
1969	4 740	935 520	6 770	35 480	--	--
1970	4 151	482 640	8 429[c]	15 460	1 420	4 225
1971	4 026	350 900	--	--	7 149	13 920
1972	3 548	214 700	--	--	5 955	27 690
1973	3 880	339 900	--	--	5 811	24 580
1974	3 694	18 320	--	--	4 126[d]	23 650
1975	5 692	13 180	--	--	3 895[e]	32 580
1976	6 212	218 800	--	--	1 103	11 075
1977	6 591	824 100	--	--	4 597[f]	37 147
1978	5 932	1 119 000	--	--	2 761[g]	40 142
1979	5 348	243 700	--	--	3 302[h]	23 892
1980	5 070	149 500			2 254	17 825
1981	3 064	130 800	--	--	2 714	26 253
1982	3 185	512 000	--	--	2 859	26 820
1983	5 474	54 760	--	--	3 035	25 993
1984	3 906	144 100	--	--	4 068	35,308
Totals	129 503	9 131 460	61 989	249 120	55 049	371 100

a. Radioactivity at time of disposal or storage, without accounting for subsequent decay.

b. Includes 7014 m^3 of offsite-generated waste received during the period that the RWMC was designated an Interim Burial Ground, 1960 through 1963.

TABLE 5. (continued)

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c. These data do not reflect the retrieval of 4830 m^3 of Rocky Flats waste from the SDA.

d. Includes 89.5 m^3 of previously buried waste retrieved in the IDR project.

e. Includes 505.3 m^3 of previously buried waste retrieved in the IDR project.

f. Includes 2006 m^3 of previously buried waste retrieved in the IDR and EWR projects.

g. Includes 1785 m^3 of previously buried waste retrieved in the IDR and EWR projects.

h. Includes 9 m^3 of previously buried waste retrieved in the IDR and EWR projects.

NOTE: Details may not add up to totals because of rounding.

Since 1970, substantial study and effort have been devoted to reducing waste volume. In 1970, the General Manager of the AEC assigned a study group to investigate compaction. A June 1970, report estimated that half of the AEC waste could be compacted and recommended funding, installing, and evaluation of demonstration units.[36] In 1971, the Naval Reactors Facility (NRF) started using a mechanical compactor to reduce the volume of NRF waste prior to shipment to the RWMC.[86]

Waste Management investigated the NRF compaction system and selected a compactor based on the design criteria developed in the Naval Reactor Program.[86] By April 23, 1973, the NRTS compactor had arrived to await completion of the building to house it. As shown in Figure 20, the compactor is a conventional vertical-downstroke, hyraulically operated, 45.4 metric ton baler, with HEPA filters added to control contamination. It was installed in the Waste Volume Reduction Facility (WVRF), the west bay of WMF-601 built in 1974. The filtered exhaust of the compactor was re-routed in June 1984 to discharge outside the WVRF Building. This modification was made to protect the operator from potentially hazardous fumes or vapors resulting from the inadvertent inclusion of prohibited materials in the compactible waste.

Since January 1974, compactible waste received from INEL waste generators (other than NRF) has been compacted.[87] The nominal volume reduction achieved at the RWMC as 10:1.[14] Routine beta-gamma compactible waste is separated at the point of origin; the waste is compacted into 272.2-kg bales at the WVRF and placed into pits. Since 1974, most onsite non-TRU compactible waste has been transported to the RWMC in plastic bags to accommodate the new compaction system.

5.4.3.2 Disposal Practices. Implementation of space-saving measures extends to present-day disposal practices. Records of all the buried waste show the distance (in feet) of the waste from a presurveyed reference point. Within the 88-acre SDA, pits, trenches, and soil vaults have been used for permanent disposal of radioactive waste.

Figure 20. NRTS 45.4- metric ton baler.

Pits--The pits are used for routine, solid, low-level, beta-gamma-contaminated waste with dose rates below 500 mR/h at 0.9 m. Figure 21 is a photograph of current pit disposal. Excavated in a previously surveyed area with scraper-carryall and bulldozers, pits average 5 m deep by 30.2 m wide and vary in length. Pit 17 was excavated to a depth of approximately 9.1 m after explosive fracturing of the basalt. As a means of making maximum use of the SDA, pits are excavated into the basalt, the exposed basalt then is covered with 0.6 m of soil. In FY-1985 Geotextile Fabric was incorporated in the upper portion of this soil cover to add stability for the waste stack. After the flooding in February 1982, the earth berm around Pit 17 was modified to eliminate the 0.3-m-high vehicle access. The continuous berm is 0.6 to 1.5 m above grade. The earth berms serve as radiation shielding, firebreaks, and dikes.

A crane pad was constructed for the bulk disposal area in FY-1985.

Soil Vaults--Beginning in 1977, areas not suited for pits were set aside for drilling of soil vaults. This practice not only helped to conserve SDA space, but also reduced personnel exposure to radiation.[84] High-radiation (greater than 500 mR/h) beta-gamma waste is deposited in the soil vaults. Rows of these vaults are drilled along predetermined centerlines, each vault separated from previously buried waste by approximately 0.6 m (Figure 21a). Soil vault diameters vary from 0.4 to 2 m; minimum depth is 2 m. If the drilling has penetrated basalt, 0.6 m of soil is placed on the vault floor. Open soil vaults are surrounded by barriers denoting the hazard.

Trenches--The edges of trenches were dug along predetermined centerlines and were separated from adjacent centerlines by no more than 4.9 m. This allowed maximum use of available space without disturbing previously buried waste. The average width of the trenches was 3.1 m (those with collapsing walls were wider). Waste with high gamma radiation levels was handled remotely using special shielded containers and boom cranes. When the trenches were full, they were covered with a minimum of 0.9 m of soil. Locations of all trenches and soil vaults were identified by concrete monuments. A brass plate on each monument was stamped with the

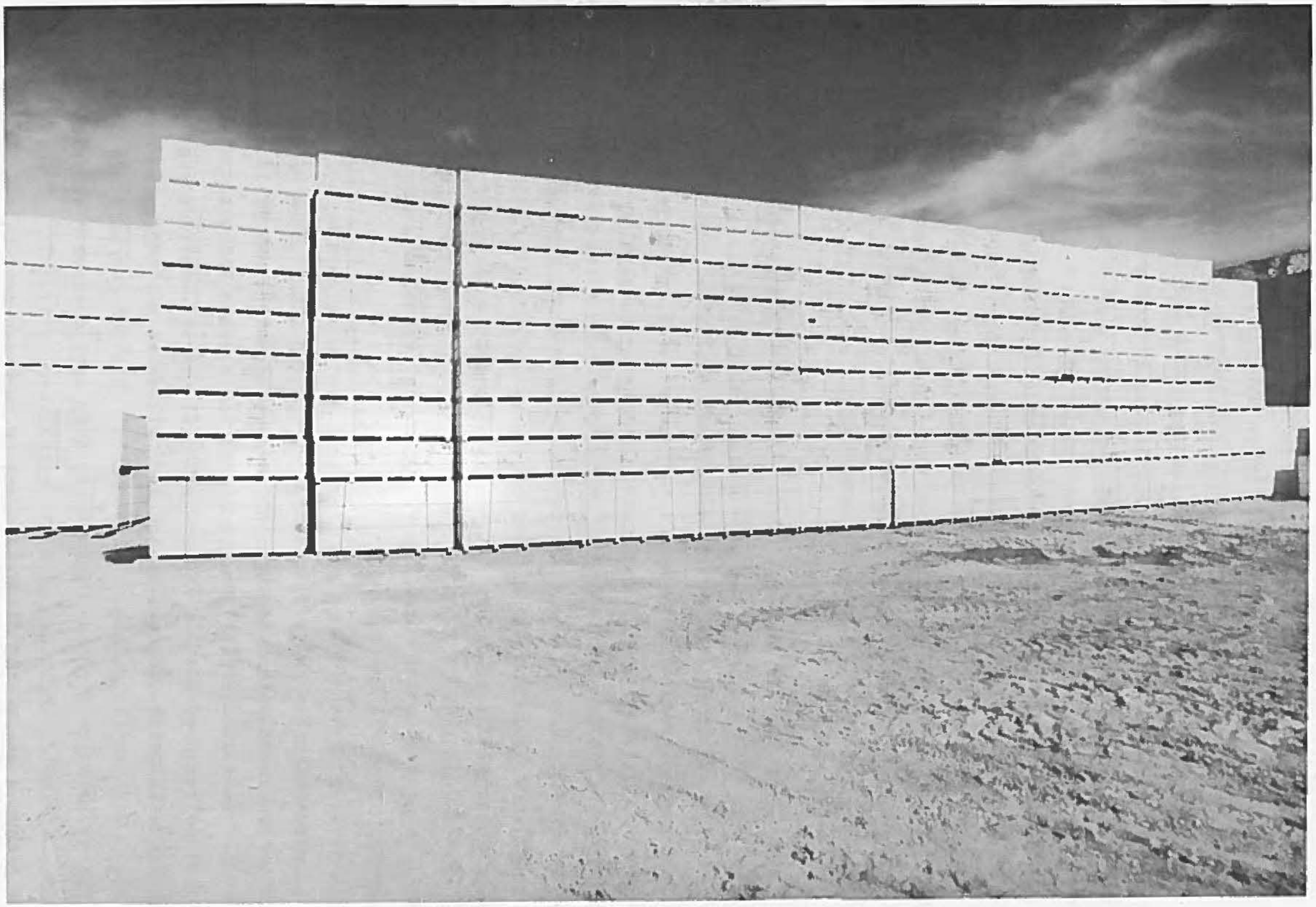

FIGURE 21. CURRENT PIT DISPOSAL

Figure 21a. Digging 45.7 cm soil vault and soil vault liner.

opening and closing dates. All non-TRU waste packages exceeding 500 mR/h at 0.9 m were deposited in trenches, except for those placed in soil vaults.

In July 1981, trench disposals were discontinued, and the unfilled trench area was redesignated for soil vault disposals.

Disposal Operations--Waste is transported to the SDA on flatbed trucks and trailers, some in shielded casks. The disposal location of all waste is recorded on "Disposed Solid Radioactive Waste Form," ID F 5480.2A, which accompanies the waste shipment.

Waste compacted into 0.4-m^3 bales in the WVRF is placed in pits. Most of the noncompactible waste received for disposal in the SDA is contained in 1.1 by 1.1 by 2.4-m wooden boxes coated with fire-retardant paint. These boxes are stacked in pits in a close-packed array with minimum space between waste packages to conserve space. Large bulky items, such as support stands and tanks, are wrapped in 0.15-mm or heavier polyethylene plastic and are also placed in pits. Baled waste, boxed waste, and large bulky items are placed in separate areas of the pit.

The close-packed array stacking, made possible with the issuance of the packaging criteria in 1978,[69] has increased pit space being utilized from 30% to about 75%. Further development of size reduction techniques currently under development (smelter, incinerator, metal compactor, etc.) will allow even more waste to be placed in the close-packed array.

Waste packages are covered with soil to isolate them from the environment and to reduce radiation levels to less than 1 mR/h at 0.9 m from the surface (at least 0.9 m of soil is required). The soil cover is crowned and compacted to allow efficient natural drainage.

5.4.3.3 Increasing Usable Disposal Space. A study[82] completed in FY 1980 predicted the useful lifetime of the SDA for disposal based on current waste projections and handling techniques, and the known available space remaining at the SDA. The study concluded that the available SDA space could be depleted as early as 1996. The study also concluded that major excavations of basalt could extend the SDA lifetime significantly. A more recent study[85a] indicated that the life expectancy of the SDA could be extended to the year 2090, if the explosive rock fracturing is continued. A bulldozer with a rockripper (added to the RWMC heavy equipment inventory in FY 1979) is used for removing fractured basalt in SDA pit areas to increase usable disposal volume. This machine is shown operating in Pit 16 in Figure 22. Other methods of fracturing rock are being evaluated. A hydraulic impact hammer was procured in FY 1979 to aid in fracturing rock that the dozer-ripper could not remove. Although effective, this method is economically unacceptable.

Testing of explosive fracturing of basalt began in FY 1980--including a scale-model test outside the RWMC and explosive tests in Pit 17. The test series in Pit 17 consisted of single-hole charges with 453.6 to 4535.9 g of explosive. A scaled pattern, similar to proposed production-scale array, was tested to evaluate maximum seismic disturbance, fracture propagation, and aggregate displacement. The 7.6 by 7.6-m array contained about 362.9 kg of explosive; 36.3 kg were detonated at each delayed firing. The aggregate pile resulting from the array test is shown in Figure 23.

Production-scale explosive rock fracturing began in Pit 17 in FY 1981. These blasting projects fractured 2977 m^3 of basalt in FY 1981,[88] 14 211 m^3 in mid-FY 1982,[89] 22 950 m^3 in FY 1982 and FY 1983 and 24,092 m^3 in FY 1984.

Blasting is prohibited within 15.2 m of buried waste or other critical receptors, such as buried water mains. Consequently, nonexplosive methods are being investigated to fracture basalt within the buffer zone. In FY 1982, BR1-STAR (a high-expansion compound) and freezing water were tested. Freezing water was unsuccessful, and BR1-STAR was successful only when used in holes drilled in basalt that had an exposed, free face.[90]

5.4.4 Liquid Corrosive Chemical Disposal Area

The Liquid Corrosive Chemical Disposal Area (LCCDA), a pit located approximately 1 km east of the main RWMC, was used for the disposal of

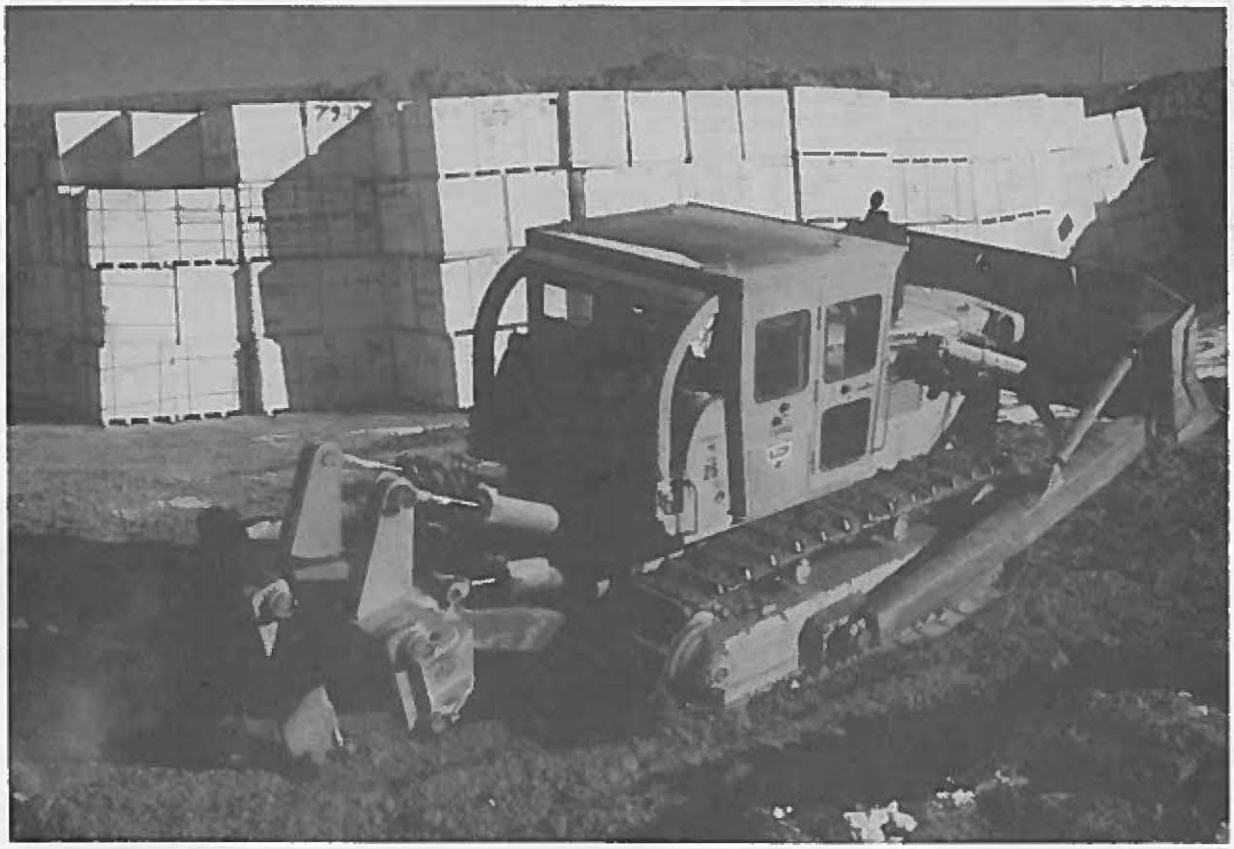

Figure 22. Rock ripper removing fractured basalt in Pit 16.

Figure 23. Aggregate pile resulting from FY 1980 explosive fracture.

small quantities of nonradioactive acid and caustic waste. Limestone material was added to the pit to neutralize the acid wastes. This pit, formerly maintained and operated by CF Maintenance, became the responsibility of the Waste Management Operations Branch (WMP-O) during FY 1979. Specific criteria for the packaging, handling, and types of material allowed for disposal were initiated by WMP-O.[91] The LCCDA was closed July 31, 1981, and was decommissioned October 31, 1981.[92]

5.4.5 Drainage

Even after improvements were made to the diking system following the 1969 spring flood, local flooding within the RWMC continued to be a concern.[76] By the fall of 1969, all holes, crevices, and cracks were routinely filled in preparation for the spring snow melt.[34] A 1970 letter noted that grading and a drainage system would probably be necessary to prevent flooding within the RWMC.[80] In FY 1972, grading was instituted to improve drainage. A topographic study of the area was also done in 1972 to determine the areas that needed to be filled. In 1976, a sump pump was installed near the perimeter fence to keep water from flowing over the trenches. In FY-1985 this drain system was enhanced with the installation of a flowmeter, automatic water sampler and two culverts. The latter provide passive flood control and were designed to meet the 100 year flood criteria.

During the last quarter of FY 1979, a controlled snow disposal area for the RWMC was installed, a 97.5 by 302-m gravel-base pad inside the TSA and northeast of TSA-2. This area drains to the northeast out of the TSA to the main RWMC drainage ditch.

Use of magnesium chloride as a dust suppressant and road surface enhancement was tried on a trial basis in 1984 and continued in 1985.

A FY 1980 paving and draining project provided discrete sumps and drainage facilities on TSA-2 at the Cell 3 location. These drains reduce moisture flow under stored waste and allow for discrete sampling of any moisture traversing Cells 2 and 3. Additional storm drains were also installed in the RWMC Facility Building Area in FY 1980.

5.4.6 Flood Control

A USGS study was performed in 1972 to determine the best method for improving flood control at the NRTS, i.e., protecting the facilities from flood waters originating outside the NRTS.[93] That study suggested doubling the capacity of the existing diversion channel into the spreading grounds as the most feasible means for improving flood control. This recommendation was later implemented in early 1983.

Numerous flood-control measures were taken following the flooding in February 1982. The drainage channel inside and outside the SDA was widened. Culverts were installed in the road between the SDA and the dry lakebed south of the SDA, and the southeastern SDA culvert was removed. A second sump pump was moved from the SDA north fence (east of the EWR site) and was installed in the SDA beside the sump pump near the east SDA fence (south of the access road). The second sump pump doubles the pumping capacity in the SDA. An additional emergency, forklift-portable sump pump was procured. Moisture-exclusion soil was placed and graded over disposed waste. In the spring of 1984 flood control Dike-1 was raised 1.8-m and Dike-2 2.4-m. Rock rip-rap was placed on both dikes.

5.4.7 Radiation Exposure Reduction

From 1971 until trench disposals were discontinued in 1981, the increased specific radiation of solid waste packages from NRF necessitated the use of a concrete shield while trenches are being filled.[4] Under early waste handling practices, a crane unloaded the high-activation-product radioactive waste from NRF into pits, and large amounts of backfill were then added to reduce surface radiation to acceptable levels. In the early 1970s, NRF waste was placed in metal baskets that were stacked inside special removable, shielded vaults in the trenches. This procedure conserved space and reduced radiation levels. In 1973, a formalized training program was developed for operators and supervisors at the RWMC. This program emphasizes the methods being implemented to perform the tasks safely and with a minimal radiation exposure to personnel. In 1974, a new trench liner and concrete cover (shown in Figure 24) were used with highly radioactive scrap waste shipments.[50]

The disposal of high-radiation beta-gamma in soil vaults has reduced personnel exposure since the practice was initiated in 1977 because:

a. Less time is required for disposal.

b. Personnel work at greater distance from the waste. Transfer is accomplished from either a bottom-discharging cask (Figure 25) or by free-air transfer from old casks.

c. More soil side shielding is provided in this mode of disposal.

In FY 1980, conceptual design and estimates were completed on a large 49.9-metric ton bottom-discharge cask for use at RWMC, NRF, ICPP, and TAN. The cask, Figure 25, provides reduced radiation exposure for operating personnel and improved space efficiency at RWMC because of the waste insert design. Specifically, the cask system eliminates the free-air transfer requirements of the NRF scrap cask. The 49.9-metric ton cask was received and placed in operation in FY 1982.

5.4.8 Fire Protection and Emergency Action Plans

After the 1966 fire, a firefighting plan evolved. In 1970, a formal Fire Protection Plan for the RWMC was implemented.[94] In 1974, a 946 250-L tank was installed to provide a water supply for firefighting.

An Emergency Action Plan was completed in 1972. In 1974, an evacuation warning system was installed at the Burial Ground,[51] and in 1977, complete RWMC standby electrical power was installed to operate evacuation sirens, lights, and a fire pump. The Emergency Action Plan is updated annually or as needed. The present procedure defines

Figure 24. Concrete shield for radiation exposure.

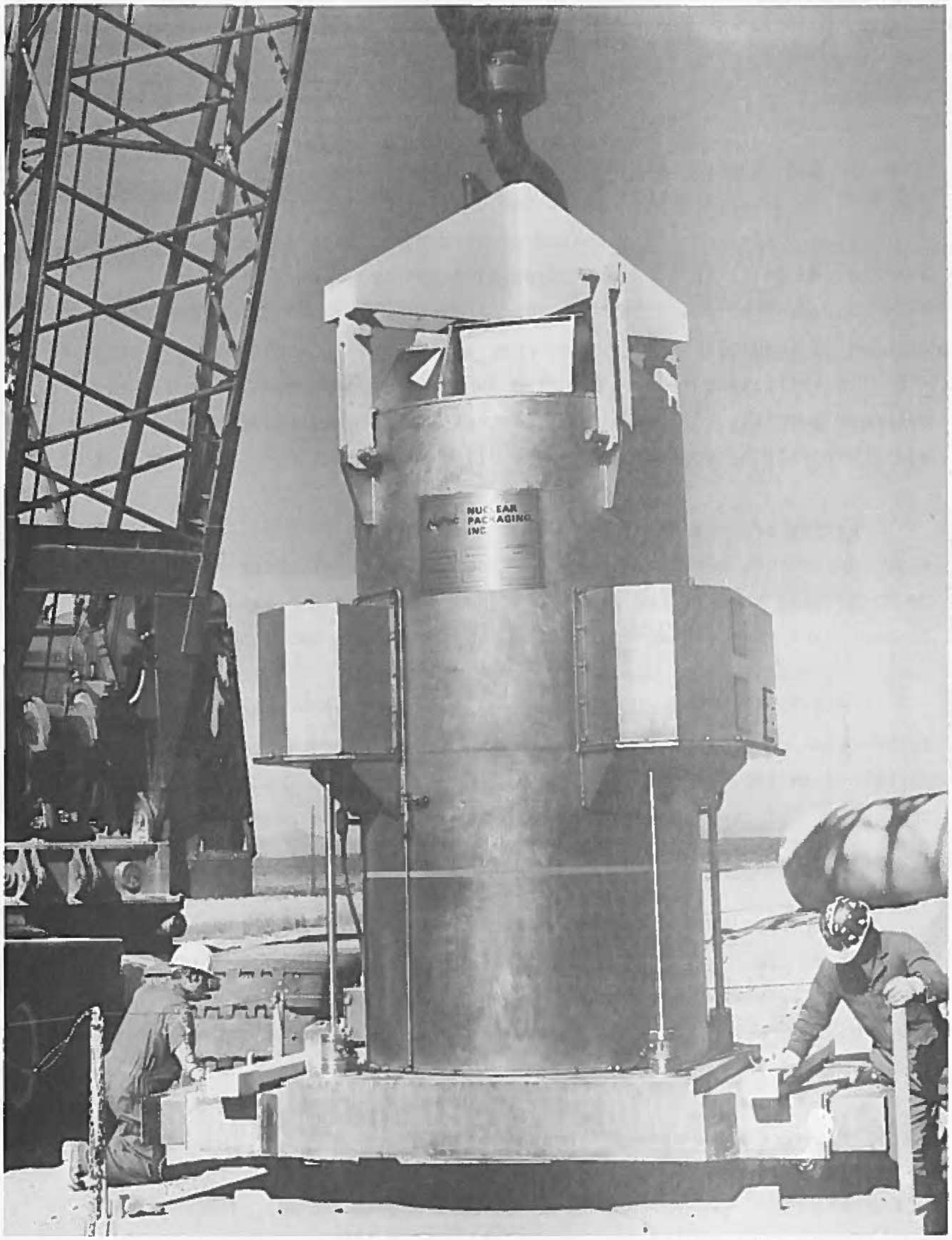

Figure 25. 49.9 metric ton bottom-discharge cask.

responsibilities of personnel and the actions required for each type of emergency--flood, tornado, earthquake, fire, bomb threat, riot, and public disturbance.

5.4.8.1 Combustion Tests of Waste Boxes. Two tests were conducted at the INEL to determine the combustion characteristics of (a) fiberglass-reinforced polyester-(FRP) coated plywood boxes used for transuranic waste storage and (b) INEL standard disposal boxes (plywood covered with fire-retardant paint). Test results indicated that if the boxes were exposed to credible ignition sources, box integrity would be maintained for a period sufficient to provide fire suppression measures, if the fire were detected promptly.[95,96] Because of the test results, fire detection equipment will be added to waste handling locations in the TSA and SDA.

Testing of fire-retardant paint continued in FY 1981 (Figure 26). Plywood surfaces were painted with fire-retardant exterior paint. On both newly painted samples and those that had weathered for 218 days, the paint foamed evenly and protected the plywood when flame was applied.[97,98]

5.4.8.2 Fire-Suppression Upgrade. Major improvements to fire suppression capabilities were begun in FY 1980. Dry pipe fire mains were installed in the SDA, and new sprinkler systems were installed in WMF-602 and -609. Old fire pumps in WMF-603 were removed in preparation for installation of the new pumps.

Ultraviolet fire detectors were installed in ASWS-2 and around Pit 17 FY 1981 and 1982. The detectors in ASWS-2 are operational, but those around Pit 17 were removed due to unsatisfactory performance. In addition, a dry-pipe fire main and two hose reels were installed along the north anchor blocks in ASWS-2.

5.4.9 Environmental Surveillance Since 1970

Since 1970, greater emphasis has been placed on environmental surveillance investigations. The following chronology highlights some events and studies.

Figure 26. Flame testing of fire-retardant paint.

5.4.9.1 Radionuclide Migration. Investigations into possible radionuclide migration have continued since 1971.

Shallow Well Sampling--In 1971, the USGS drilled six shallow wells within the SDA, and took sedimentary samples from each.[3] Four deeper wells were drilled outside the SDA. Trace amounts of radioactivity were found in about one-half of 44 samples from the six holes and from one hole tapping a zone of perched water.[99] In most instances, the levels of radioactivity detected were below those found in surface soil of this same region resulting from atmospheric weapons testing fallout. Results of these investigations were inconclusive, because it was suspected that insufficient control during drilling and handling contributed to the sample contamination. Statistical error also may have produced some of the positive determinations.

In 1975, ERDA conducted a core drilling study using improved coring and anticontamination procedures. Analyses of the samples showed no detectable quantities of waste radionuclides, and this study suggested that artificial contamination of samples probably was a factor in the USGS study.[100] Five of the six shallow holes were filled with concrete after subsurface core samples were taken.

In an investigation conducted in 1976 and 1977, samples were obtained from wells drilled adjacent to the waste, as in previous investigations. Samples also were collected from undisturbed soil directly beneath buried waste. Analyses of samples obtained from immediately beneath the waste showed limited waste radionuclides were well contained. Trace amounts were obtained in a few well samples to depths of about 70.1 m. In order to confirm these positive results, samples were analyzed again where enough material was available. The second analysis failed to confirm the presence of the trace quantities of waste radionuclides. The positive levels first indicated were far less than background levels found in surface soils, and accurate laboratory analysis for these extremely low levels is very difficult.[99]

In 1978, another study was performed to identify and characterize radionuclide migration in soils and substrata of the RWMC. A complete set of new samples was obtained from core material collected in the 1976 and 1977 core drilling program. This investigation indicated that there is no conclusive evidence that radionuclides originating from the buried waste have migrated to the underlying Snake River Plain aquifer. Furthermore, the concentration and location of waste radionuclides detected in subsurface samples are not great enough to indicate that the buried waste constitutes a hazard to the aquifer under present climatic conditions. The study concluded that most positive results observed in core samples from all studies since 1975 were probably a result of statistical variation rather than evidence of radionuclide migration.[101]

In the summer of 1979, three wells were drilled in and around the RWMC. Two wells were drilled in the eastern half of SDA (one adjacent to the TDA and one in the extreme southeast corner of the SDA); another was drilled east of the TSA (outside the fence). Two wells were drilled through the 73.2-m sedimentary interbed; the third was abandoned at approximately 61.3 m, because of drilling difficulties. Core samples above, within, and beneath the 33.5 and 73.2-m sedimentary interbeds were collected. Liquots from each core sample were radiochemically analyzed for the presence of waste nuclides from the RWMC.[114]

During June and July 1985 seventeen shallow holes were drilled through the surficial sediments to the basalt. Each hole was sampled continuously from the surface to the basalt. Each hole was instrumented with various combinations of suction lysimeters, psychrometers, tensiometers, and gypsum blocks. The holes were backfilled and provided with 8 x 24 inch surface casings and caps. Radioanalysis of the samples collected will be performed in late FY-1985.

<u>Subsurface Water Sampling</u>--The deep wells, plus the RWMC production well (drilled in 1974) became the basis of the subsurface water (aquifer) sampling program. The USGS formulated and conducted the initial sampling program during 1971 and 1972 and conducted subsequent sampling and analysis semiannually.[102]

A study by ERDA and USGS was initiated in 1975 to determine if reproducible results on either detectable or nondetectable quantities of americium or plutonium could be obtained from water samples collected from the aquifer. Analyses of water samples from the RWMC production well showed no plutonium or americium concentrations distinguishable from the background.[103]

Subsurface Soil Water Monitoring--In 1973, a Burial Ground surface soil water monitoring plan was established, 26 shallow holes were drilled to the first basalt underlying the surface soil, and perforated pipes were installed in the RWMC. These pipes are capped on the upper end. Seven similar holes were installed in the SL-1 Burial Ground. Monitoring of these holes became a part of the surveillance plan. The USGS takes samples from these holes in late fall and early spring.

5.4.9.2 Sampling Grid. During the summer of 1972, a sampling grid was established near the Burial Ground. This grid was used for collecting small mammals and soil samples near the RWMC in 1972 and 1973. Analyses of the animals and soil samples led to the conclusion that storing radioactive waste at the RWMC had little effect on the concentrations of activation and fission products in the environment near the RWMC.[104] However, trace amounts of transuranic nuclide concentrations slightly above background could be detected 2.9 km from the SDA perimeter.[105]

5.4.9.3 Environmental Surveillance Plan. In 1973, when the environmental monitoring program for RWMC was expanded to include geologic and deep subsurface hydrologic studies, a draft environmental surveillance plan made eight efforts routine:[106]

a. Surface radiation survey

b. TLD perimeter survey

c. Soil sampling

d. Air sampling

e. Surface water sampling

f. Subsurface moisture probing

g. Subsurface water sampling

h. Periodic visual inspections.

A revised plan was issued in March 1977.[102] In May of that year, five additional TLD locations were established around the perimeter of the TSA.[107] In 1979, a project plan for environmental monitoring was issued for the first time.[108]

During FY 1980, the Environmental Monitoring Program at RWMC published a detailed project plan[109] and the RWMC Environmental Handbook.[110] Purposes of the project plan are:

a. To define which environmental surveillance activities are basic to the monitoring programs

b. To detail the experimental design for each activity

c. To identify and schedule special investigative studies that will establish a complete environmental data base for RWMC and surrounding environs

d. To accommodate potential changes in operations at the RWMC, e.g., possible retrieval of stored and buried TRU-contaminated waste, and construction of the Transuranic Waste Treatment Facility (TWTF)

e. To detail the entire environmental monitoring program at RWMC for FY 1981 and succeeding years.

The RWMC Environmental Handbook[110] is the detailed procedures manual for implementing those environmental monitoring activities identified in the Project Plan for Environmental Monitoring at RWMC.[109] In addition, the handbook includes a synopsis of rules and regulations governing environmental monitoring programs for radioactive disposal sites, and brief reviews of major environmental legislation. Table 6 summarizes the current environmental monitoring at the RWMC. Figure 27 shows locations of air-monitoring stations, and Figure 28 shows the locations of thermoluminescent dosimeters (TLDs) at the RWMC. The monitoring and study data are reported annually as required by the handbook.

5.4.9.4 Soil Moisture Studies. Soil moisture studies were begun in the spring of 1975; these studies investigated readily available chemical sealants and moisture repellants that would eliminate potential seepage of run off water into the TRU waste in Pits 1 and 2, in addition to the physical barrier, e.g., soil. The 1975 investigations indicated that soil cover was effective. In the fall of 1976, Pits 4, 6, and 10 were covered with 40.6 cm of soil, making a total of 9 ha covered in this manner.[111]

A soil moisture and temperature study was begun in January 1977 to investigate moisture movement in the RWMC soil.[112] As part of a long-term study on seasonal moisture movement vertically through surface soils of RWMC, two weighing lysimeters were installed near the RWMC. Information gathered from these devices will (a) contribute to an understanding of moisture movement through RWMC surface soils and (b) assist in predicting rates of radionuclide transport upward through soils overlying pits and trenches in the SDA. This latter information will also be used in surface stabilization studies being conducted at RWMC and will assist improving operations there. Additional information about lysimeters and soil moisture studies at RWMC is included in Reference 118. This study was completed at the end of FY 1982 and the data entered into the environmental computer program.

5.4.9.5 Studies of Radionuclide Uptake. In FY 1978, other studies to investigate radionuclide uptake and movement within the RWMC ecosystem were begun. These studies are being conducted by DOE-RESL personnel, who

TABLE 5. SUMMARY OF RWMC MONITORING

Study	Apparatus/ Collection Method	Frequency	Approximate Number of Samples/Values	Analysis Performed/Results
Wind patterns (DOE, RESL)	Anemometer, wind vane	Continuous	Averaged hourly	Wind rose maps plotted
Temperature (DOE, RESL)	Thermometer, °C	Continuous	Averaged hourly	Values recorded, used in ET[a] studies
Surface runoff	Manual collection 4-L samples	Quarterly	25 to 35 per year	Gross alpha, gross beta, gamma emitters and specific alpha and beta emitters
Stationary air samplers	12 high-volume (0.06 m^3/min) air samplers; 3 (0.06 m^3/min) constant air monitors (CAM)	Continuous	Filters collected every 7 days	Gross alpha, gross beta, and gamma emitters and specific alpha and beta emitters
Soil survey outside RWMC (DOE, RESL)	Manual soil collection at 0 to 5- and 5 to 10-cm depths	Once every 7 years (minimum)	108 per period	TRU[c] and major gamma emitters, isopleth maps plotted
RWMC surface soil survey	Manual collection of soil at 0-5 cm depths	Biennual	Minimum of 41	Major gamma emitters, some Pu and Am analysis
Gamma surveys	18 GM[b] tubes suspended from a 6.1-m boom	Biannual	NA[d]	Isopleth maps plotted
Aquifer monitoring (USGS)	H_2O sampled from aquifer wells, H_2O depth of aquifer	Quarterly; H_2O level one a month	16 per year	^3H, ^{90}Sr, specific conductance, Cl^- (quarterly); TRU and gamma emitters (semiannually)
Perched water zone monitoring	H_2O from wells, H_2O level	Semiannual (if possible); H_2O level monthly	Varies; some wells not sampled in 1978	^3H, ^{90}Sr, specific conductance, Cl^- TRU, gamma emitters
Phase-lag studies (USGS)	Pressure sensors	Continuous	Varies	Degree of permeability

TABLE 6. (continued)

Study	Apparatus/ Collection Method	Frequency	Approximate Number of Samples/Values	Analysis Performed/Results
Soil moisture probes (EG&G)	47 probes	Discontinued	Varies	Soil-temperature, soil-moisture graph
Moisture exclusion testing plots	4 chemical sealants, 1 compacted soil berm, 1 plastic sheet instrumented with 28 soil moisture probes	Discontinued	Varies	Soil temperature and moisture, visual examination of surface for degradation
Mineralogical and geochemical soil parameters	Random soil samples from RWMC	Irregular	NA	pH, CEC[e]; water potential, field capacity
Area monitoring (DOE)	TLD packets	Biannual	46 per year	mrem per period
TSA-1 monitoring	Dewpoint probes, thermocouples	Discontinued	56 per month	Relative humidity, temperature
TSA-2 monitoring	Relative humidity discs, thermocouples, soil moisture, corrosion coupons	Bimonthly	114 per month	Relative humidity, temperature, soil moisture

a. ET = evapotranspiration.

b. GM tube = Geiger-Muller radiation detector.

c. TRU = transuranic isotopes.

d. NA = not applicable.

e. CEC = cation exchange capacity

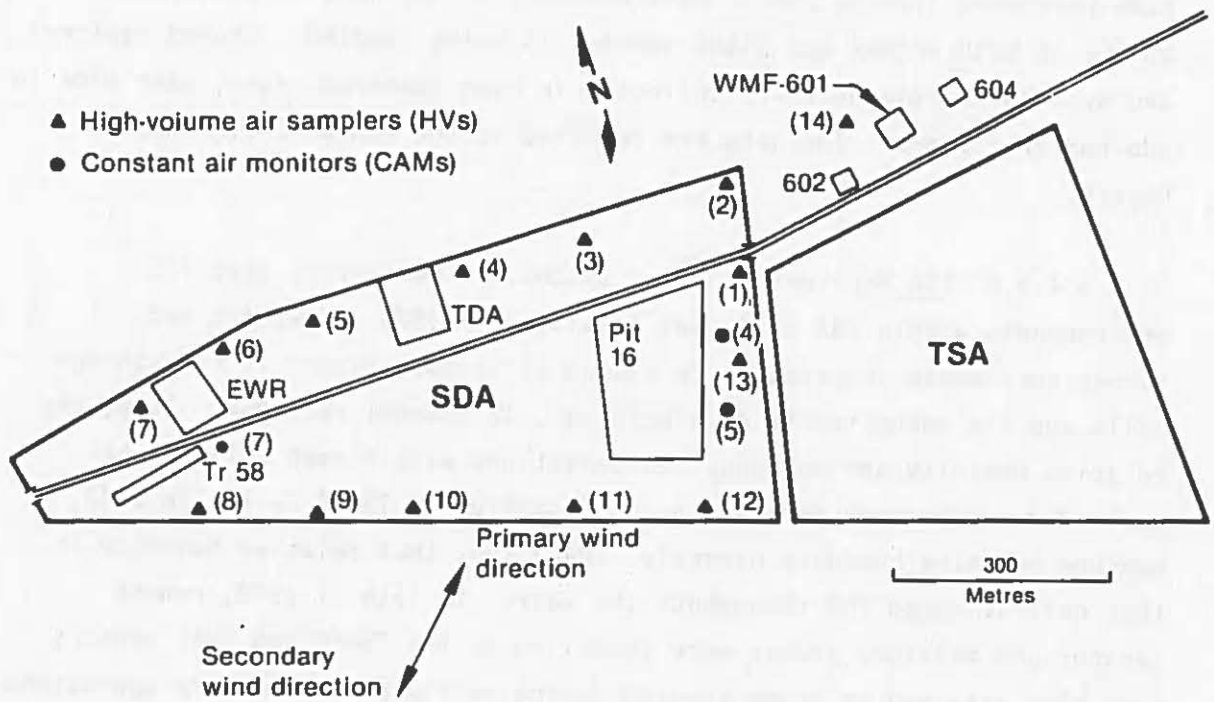

Figure 27. RWMC air-monitoring locations.

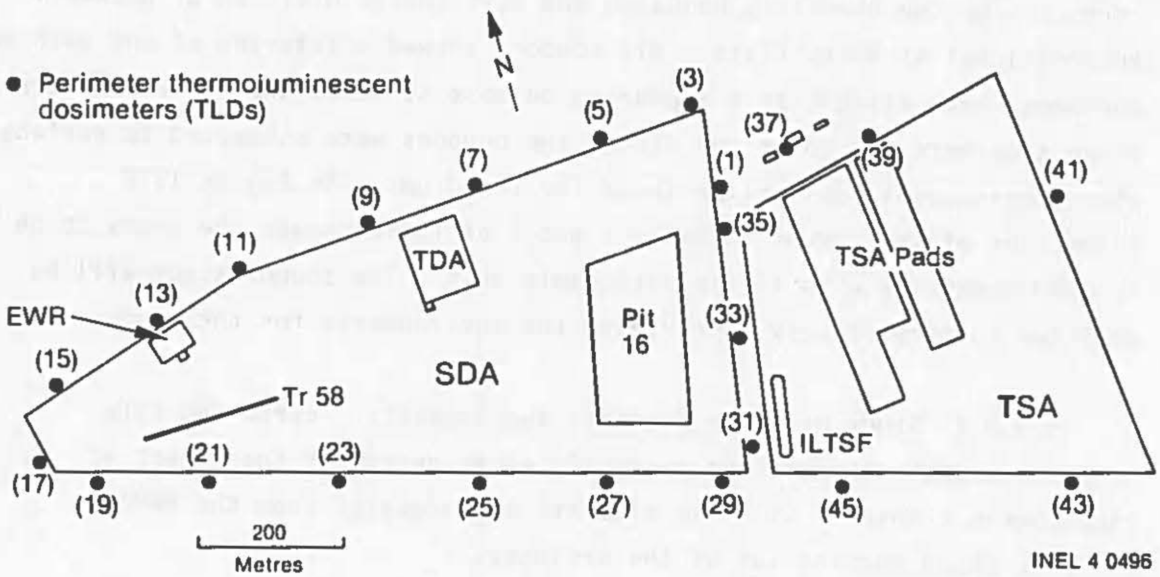

Figure 28. TLD locations.

have performed limited biotic work adjacent to the RWMC in past years. Uptake in both animal and plant species is being studied. Ground squirrel and Russian thistle data are collected in even numbered years; deer mice in odd numbered years. The data are reported in the Annual Environmental Report.

5.4.9.6 TSA Monitoring.[108] A system for monitoring specific environments within TSA cells was initiated in 1974. Dewpoint and temperature measuring probes are placed at various depths in the storage cells and are connected to an electrical, 12-channel recorder. Thus, the relative humidity and condensation conditions within each cell may be monitored. Electro-humidity sensors installed in TSA-2 Cell 1 in 1977, measure relative humidity directly. Data show that relative humidity in that cell averaged 75% throughout the year. In late FY 1979, remote sensors and moisture probes were installed on the TSA-R and TDA; sensors were also attached to drums exposed during retrieval and reentry operations at the TDA.

In February 1978, 34 painted steel, corrosion coupons measuring 5.1 by 7.6 cm were retrieved from various locations in TSA-1 monitoring pipes. These coupons, left in place about three years, were evaluated for corrosion by the Chemistry Research and Development Division of Rockwell International at Rocky Flats. All coupons showed blistering of the painted surfaces, with visible rust appearing on most surfaces and edges. However, since they were placed in the pipes, the coupons were subjected to surface atmospheric conditions unlike those for the drums. An August 1978 inspection of some drums in Cells 1 and 6 of TSA-1 showed the drums to be in good condition with little noticeable rust. The coupon study will be modified to more closely approximate the environments for the drums.

5.4.9.7 Study of Trace Elements and Organics. Earth and Life Sciences Branch sampled fine particulates to determine the extent of atmospheric transport of trace elements and organics from the RWMC. Analyses found nothing out of the ordinary.

5.4.9.8 Study of Uptake and Deposition of Radionuclides in Russian Thistle. Earth and Life Sciences Branch sampled and analyzed Russian thistle growing (a) in subsidence areas over buried waste, (b) over buried waste without subsidence, (c) downwind of, but not over, buried waste, and (d) offsite (control group). The thistle samples were analyzed for uptake and deposition of radionuclides. No abnormal results were reported.

5.4.10 Criticality Control

Criticality control limits have been established for the RWMC transuranic storage and disposal areas. In addition to strict criticality control limits, a fixed percentage of certain categories of waste received from Rocky Flats in drums is analyzed by a computer-controlled drum assayer to verify that the fissile material loading of 200 g per drum is not exceeded. In addition, a statistical sampling of containers is inspected for weight, radiation levels, and contamination levels to verify that the waste-generator-supplied information is correct.

6. SUMMARY OF CURRENT FACILITIES AND PRACTICES

This section briefly summarizes the Radioactive Waste Management Complex (RWMC) as it exists in 1984. A 1984 aerial photograph of the RWMC is shown in Figure 29.

6.1 Site

The RWMC consists of two main areas: the Subsurface Disposal Area, previously known mainly as the Burial Ground, and the Transuranic Storage Area. Within these areas are smaller specialized disposal and storage areas (Figure 30). Solid waste arrives at the RWMC from onsite and offsite and is routed to the different areas depending on its content and packaging. Figure 31 illustrates the origin and final disposition of solid waste at the RWMC including the radioactive solid wastes processed at WERF.

6.1.1 SDA

The Subsurface Disposal Area is a fenced 35.2 ha are devoted primarily to pit, and soil-vault disposal of nontransuranic solid waste. Located within this SDA are the Transuranic Disposal Area (TDA), (also known as Pad A), the soil vault area, the pit area, and many closed pits and trenches.

6.1.2 TSA

The Transuranic Storage Area, a 22.4-ha plot adjacent to the SDA, was used to store TRU waste greater than 10 nCi/g in each container. DOE Order 5820.1, "Management of Transuranic Contaminated Material," dated September 30, 1982, changed the definition of TRU-contaminated material to include alpha-emitting radionuclides of atomic number greater than 92 and half-life greater than 20 years in a concentration greater than 100 nCi/g. Located within this area are the two TSA Pads 1, 2, and 3, the TSA-R pad, and the Intermediate-Level Transuranic Storage Facility, which stores TRU

Figure 29. Aerial photograph of the RWMC (Spring 1984).

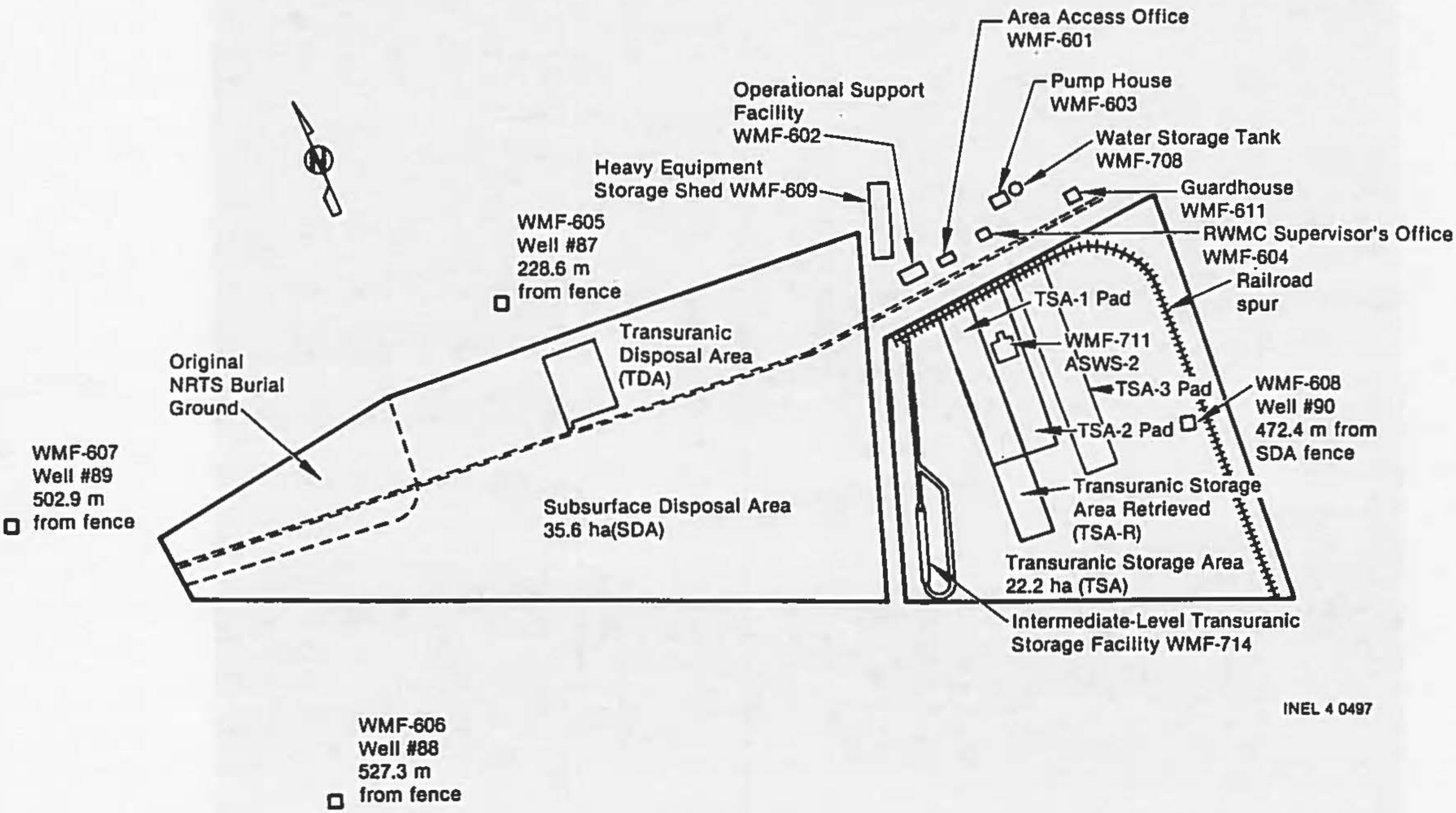

Figure 30. Layout of the RWMC.

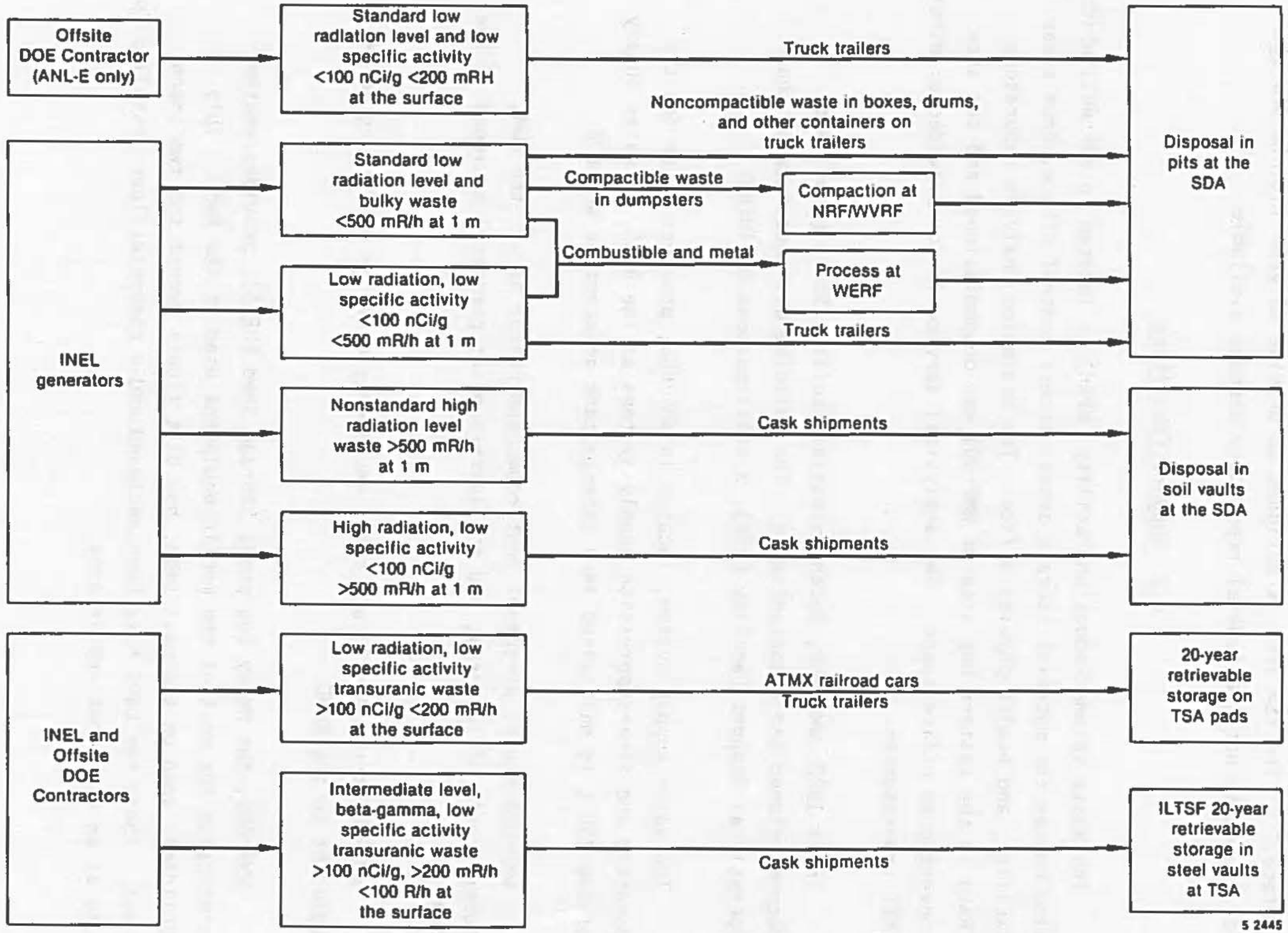

FIGURE 31. FLOW CHART OF SOLID WASTE DISPOSITION AT THE RWMC

waste that is contaminated with activation or fission products and has radiation levels between 200 mR/hr and 100 R/hr at the container surface.[113] The TSA area is designed to provide 20-year interim storage for TRU waste until a federal repository becomes available.

6.2 Support Facilities

The Waste Volume Reduction Facility (WVRF) is located in WMF-601, which also houses the material storage areas, access control office, drum assay facility, and health physics office. The Radiation Analysis Laboratory (RAL) in the eastern bay area of WMF-601 was decommissioned and the area converted to office space. The analytical service is now provided by other INEL Laboratories.

In FY 1982, WMF-602, Decontamination Facility South (DFS), was decommissioned and decontaminated. The building was redesignated the Operational Support Facility (OSF), a multi-purpose building.

The water supply system, located in WMF-603, provides water for the domestic and fire-suppression supply systems at the RWMC. A water supply of 946 250 L is maintained in a storage tank adjacent to WMF-603.

WMF-604 houses personnel rest rooms and change areas, the RWMC supervisor's office area, and the lunchroom for personnel assigned to the RWMC.

WMF-605 through -608 are small enclosures over the monitoring wells adjacent to the RWMC.

WMF-609, the Heavy Equipment Storage Shed (HESS), provides weather protection for most of the mobile equipment used at the RWMC. This building, open on the east side, has dirt floors except the two south bays. These two bays have been enclosed and a concrete floor installed for use as an equipment repair area.

WMF-611, RWMC Guardhouse (Figure 32) was completed in FY 1982. WMF-611 houses Guard Post-301, instrumentation for the motion-detection system in ASWS-2, and a control box and printer for the industrial monitoring system.

A health physics (HP) trailer equipped with an alpha and beta-gamma continuous air monitor, a radiation area monitor, and a portable power supply were purchased in FY-1979. Use of the trailer and equipment began in early FY 1980.

A firehose trailer was procured in FY 1980 to extend covering provided by the fire mains. The hose trailer contains 304.8 m of 10.2-cm hose, 91.4 m of 5.1-cm hose, and tools for connecting to fire hydrants.

6.3 Administration of the RWMC

Presently, the Department of Energy (DOE) is responsible for radioactive waste management at the INEL, including that for the RWMC.

EG&G Idaho, Inc., currently has responsibility for the technical operation of the RWMC under contract with DOE.

Operating procedures at the RWMC are defined in three documents that have been standardized since 1978. These documents are:

1. Waste Programs Division Standard Practice, which deals with overall division policy.

2. Operations Project Directives, which defines the operational responsibilities and actions required by Waste Programs Division, RWMC Operations (WMPD-RO) Branch, personnel.

3. The RWMC Operations Branch Detailed Operating Procedure, which gives an in-depth procedure for examination, certification, storage and disposal operations.

Figure 32. WMF-611, RWMC Guardhouse.

Major documentation for RWMC/SWEPP planning, safety, and operation are shown by administrative ranking in Figure 33 and are briefly described below:

RWMC Safety Assessment Document (PR-W-79-020)--The updated RWMC Safety Review Document (formerly TREE-1064) is an assessment of the safety of RWMC operations in accordance with DOEM 0531. The document was approved by EG&G and DOE-ID.

RWMC Long Range Plan (PR-W-79-016)--A planning document for RWMC activities and overall direction through 1992 was issued to DOE-ID.

Work Package Proposal and Authorization Schedule (WPAS)--The WPAS provides the projected work packages and associated funding requirements for a five-fiscal-year period.

Current Year Work Plan--The Current Year Work Plan provides a detailed schedule for projects and capital equipment in the current fiscal year.

Waste Programs Manual--The training program requirements for RWMC personnel were formalized and approved by EG&G Waste Programs Division (WPD). The existing training activities were revised and upgraded to comply with the Waste Programs Manual requirements.

Quality Program Plan--A quality assurance program for the operation of the RWMC was issued and approved by EG&G WPD and the Quality Division. Implementation of the plan in FY 1980 satisfied DOE initial disposal criteria requirements for a quality assurance program.

Criteria for Packaging Radioactive Waste

The packaging criteria requirements for radioactive waste shipment to the RWMC were revised in February 1984 into two DOE-ID documents, one for TRU waste and a second for Low Level (beta-gamma) waste. The documents are:

- RESOURCE MANUAL - - - - - DOE ORDERS
  - USER MANUALS - - - - - DIVISION MANUALS
    - -CAPS
    - -CONFIGURATION MGMT.
    - -DRAWING REQUIREMENTS
    - -EMERGENCY ACTION
    - -HAZARDOUS MATERIALS
    - -HOISTING AND RIGGING
    - -NUCLEAR MATERIALS
    - -OFFICE PROCEDURES
    - -PROPERTY MGMT.
    - -QUALITY
    - -SAFETY
    - -SALARY
  - DIVISION MANUALS
    - STANDARD PRACTICES
    - RWMC CONTROLLING DOCUMENTS
      - SAFETY ANALYSIS
      - OPERATING SAFETY REQUIREMENTS
      - SAFETY ANALYSIS DOCUMENT
      - QUALITY PROGRAM PLAN
      - RADIOLOGICAL CONTROL POLICY
      - EMERGENCY ACTION MANUAL
      - WASTE PACKAGING CRITERIA
        - LOWLEVEL
        - TRANSURANIC
      - TRAINING MANUAL
      - FACILITY DESIGN DESCRIPTION
      - PRODUCT SPECS. (OUTSIDE PROCUREMENT SPECS.)
      - 55-TON CASK TRANSPORT PLAN
    - RWMC PLANNING DOCUMENTS
      - WPAS - Work Planning Activity Schedule
      - LONG-RANGE PLAN
      - CURRENT YEAR WORK PLAN
      - RWMC WEEKLY OPERATIONS SCHEDULE
    - RWMC OPERATING DOCUMENTS
      - PROJECT DIRECTIVES
      - DETAILED OPERATING PROCEDURES
      - OPERATIONS & MAINT. MANUALS (TBD)
        - VENDOR DATA
    - RWMC ADMINISTERED DOE DOCUMENTS
      - WASTE PACKAGING CRITERIA
        - TRANSURANIC
        - LOWLEVEL

FIGURE 33. RWMC BRANCH DOCUMENTATION

1. Criteria for Packaging Transuranic Waste for Receipt at the Idaho National Engineering Laboratory Radioactive Waste Management Complex, IDD-10074, Rev. 2.[69a]

2. Criteria for Packaging Low-Level, Radioactive Waste for Receipt at the Idaho National Engineering Laboratory Radioactive Waste Management Complex, DOE/ID-10112.[69b] This document was revised, updated and reissued in March, 1985 as: INEL Low-Level Waste Acceptance Criteria, DOE/ID-10112, March, 1985.[115]

RWMC Facility Design Description (FDD)--The FDD, which was completed in FY 1982, provides, design detail and system descriptions of all RWMC systems, facilities, and equipment for general information, use in future projects or modifications, and as support for overall safety analysis of the RWMC.

RWMC Operational Safety Requirements (PR-W-79-024)--Completed in FY 1980, this document defines the safe boundaries, operating limits, and administrative controls required to ensure that RWMC operations constitute (a) no undue risks to the health and safety of employees and the public and (b) no undue hazard to the environment.

Operational Safety Requirements for the Stored Waste Examination Pilot Plant--Prepared in FY-1985. This document defines the safe boundaries, operating limits, and administrative controls for SWEPP.

Safety Analysis for the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory--Completed in FY 1982, this document provides a safety analysis of operations at the RWMC. It provides documentation and the basis for assessing the magnitudes of hazards. It documents that hazards have been identified and evaluated and that reasonable measures for their elimination, control, or mitigation have been considered.

Safety Analysis for the Stored Waste Examination Pilot Plant (SWEPP) at the Idaho National Engineering Laboratory--This document provides the analysis and assessment of the safety of the SWEPP Operations in accordance with DOE Orders 5480.1A and 5481.1.

Radiological Control Plan for the Stored Waste Pilot Plant (SWEPP) July, 1985.

Operation and Maintenance Manual (OM&M)--The OM&M will be a multi-volume manual, an individual volume for each major RWMC facility and piece of heavy equipment. The first volume completed was for the 45.4 metric ton cask.

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APPENDIX A

AREA AND FACILITY TERMINOLOGY CHANGES
AND ACRONYM LISTING

APPENDIX A

AREA AND FACILITY TERMINOLOGY CHANGES AND ACRONYM LISTING

Names for the INEL, RWMC, and areas within the RWMC have changed during the last 30 years as shown in Table A-1. Table A-2 is an alphabetical listing of acronyms appearing in this report with the full definition for each.

TABLE A-1. TERMINOLOGY CHANGES

Old Name(s)	Present Name
National Reactor Testing Area (NRTS)	Idaho National Engineering Laboratory (INEL)
Burial Ground (BG)	Radioactive Waste Management Complex (RWMC)
Radioactive Waste Disposal & Storage Area (RWDSA)	Radioactive Waste Management Complex (RWMC)
Atomic Energy Commission (AEC)	Department of Energy (DOE)
Energy Research and Development Administration (ERDA)	Department of Energy (DOE)
Idaho Transuranic Storage Area (ITSA)	Transuranic Storage Area (TSA)
Pad "A"	Transuranic Disposal Area (TDA)
Engineered Waste Storage Area	Transuranic Disposal Area (TDA)
Burial Area	Subsurface Disposal Area (SDA)
Solid Waste Compactor Facility	Waste Volume Reduction Facility (WVRF)
Waste Compactor and Equipment Building (WCEB)	Waste Volume Reduction Facility (WVRF)
Health Services Laboratory (HSL)	Radiological and Environmental Sciences Laboratory (RESL)
Idaho Center for Radiological and Environmental Services (ICRES)	Radiological and Environmental Sciences Laboratory (RESL)
Decontamination Facility South (DFS)	Operational Support Facility (OSF)

TABLE A-2. ACRDNYM LISTING

Acronym	Definition
ACC	Allied Chemical Corporation
AEC	Atomic Energy Commission
AEC-ID	Atomic Energy Commission-Idaho Operations Dffice
ANC	Aerojet Nuclear Company
ANL-E	Argonne National laboratory (East), Chicago, IL
ARA	Auxiliary Reactor Area
ASWS	air-support weather shield
BORAX	Boiling Water Reactor Experiment
CAM	constant air monitor
CEC	cation exchange capacity
CFA	Central Facilities Area
C&S	Certified and Storage
DFS	Decontamination Facility South
DDE	Department of Energy
DDEM	Department of Energy Manual
DDT	Department of Transportation
EBR-I	Experimental Breeder Reactor-I
EGG	EG&G formal report
EG&G	Edgerton, Germeshausen, and Grier
EIS	environmental impact statement
ERDA	Energy Research and Development Administration
ET	evapotranspiration
ETR	Engineering Test Reactor
EWR	Early Waste Retrieval (project)
FDD	Facility Design Description
FRP	fiberglass-reinforced polyester
FY	fiscal year
GM (tube)	Geiger-Muller radiation detector
HEPA	high-efficiency particulate air (filter)
HESS	Heavy Equipment Storage Shed
HFEF	Hot Fuel Examination Facility
HP	health physics, health physicist
HSL	Health Services Laboratory
IAD	Immediate Action Directive
ICPP	Idaho Chemical Processing Plant
ICRES	Idaho Center for Radiological and Environmental Services

TABLE A-2. (continued)

Acronym	Definition
ID	Idaho Operations Office
ID-E&C	ID Division of Engineering and Construction
ID-H&S	ID Health and Safety Division
ID-HSL	ID Health Services Laboratory
ID-OSTS	ID Operational Safety and Technical Support Division
IDR	Initial Drum Retrieval (project)
INC	Idaho Nuclear Corporation
ILTSF	Intermediate-Level Transuranic Storage Facility
INEL	Idaho National Engineering Laboratory
ITSA	Idaho Transuranic Storage Area
LCCDA	Liquid Corrosive Chemical Disposal Area
MFP	mixed fission products
NIMCO	National Industrial Maintenance Company
NOS	Nuclear and Operational Safety Division (of INC)
NRF	Naval Reactors Facility
NRTS	National Reactor Testing Station
NT-ID	Idaho Operations Office Nuclear Technology Division
NWCF	New Waste Calcining Facility
OAC	Operating Area Confinement (building)
ORNL	Oak Ridge National Laboratory
OSF	Operational Support Facility
PPCo	Phillips Petroleum Company
PR	Power Reactors (department-EG&G)
RAL	Radiation Analysis Laboratory
RESL	Radiological and Environmental Sciences Laboratory
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
SDA	Subsurface Disposal Area
SL-1	Army Stationary Low-Power Reactor
SWEPP	Solid Waste Experimental Pilot Plant
SWIMS	Solid Waste Information Management System
TCWCIS	Transuranic-Contaminated Waste Container Information System
TDA	Transuranic Disposal Area
TLD	thermoluminescent dosimeter
TREE	technical report, external, EG&G Idaho
TRU	transuranic

TABLE A-2. (continued)

Acronym	Definition
TSA	Transuranic Storage Area
TSA-R	Transuranic Storage Area-Retrieved (pad)
UOR	Unusual Occurrence Report
USGS	United States Geological Survey
WERF	Waste Experimental Reduction Facility
WMF	Waste Management Facility
WMIS	Waste Management Information System (now RWMIS)
WMP	Waste Management Programs
WMP-O	Waste Management Operations Branch
WP	Waste Programs
WP-D	Waste Programs Division
WP-O	Waste Programs Division-RWMC Operations Branch
WVRF	Waste Volume Reduction Facility
WMPD	Waste Management Program Division
WMPD-RO	Waste Management Program Oivision RWMC Operation Branch

APPENDIX B

CONVERSION FACTORS

APPENDIX B

CONVERSION FACTORS

TABLE B-1. CONVERSION FACTORS

To Convert	Into	Multiply By
acres	hectares	0.40
cubic feet	cubic meters	0.028
cubic yards	cubic meters	0.765
feet	meters	0.3048
gallons	liters	3.785
inches	centimeters	2.54
miles	kilometers	1.609
mils	millimeters	0.00254
pounds	kilograms	0.4536
square miles	square kilometers	2.590
tons	metric tons	0.907