8.0 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Disposal of low-level radioactive waste (LLW) from the U.S. Department of Energy (DOE)-approved generators occurs at two areas on the Nevada Test Site (NTS). Disposal of packaged LLW at the Radioactive Waste Management Site, Area 5 (RWMS-5) is in shallow pits and trenches. LLW packaged in large bulk waste containers, and unpackaged bulk waste (only from the NTS) are buried in selected subsidence craters at the RWMS, Area 3 (RWMS-3).

Hazardous waste and specific categories of radioactive waste are stored above ground in Area 5. Transuranic (TRU) waste categorized as mixed waste, i.e., radioactive material mixed with hazardous waste, is stored in a covered building on a specially constructed Resource Conservation and Recovery Act (RCRA)-designed pad. The TRU waste will be characterized for proposed disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico. Low-level radioactive mixed waste is currently being stored on the TRU waste storage pad before permanent disposal. Uranium ore residues are stored north of the RWMS-5. Hazardous wastes generated on the NTS are accumulated at the Hazardous Waste Accumulation Site (HWAS) east of the RWMS-5 before shipment to an offsite treatment, storage, and disposal (TSD) facility.

During 1996, environmental monitoring involved air sampling, radiation dose rate surveys, groundwater analysis, and environmental sampling. Air samples were collected at RWMS-3 and RWMS-5 for analysis of gross beta radiation, photon-emitting radionuclides, plutonium, and tritium. Tritium arising from the disposal of LLW was the only airborne radionuclide detected at the RWMS-5. All radionuclide concentrations were well below derived concentration guides (DCGs). Gamma radiation fields were monitored by thermoluminescent dosimeters (TLDs). Gamma doses greater than background were detected at the RWMS-5 in areas where waste is stored or disposed. Neutron radiation fields at the perimeter of the TRU waste storage pad were monitored by proton recoil dosimeters. Radiation exposure rates were consistent with historical ranges.

8.1 WASTE DISPOSAL OPERATIONS

Radioactive waste disposal was initiated at Area 5 on the NTS in 1961. By July 1976, six out of nine developed trenches had been filled with LLW. In 1978, waste disposal operations were expanded when the DOE established the Radioactive Waste Management Project for the disposal of defense-related LLW, from the NTS, from offsite DOE generators, and from U.S. Department of Defense facilities.

In 1987, the state of Nevada granted the NTS interim status for the disposal of low-level mixed waste in Pit 3 of the RWMS-5. LLW disposed prior to 1986 may contain low levels of constituents that would be regulated as hazardous waste under RCRA (Title 40 C.F.R. 260-281). Mixed waste disposal was curtailed in 1990 by the DOE

due to the possible presence of Land Disposal Restrictions (LDR) constituents. The state of Nevada later directed that DOE provide National Environmental Policy Act (NEPA) documentation and implement a state-approved Waste Analysis Plan. No offsite mixed waste has been received for disposal since 1990. Mixed waste generated on the NTS may be disposed of in Pit 3 of the RWMS-5 if LDR requirements are met. The RWMS-3 has been used for the disposal of bulk atmospheric test debris, bulk LLW in large containers, and packaged LLW.

Hazardous waste generated on the NTS is accumulated at the HWAS which is adjacent to and east of the RWMS-5. At this site, the hazardous waste is prepared for shipment to an offsite TSD facility. Hazardous waste is not accepted from offsite generators.

AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-5 occupies approximately 296 ha (732 acres) and is located in the northern area of Frenchman Flat, approximately 26 km (16 mi) north of the NTS main gate. Currently, 37 ha (92 acres) are posted as radiological areas used for waste storage and disposal. Before 1968, Area 5 had been used for the testing of conventional weapons and both above and below ground testing of nuclear weapons.

The general surface geology of the area is alluvial sediment derived from tuffaceous material. The basin contains up to 305 m (1,000 ft) of alluvium from the surrounding mountain ranges. The disposal site is located on a gently sloping alluvial fan extending southward from the Massachusetts Mountains, which lie approximately 3.3 km (2 mi) to the north. The slope of the terrain is 2 percent near the disposal site, but increases to 3 percent to the west. Two shallow dry washes cross the site, from the northwest and from the northeast. An earthen dike has been constructed along the western, northern, and eastern borders of the RWMS-5 to prevent water flow into the disposal area.

Disposal of waste occurs in shallow land burial trenches and pits at depths ranging from 4.6 m to 9.1 m (15 to 30 ft). Deeper trenches have been constructed for wastes that generate radon. Pits and trenches that reach full capacity are temporarily covered by 2.4 m (8 ft) of soil until a permanent closure cap is constructed. Disposal of high-specific activity waste has occurred in augured shafts that are 36 m (120 ft) in depth, termed Greater Confinement Disposal (GCD). When disposal capacity is reached, GCD shafts are filled with soil from 21 m (70 ft) to the surface.

LLW is accepted for disposal from generators that have received approval from DOE Headquarters and DOE Nevada Operations Office (DOE/NV). During 1996, the NTS Waste Acceptance Criteria (WAC) were revised to make the acceptance process more efficient (NTS WAC, Rev. 0, September 1996). The requirement for the generator to develop a waste application was replaced by a waste profile format. The profile requires nearly the same information as did the waste application, but it streamlines the documentation process. The new criteria require a programmatic audit of the waste generator every three years instead of every year, an annual assessment to be performed to ensure generator compliance, and it provides clarification on the reporting of radionuclides. Overall, the new criteria will be more consistent with industry standards, and they will streamline the approval process, reduce generator facility costs, and increase resources for environmental cleanup.

During 1996, LLW from 16 generators was disposed of at RWMS-5. A volume of 7,293 m^3 (2.58×10^5 ft^3) containing a total of 7,692 Ci (285 TBq) of radioactivity was disposed of at the RWMS-5. This was a decrease in volume but an increase in radioactivity from the previous year (see Table 8.1). Tritium accounted for approximately 96 percent of

total radioactivity disposed of (see Table 8.2). The majority of the remaining radioactivity was attributed to isotopes of uranium.

RWMS-5 MIXED WASTE MANAGEMENT UNIT (MWMU)

A MWMU is planned for construction in the northeastern area of the RWMS-5. The proposed MWMU will cover approximately 10 ha (25 acres) and contain eight landfill cells. Mixed waste disposal operations at the NTS will recommence under interim status in Pit 3 upon completion of NEPA documentation, approval of the Waste Analysis Plan, and issuance of a state RCRA Part B Permit. In the interim, an agreement between DOE/NV and the NDEP has been negotiated that allows low-level mixed waste generated on the NTS to be stored on the TRU waste storage pad until characterization. If the waste meets or is treated to meet LDR requirements, it may be disposed of in Pit 3, RWMS-5.

RWMS-5 GROUNDWATER MONITORING

Data collection was initiated in 1993 and continued through 1996 to monitor the groundwater chemistry under the waste disposal cells at RWMS-5. The purpose of this monitoring is to determine if the disposal facility is in compliance with RCRA requirements. Sampling is being performed using three pilot wells drilled in 1992 into the uppermost aquifer under the disposal cells. Further information on this study can be found in Section 9.2 of this document and in the "1996 Groundwater Monitoring Report" (Bechtel 1996).

AREA 3 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-3 lies at an elevation of 1,230 m (4,050 ft) and covers approximately 20 ha (50 acres). It is located in the center of Yucca Flat approximately 5 mi north of the Yucca Dry Lake Bed. Alluvial sediments that are about 1,500 ft deep underlie the site. Atmospheric and underground nuclear tests have been conducted in several areas in Yucca Flat including Area 3. Safety tests have resulted in the dispersion of plutonium in surface soils in Area 3.

The RWMS-3 is used for the management of bulk debris from aboveground nuclear tests and packaged bulk LLW generated offsite. Subsidence craters formed by underground nuclear tests are used for disposal. The subsidence craters range in depth from 15 to 24 m (49 to 78 ft) and are filled by alternating layers of stacked waste packages and 3 ft of clean fill dirt. Two craters, U-3ax and U-3bl, have been filled to date. A 2.5-m (8-ft) thick operational cap of clean soil extending 1.2 m (4 ft) above grade has been used for temporary closure of U-3ax/bl craters. The adjacent craters U-3ah/at are currently being used for LLW disposal.

In 1996, the RWMS-3 received 7,033 m^3 (2.48×10^5 ft^3) of waste containing 5.75 Ci (213 GBq) of radioactivity (see Table 8.3) from four generators. This was a decrease in the volume of waste but a slight increase in the amount of radioactivity disposed of when compared to 1995. Isotopes of plutonium and ^{241}Am from the cleanup of the DOUBLE TRACKS site on the Nellis Air Force Range Complex about 14 mi (22 km) east of Goldfield, Nevada, accounted for approximately 88.6 percent of the total radioactivity disposed of during 1996 (see Table 8.4). Isotopes of uranium accounted for approximately 11 percent.

STRATEGIC MATERIALS STORAGE YARD (SMSY)

The SMSY is used for storage of mixed waste that consists of residues from the processing of uranium ores from the Mound Plant in Miamisburg, Ohio. On a mass basis, this material is primarily ^{238}U and iron. The residues contain approximately 290 Ci (11 TBq) of total radioactivity. The residue material is packaged in steel drums inside wooden boxes that are stored inside steel cargo containers. A total of 28 cargo

containers is stored on concrete pads that are surrounded by a control fence. Required inspections are performed routinely to ensure that the integrity of the waste containers is maintained. Opening of the cargo containers for inspection is controlled following established as low as reasonably achievable (ALARA) principles to reduce radiation exposure to personnel.

The original management plan for this material was treatment and disposal. During 1996, DOE/NV determined that transferring this material to a mill for additional uranium extraction will expedite the handling of this material by two years and will recycle approximately 260 m^3 of the material. For further information on managing this material, please refer to the "NTS Site Treatment Plan" (DOE 1996a).

TRANSURANIC WASTE STORAGE

The TRU waste storage pad is located in the southeast corner of the RWMS-5. The pad is used for interim storage of TRU waste previously received from Lawrence Livermore National Laboratory. During 1992, all of the mixed TRU waste packaged in 55-gal drums was overpacked into 85-gal steel drums with carbon filter vents. This waste is stored in a covered building that is located on a curbed asphalt pad surrounded by a security fence. The pad and waste storage configuration comply with RCRA, Title 40 C.F.R. 265, Subpart I.

Inspections of all mixed TRU waste containers are performed weekly, while inspections of the TRU waste storage pad are performed monthly. The current inventory is awaiting permanent disposal at the WIPP. This waste will be characterized and packaged for certification according to WIPP criteria. DOE/NV plans to examine this waste in the Waste Examination Facility scheduled to be completed in 1997 at RWMS-5. Further information on this material is contained in the "NTS Site Treatment Plan" referred to above.

8.2 ENVIRONMENTAL MONITORING AT WASTE STORAGE AND DISPOSAL SITES

The Analytical Services Laboratory, Environmental Monitoring Group is responsible for collection of samples and verifying sample results. The Radioanalytical Section is responsible for analysis of the samples. Collection and analysis of samples are performed in accordance with approved operating procedures. The Waste Management Project reviews the sampling results for any unexpected trends.

AIR MONITORING

Air sampling is conducted at eight (reduced to four in the fourth quarter) stations along the perimeter of the RWMS-5 fence for both particulates and tritiated water (HTO), at two stations inside the TRU waste storage cover, and at one station in Pit 5 for particulates. Two samplers inside the TRU cover building along with the perimeter samplers were determined to provide adequate monitoring for the TRU waste storage facility. Originally, there were six stations that surrounded the TRU waste storage facility. Air sampling is also conducted for particulates at four stations along the perimeter of the U-3ah/at craters and for HTO at one station north of the craters at RWMS-3.

Air samplers operate at an air flow rate of approximately 140 L (5.0 ft^3) per minute. Sampling media is a 9-cm (approximately 4-in) glass-fiber filter. Filters are exchanged on a weekly basis. Each filter is analyzed for gross beta/gamma radiation. The filters are composited quarterly for samplers located at the perimeter of RWMS-5 and monthly for all other sample locations and analyzed for ^{238}Pu and $^{239+240}Pu$. Samplers for HTO in air are located with the particulate

samplers along the perimeter of the RWMS-5. Sampling for radioiodine was discontinued in 1995, because radioiodine is not expected to be produced from LLW disposal operations. Radioiodine was measured in the past because of its production during nuclear testing.

RWMS-5 AIR MONITORING

Tritium, ^{238}Pu,$^{239+240}$Pu, and gross beta activity were measured in air at the RWMS-5 during 1996. Composite data for the first three radionuclides (see Table 8.5) include both RWMS-5 onsite and perimeter air sampling. The 1996 airborne plutonium levels were generally lower than those in 1995. The range was from <0 to 73 x 10^{-18} µCi/mL with a network average concentration of 4.9 x 10^{-18} µCi/mL (0.18 µBq/m^3). The maximum annual average concentration was 1.2 x 10^{-17} µCi/mL (0.44 µBq/m^3). That maximum average concentration is only 0.6 percent of the 10 mrem per year modified DCG for $^{239+240}$Pu (2 x 10^{-15} µCi/mL [74 Bq/m^3]) (DOE Order 5400.5). The average air concentration of ^{238}Pu was approximately a factor of 30 lower than the airborne concentration of $^{239+240}$Pu. Airborne plutonium in Area 5 is probably due to resuspension of contaminated soils and not attributable to the waste disposed of in this LLW site.

The average HTO concentration was 3.2 x 10^{-12} µCi/mL (0.12 Bq/m^3) and the highest annual average was 5.4 x 10^{-12} µCi/mL (0.2 Bq/m^3). The high value is less than 0.06 percent of the 10 mrem per year modified DCG for HTO (1 x 10^{-8} µCi/mL [370 Bq/m^3]). Tritium is associated with waste disposal operations. The levels of tritium have remained consistent with historical averages. The average HTO air concentration in 1996 was in the range of the 1994 average concentration of 4.9 x 10^{-12} µCi/mL (0.18 Bq/m^3) and the 1995 average concentration of 5.8 x 10^{-12} µCi/mL (0.21 Bq/m^3). Gross beta air concentration results are used as a screening tool to check if a significant release occurred and if other radionuclides warrant analysis. The results were in the range of 10^{-14} and 10^{-15} µCi/mL. These levels are consistent with levels for previous years and with the sitewide average gross beta concentration.

RWMS-3 AIR MONITORING

Traces of plutonium (^{238}Pu and $^{239+240}$Pu) were detected in air at all of the RWMS-3 samplers in 1996. The average air concentration of $^{239+240}$Pu in 1996 was 1.65 x 10^{-16} µCi/mL (6.1 µBq/m^3), which was slightly more than the 1995 average of 0.89 x 10^{-16} µCi/mL (3.3 µBq/m^3). The average air concentration of ^{238}Pu was approximately a factor of 150 lower than the average concentration of $^{239+240}$Pu. The highest average concentration of $^{239+240}$Pu detected in 1996 was 26 x 10^{-17} µCi/mL (9.6 µBq/m^3), which is far below the Derived Air Concentration for $^{239+240}$Pu. Airborne plutonium is most likely due to resuspension of soils contaminated by atmospheric weapons testing and is not attributable to the waste being disposed of at this site. Gross beta air concentrations were consistent with the RWMS-5 results.

The HTO in air average concentration was 0.54 x 10^{-12} µCi/mL (20 mBq/m^3), and the maximum concentration was 5.0 x 10^{-12} µCi/mL (0.18 Bq/m^3), both less than the RWMS-5 results.

RADIATION EXPOSURE RATES

Areas where disposal operations take place are radiologically controlled through engineering and administrative controls to ensure radiation exposures are ALARA. Workers are thoroughly trained in exposure reduction techniques and ALARA practices. Worker radiation doses have remained below ALARA administrative goals that are considerably less than the DOE occupational limit.

GAMMA EXPOSURE

TLDs were deployed at 44 locations at RWMS-5 and at 5 locations at RWMS-3 disposal site U-3ah/at to measure the gamma radiation exposure (see Table 8.6).

Ten TLDs were placed within the perimeter of RWMS-5, including six TLDs around the TRU waste storage pad, two TLDs in Pit 3, and two TLDs in the operational disposal Pits 4 and 5. The TLDs in the pits were about 100 ft (30 m) from the waste stacks. Fifteen TLDs were located at the perimeter of the RWMS-5 site and one was placed at the facility office. All the TLDs were exchanged and analyzed quarterly.

The TLDs located at the perimeter of RWMS-3 and RWMS-5 had exposures that were at or slightly above background levels (see Table 8.6). Exposure rates at the TRU pad, in the operational disposal pits of RWMS-5 and at the Strategic Materials Storage Yard were above background due to their proximity to the radioactive waste containers. No significant increases were identified when comparing the 1996 exposure rates with historical levels.

NEUTRON DOSE EQUIVALENTS

Neutron dose equivalents were measured at six locations at the perimeter of the TRU waste storage pad. The dose equivalents for 1996 ranged from the detection limit of 80 mrem to 168 mrem per year. Neutron doses for 1996 were consistent with previous results.

VADOSE ZONE MONITORING FOR MIXED WASTE DISPOSAL

A vadose zone monitoring program has been implemented to allow earlier detection of potential contaminant migration from the mixed waste disposal pit (Pit 3) at the RWMS-5 and under U-3ah/at and U-3ax/bl craters at RWMS-3. Monitoring is conducted in 24 access tubes. Tubes are installed through the operational cover (approximately 8 ft), waste zone (20 - 30 ft), and ten feet of soil below the pit floor. Drill casings are angled under the disposal craters in RWMS-3. Tubes are monitored quarterly with neutron moisture meters to detect wetting fronts from precipitation. Wetting fronts that progressed through the operational cap and into the waste zone could indicate that contaminant migration might have occurred. In 1996, as in the past, no wetting fronts have been detected below the operational cap.

TRITIUM MIGRATION STUDIES AT THE RWMS-5

The results of the tritium migration study at the GCD site have shown that the waste buried between depths of 70 and 120 ft has remained isolated from the accessible environment (i.e., the land surface). In addition, sampling of plants and near surface soil above shallow land disposal cells in RWMS-5 have shown a seasonal variation in tritium concentration. The results have indicated that worker and public radiation exposures are negligible.

Table 8.1 Low-Level Waste Disposed of at the RWMS-5, 1993 - 1996

Calendar Year	Volume of LLW Disposed (m^3)	Activity of LLW Disposed (Ci)
1996	7293	7.69×10^3
1995	9171	5.56×10^2
1994	12300	5.17×10^4
1993	8327	3.00×10^4

Table 8.2 Radionuclides Disposed of at the RWMS-5 - 1996

Radionuclide	Activity (Ci)	Percent of Total Activity
^{3}H	7354.292	95.608
^{238}U	184.218	2.395
^{234}U	80.979	1.053
^{228}Th	15.648	0.203
^{232}Th	14.540	0.189
^{228}Ra	13.641	0.177
^{99}Tc	9.057	0.118
^{235}U	4.567	0.059
^{230}Th	4.534	0.059
^{241}Pu	4.403	0.057
^{236}U	3.007	0.039
^{239}Pu	1.166	0.015
^{90}Sr	0.453	0.006
^{137}Cs	0.373	0.005
^{226}Ra	0.329	0.004
^{240}Pu	0.243	0.003
^{238}Pu	0.199	0.003
^{241}Am	0.182	0.002
^{210}Pb	0.155	0.002
Other	0.143	0.002
Total	7692	100.000

Table 8.3 Low-Level Waste Disposed of at the RWMS-3, 1993 - 1996

Calendar Year	Volume of LLW Disposed (m^3)	Activity of LLW Disposed (Ci)
1996	7033	5.7
1995	11073	3.1
1994	10550	0.21
1993	9848	0.24

Table 8.4 Radionuclides Disposed of at the RWMS-3 - 1996

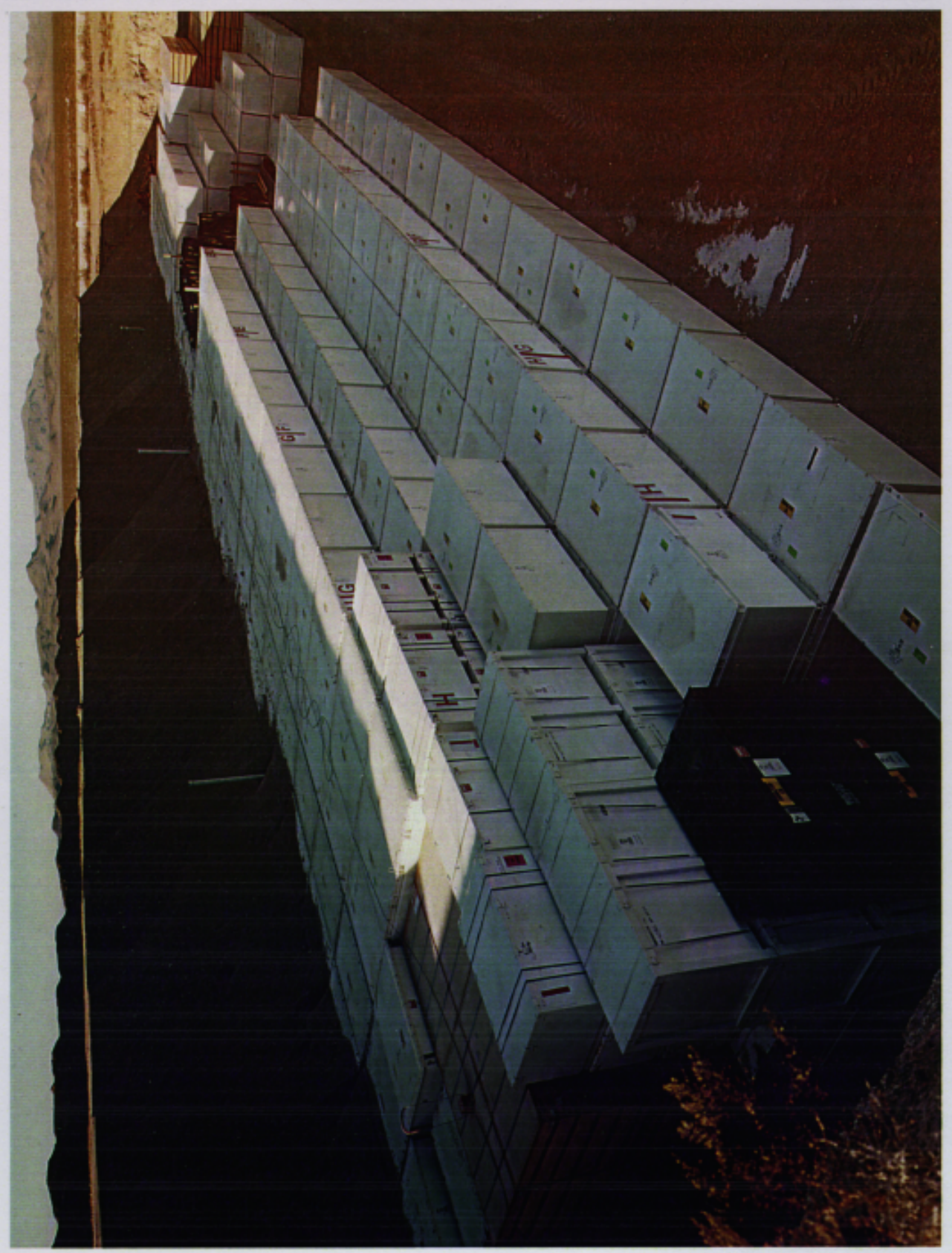
Radionuclide	Activity (Ci)	Percent of Total Activity
^{239}Pu	3.160	55.00
^{241}Pu	1.419	24.70
^{238}U	0.359	6.25
^{240}Pu	0.299	5.20
^{234}U	0.249	4.33
^{241}Am	0.213	3.71
^{99}Tc	0.021	0.37
^{235}U	0.013	0.23
^{236}U	0.012	0.21
Total	5.7	100

Table 8.5 Air Monitoring Results for Various Radionuclides at the RWMS-5, 1994 - 1996

Year	$^{239+240}Pu$ (x 10^{-17} µCi/mL)	^{238}Pu (x 10^{-17} µCi/mL)	Tritium (x 10^{-6} pCi/mL)
Average 1996	0.51	0.02	3.2
High Average 1996	1.2	0.06	5.4
Average 1995	0.6	0.013	5.7
High Average 1995	3.4	0.11	15
Average 1994	1.1	0.038	4.9
High Average 1994	5.9	0.15	14
Derived Concentration Guide (10 mrem for nonworkers)	200	300	10^4

Table 8.6 External Gamma Exposure Measured by TLDs at the RWMS - 1996

Calendar Year	Number of Dosimeters	Average (mR/y)	Standard Deviation (mR/y)
RWMS-5, perimeter	16	121	7.1
RWMS-5, TRU pad, Pit 3 and 5	10	376	401
RWMS-3, U-3ah/at perimeter	9	147	24.2
Strategic Material Storage Yard	18	1948	1201



Area 5 Disposal Pit #4 Showing Stacking Conditions