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CHARACTERIZATION OF WASTE STREAMS ON THE OAK RIDGE RESERVATION*

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ABSTRACT

For the foreseeable future, the Oak Ridge Reservation (ORR) plants will generate solid low-level waste (LLW) that must be disposed of or stored on-site. The available disposal capacity of the current sites is projected to be fully utilized during the next decade. During the 1980s, several factors coincided which made the process of developing new disposal sites significantly more difficult. An LLW disposal strategy has been developed by the Low-Level Waste Disposal Development and Demonstration (LLWDDD) Program as a framework for bringing new, regulator-approved disposal capacity to the ORR. An increasing level of waste stream characterization will be needed to maintain the ability to effectively manage solid LLW by the facilities on the ORR under the new regulatory scenario. In this paper, current practices for solid LLW stream characterization, segregation, and certification are described. In addition, the waste stream characterization requirements for segregation and certification under the LLWDDD Program strategy are also examined.

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INTRODUCTION

The Reservation currently segregates solid waste into five major categories: (1) sanitary/industrial, (2) hazardous/mixed, (3) Toxic Substances and Control Act (TSCA), (4) LLW, (5) transuranic (TRU), and (6) classified. Segregation of wastes is performed by the waste generator. Sanitary/industrial, classified, and LLW are the only solid waste categories currently being disposed on the Reservation. This paper will focus on the sanitary/industrial and LLW categories.

A total of about 4.1 million cubic feet of solid LLW and sanitary/industrial waste was generated on the Reservation during CY 1986. The generation and management of this solid waste is described in Fig. 1. As shown in Figs. 2 and 3, the Y-12 Plant generates 78.5% of the sanitary/industrial waste and 91.0% of the solid LLW on the Reservation.

CURRENT WASTE SEGREGATION AND TSD PRACTICES

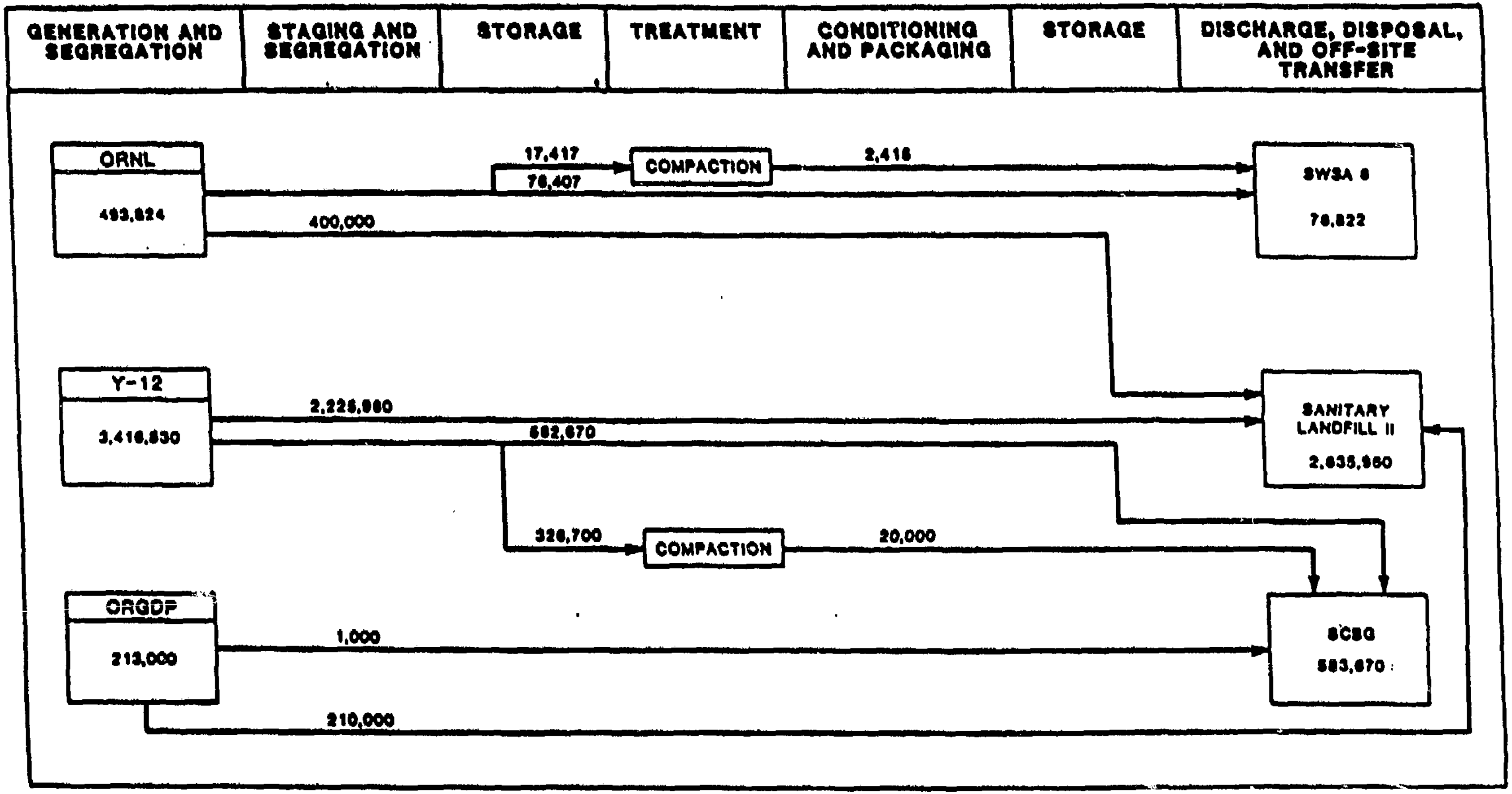
At the present, solid LLW segregation involves the separation of compactible (conventional compaction) from noncompactible waste and the separation of high-activity or high-exposure from low-activity or low-exposure waste at ORNL. Y-12, in addition, segregates compactible and shredible wastes from noncompactible and nonshredible wastes. This section describes the current solid waste segregation practices on the Reservation and the associated waste volumes and disposal practices.

Oak Ridge National Laboratory

Low-level waste (LLW) at ORNL is radioactive waste that cannot be classified as high-level waste, TRU waste, spent nuclear fuel, or by-product material, as defined by DOE Order 5820.2. In general, LLW contains radionuclides that are beta-gamma emitters with short half-lives and/or nonfissile alpha activity. LLW is also characterized as radioactive waste containing <100 nCi/g of TRU radionuclides.

Sanitary/industrial, or conventional, waste at ORNL includes sanitary waste, construction waste, and process by-products and is disposed of in a Tennessee-permitted sanitary waste landfill. ORNL does not generate classified waste.

ORNL DWG 87-904



VOLUMES SHOWN ARE IN CUBIC FEET PER YEAR.

Fig. 1. Solid low-level waste and sanitary/industrial waste generated on the Oak Ridge Reservation during CY 1986. (The difference between the disposal and generation rates represents inventories and volume reduction by compaction. Less than 1% of the solid LLW disposed of in SWSA 6 is generated by Y-12 and Oak Ridge Associated Universities.)

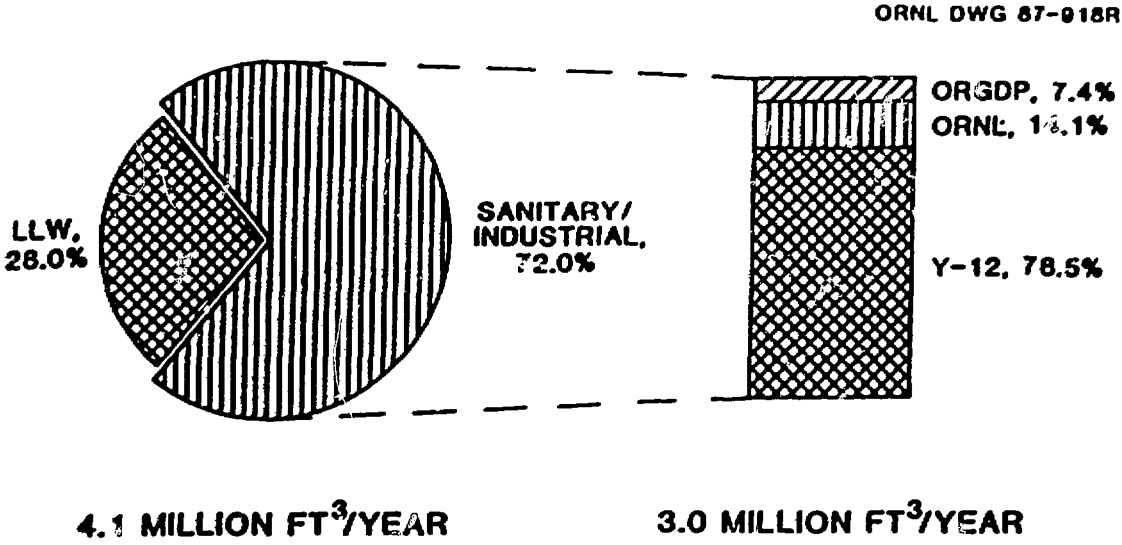


Fig. 2. Solid LLW and sanitary/industrial waste generated on the ORR in CY 1986, showing breakdown, by plant, of the sanitary/industrial waste portion.

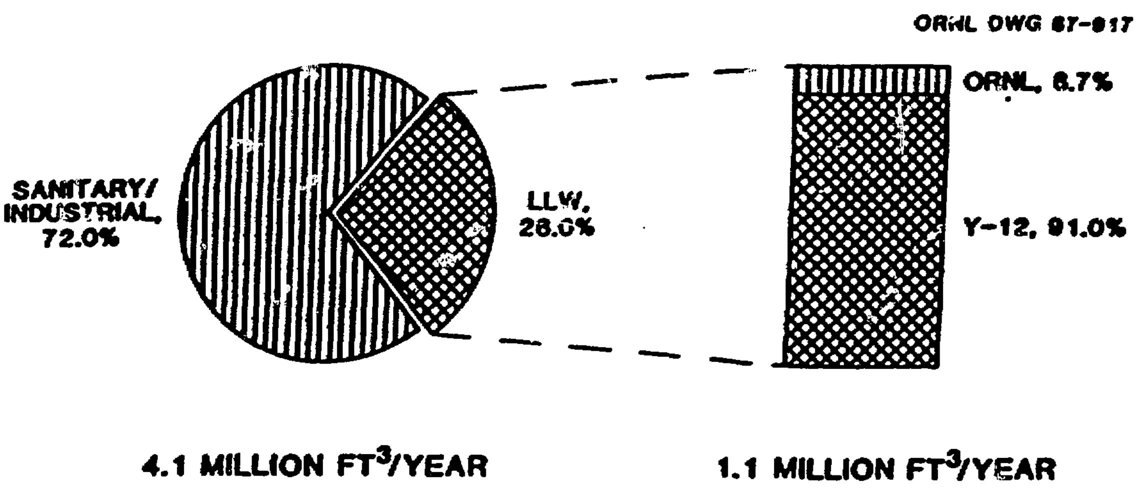


Fig. 3. Solid LLW and sanitary/industrial waste generated on the ORR in CY 1986, showing breakdown, by plant, of the LLW portion.

As shown in Table 1, solid LLW at ORNL is segregated on the basis of radiation field, ^{235}U content, level of contamination, biodegradability, sources, compactibility (Table 2), and status as routine or nonroutine waste (ORNL, 1985, 1987a, 1987b, 1987c, 1987d). The ORNL generation rates for solid LLW during CY 1986 are shown in Table 3.

The current solid waste certification practices at ORNL for solid LLW begins at the point of generation. The waste generator surveys the material, and from a knowledge of the source of the waste, estimates and documents the radionuclides likely to be present and estimates the curie content. Waste drums with a surface exposure rate of below 200 mrem/h are examined at the Waste Examination and Assay Facility. This radiographic scan is used to identify drums containing free liquids and lead.

Past disposal practices have primarily been the use of unlined disposal trenches and auger holes. These trenches and auger holes have been constructed in areas with depths-to-groundwater of 16 ft and 21 ft, respectively. Standard trench dimensions are 50 ft by 15 ft by 15 ft, and auger hole dimensions are 3 ft in diameter by 20 ft in depth. Low-level waste with contact dose rates below 200 mR/h has been placed in trenches, while waste exceeding this rate has been placed in auger holes. Because of increased regulatory requirements, the use of unlined trenches and auger holes has been discontinued.

Greater confinement disposal (GCD) is defined as the use of techniques for the disposal of radioactive waste, utilizing engineering barriers, to provide long-term isolation and containment of the waste material from the surrounding environment. Currently at ORNL, GCD is being practiced for all LLW being disposed of at Solid Waste Storage Area 6 (SWSA 6).

For the disposal of low-activity-range LLW at SWSA 6, concrete disposal silos are constructed by using large precast concrete pipes or nested corrugated metal pipes, with the annular space filled with concrete. These units are installed vertically below grade. These units are typically 8 ft in inside diameter by 20 ft in depth, with wall thicknesses of 8 and 6 in., respectively. Each unit has a 1-ft-thick concrete bottom. The units are filled to within 2 ft of the top with waste and then capped with concrete to provide long-term waste confinement. This type of unit is typically filled with bulk-

Table 1. Summary of waste segregation practices at ORNL [a,b]

Waste class	Segregation/criteria
Nonradioactive wastes	Material within the limits given in Table 4 of the HPPM, Procedure 2.5 ("green tag" limits) Direct survey (300 d/m/100 cm^2; 0.05 mrad/h) Transferable (smear) (20 d/m/100 cm^2; 200* d/m/100 cm^2) *For I-125, I-129, and AC-227 the guide is 20 d/m/100 cm^2.
Suspect waste	Waste with no measurable levels of radioactivity (by field survey techniques) but judged by the generator because of its history to be radioactively contaminated above "green tag" limits.
High-range waste	All beta-gamma emitting radioactive waste excluding TRU and ^{235}U, the transferable contamination of the outer surface meeting the requirements of HPPM, Procedure 4.1. The radiation reading at contact of the surface of the unshielded package <200 mrem/h. All waste from inside hot cells and glove boxes used for work involving pure beta emitters (which may read <200 mrem/h at the surface of the package) is included in this class.
Very high range waste	The same as high-range waste except that the radiation reading at contact with the outer surface of the unshielded package is >2000 mrem/h).
Low-range compactible waste	The same as high-range waste except that the radiation reading at contact with the outer surface of the unshielded package is 10-200 mrem/h. This waste can be compacted by conventional compaction.
Low-range noncompactible waste	The same as low-range compactible except that it is noncompactible by conventional compaction. This waste class is suitable for supercompaction.
Very low range waste	The same as low-range compactible and noncompactible waste except that the radiation reading after packaging is $\leq$10 mrem/h and is acceptable for storage at ORGDP.
^{235}U (Fissile waste)	Contains 1 g or more of ^{235}U.
Radioactive asbestos	Asbestos contaminated with radioactive materials.

Table 1. (continued)

Waste class	Segregation/criteria
Biological waste	Mostly animal carcasses contaminated with radioactive material.
Special waste	Special waste is classified for disposal as low-range, high-range, etc. In addition, it is managed based on source-specific characteristics.

[a]Health Physics Procedures Manual (HPPM), Procedures 2.5, 4.1, and 5.1.
[b]Environmental Protection Manual Procedures (EPMP), Procedures 1.0 and 17.0.

Table 2. Examples of compactible and noncompactible radioactive wastes and acceptable containers[a] at ORNL

Compactible waste	Noncompactible waste
Radiation reading ≤2 mSv/h (200 mrem/h) at surface of individual package (bag, carton, bucket, etc.).	Radiation reading ≤2 mSv/h (200 mrem/h) at surface of outer container (dumpster, 55-gal drum or metal box) used to transfer waste to SWSA.
Container must be compactible: plastic bags, plastic buckets, paperboard ice cream cartons, lard cans, and other thin metal cans.	Container must be suitable for transfer of the material from the generating point to the SWSA without spillage or spread of contamination.
Container size: Max. 50.8 cm x 50.8 cm x 91.4 cm (20 in. x 20 in. x 36 in.).	
Container must be closed (example: plastic bag taped shut) to prevent spillage during transport to and transfer into the compactor. Double bagging should be considered for packages that are heavy.	
Waste must be dry - contain no liquid.	
Examples - compactible waste: Plastic bags and sheets Paper, blotter paper Glass bottles (no liquids) Rubber gloves, shoe covers Plastic bottles (no liquids) Cardboard-frame dust-stop filters Glass container	Examples - noncompactible waste: Drained acid bottles Angle iron, piping >15 cm (6 in.) long Files, other tools >15 cm (6 in.) long Metal frame filters Wood >15 cm (6 in.) long

[a]Health Physics Procedures Manual, Procedure 5.1, pp. 17, Jan. 12, 1987.

Table 3. Summary of solid LLW generation at ORNL during CY 1986[a]

Waste category	Generation rate, uncompacted (ft^3/year)	Generation rate after compaction	Disposal	Inventory[b]
Biological	935			
Contaminated asbestos	226		226	
Suspect	15,139		15,139	
Low range[c]				
Compacted	17,417	2,415	2,415	
Uncompacted	56,865		32,755	24,110
High range	2,352		2,352	
Very high range	649		649	
Fissile	241		241	
Total	93,824	2,415	54,712	24,110

[a]Based on ORNL Solid LLW Data Base.

[b]Inventoried waste includes temporary storage prior to disposal of compacted waste and supercompaction of uncompacted wastes. The supercompaction was performed during CY 1987.

[c]Solidified sludge from Process Waste Treatment Plant (Bldg. 3544) is disposed of as low range and very low range; about 268 ft^3 of low range waste was inventoried at ORGDP.

type waste. These units can be constructed where surface slope is less than 10%. There will be an ongoing demand for this type of disposal unit since they are the optimum way to dispose of construction waste, which typically contains objects of unusual size and shape.

For the disposal of high-activity LLW, modified versions of the units discussed above are used. This type of waste typically contains either high levels of activity concentrations or waste containing radionuclides of long-half-life duration. These types of wastes are disposed of in below-grade containment wells. The wells are constructed of cast iron pipe, 20 ft long by 20 in. in inside diameter. Nine cast iron pipes are placed in either the precast concrete pipe or are nested corrugated metal pipes, as discussed above. These units have a 1.5-ft-thick concrete bottom, and the annular space between the nine wells and containing cylinder is filled with concrete.

Waste packages are placed in the cast iron pipe containment wells. A precast concrete shielding plug 12 in. thick is placed above the waste package. Each well is capable of holding an average of 10 waste packages, before being filled to within 3 ft of the top of the well. When the well is full, the remaining 3 ft of space is capped with concrete to completely seal that particular well. Each well is filled and capped until the entire unit is utilized. In addition to these units, individual 20- and 30-in.-diam disposal wells are also used, on a limited basis, in SWSA 6. They are primarily used for the disposal of low-level, high-activity waste and fissile waste. The 30-in.-diam wells are designed for the disposal of 55-gal drums of waste.

An alternative to subsurface burial for low-level, low-activity radioactive waste is an above-grade earth-mounded bunker. This type of disposal does not require subsurface burial and can therefore be used in areas where shallow depth to groundwater is encountered, although relatively flat terrain (slope less than 5%) is required. This technique involves the use of a concrete slab on-grade, onto which leach-resistant containers of LLW will be stacked. When the slab is loaded with the desired number of containers, it is covered by a substantial mound of compacted soil. This technology has the benefits of improved monitorability and improved remediation, should it prove necessary.

Y-12 Plant

Low-level radioactive wastes are now segregated and transported to the Bear Creek Burial Ground (BCBG) with disposal as follows:

1. Radioactive contaminated trash (waste contains >132 pCi/g of depleted uranium) - Examples of this waste include nonuranium machine turnings, wood, concrete and asphalt, dirt, other construction spoils, drums, cans, and other miscellaneous trash, all contaminated with uranium. Certain special wastes (asbestos and beryllium oxide) contaminated with low-level radioactivity are disposed of in the A area.
2. Depleted uranium chips of uranium turnings are presently transported in water with traces of water-soluble, biodegradable coolant solutions in dumpsters and disposed of in earthen pits.
3. Uranium fines and sawdust are disposed of in "walk-in pits" with a suitable layer of soil used as cover.
4. Uranium-contaminated asbestos is disposed of in special cells in the A area. Both asbestos materials and BeO wastes not contaminated with radioactivity are permitted for disposal in Sanitary Landfill II.

The total volumes of solid LLW generated and disposed at Y-12 during CY 1986 are shown in Table 4 (Butcher, 1987).

Disposal techniques have been primarily shallow land burial trenches in area fill and hillcuts. The trenches have been constructed so that they best utilize the existing surface and subsurface conditions. A typical trench is approximately 30 ft wide by 18 ft deep by 500 ft long. The trenches have been constructed so that the bottom slopes to one slide and to the entrance to direct water away from the waste.

Periodically, the trench excavation is extended as space is needed for additional waste. Earth berms are used to segregate various types of wastes. The berm heights are extended as the waste level rises. Silt fencing is used around the trenches, along surface drainage ditches, and around stockpiled earth to minimize movement of sediment from the area. Monitoring wells installed upgradient and downgradient of each trench are used to identify soil and groundwater parameters during and after burial operations. Monitoring is performed on a quarterly basis.

Table 4. Annual generation rates for major Y-12 solid waste streams (volume in ft^3 based on data for October 1, 1986–March 31, 1987)[a]

Waste stream	Sanitary Landfill[b]	Burial ground[b]	Salvage yard[b] Clean	Salvage yard[b] Contam.	Waste feed preparation[c]	ORGDP[b]	Chip Ox/ oxide vaults[b]	Total
Scrap metal	500	100,000[d]	190,000	80,000	1,900			372,400
Soil and concrete	4,500	20,000						24,500
Carbon	1,800	11,000				1,200		14,000
Mixed chips	39,000	50,000						89,000
Mixed chips with Be	30	120						150
Aerosol cans	330							330
Asbestos	27,000	28,000						55,000
Glass	25,400							25,400
Wood	45,000	2,100			18,800			65,900
Blotter paper/floor sweeping		3,400						3,400
Dumpster trash	1,600,000	74,000			276,000			1,950,000
Li waste	3,800							3,800
BeO Shopwaste	3,100	6,800						9,900
Be Shopwaste	5,400	5,900						11,300
D38 oxide		900					1,200	2,100
D38 sawdust		2,800						2,800
D38 scrap		750						750
D38 chips		210,000					3,800	213,800
Air filters	20,000	25,000						45,000
Brick and block	100	1,900						2,000
Waste bales[e]		20,000						20,000
Miscellaneous	450,000[f]	20,000			30,000	5,300		505,300
Total	2,225,960	582,670	190,000	80,000	326,700	6,500	5,000	3,416,830

[a]Waste volumes represented in the table reflect wastes generated during the first six months of FY 1987 and extrapolated over a 12-month period. It is intended to provide a "snapshot" of generation rates and not necessarily accurate for long-term projections. Indeed, these quantities can easily vary significantly from one fiscal year to the next. Also, waste segregation and minimization are already having an effect on generation rates. Classified, RCRA, and sludge wastes are not included in these waste totals.

[b]The Y-12 Sanitary Landfill, Bear Creek Burial Ground, Salvage Yard, ORGDP, and D38 Oxide Vaults are long-term storage and disposal facilities currently in use.

[c]The Waste Feed Prep provides volume reduction for primarily combustible waste prior to disposal in Bear Creek Burial Ground.

[d]Scrap metal delivered to Bear Creek Burial Ground includes metal contaminated with non-recoverable amounts of enriched uranium.

[e]Waste materials delivered to the Waste Feed Prep are compacted into waste bales prior to disposal. Therefore, the volume of waste bales represents the effect of compaction on those materials delivered to the Waste Feed Prep.

[f]This category consists primarily of trash truck deliveries of combustible wastes rather than waste delivered in dumpsters. This waste is not measured for uranium prior to disposal.

Solid waste generated at Y-12 is monitored by gamma scintillation using a sodium iodide detector. Based on limitations of the monitor station, LLW is defined as containing greater than 132 pCi/g of uranium (as depleted). Wastes that contain between 132 pCi/g and 3,200 pCi/g are scanned to verify absence of depleted uranium chips and then compacted and baled. The bales are wrapped in 3-mil plastic to control the spread of contamination during handling and transport. Waste which contains in excess of 3,200 pCi/g of uranium contamination is left unbaled and transported in a loose condition.

Daily operations consist of disposal of nonbaled solid wastes and baled solid waste. The nonbaled wastes are transported to the trenches in designated vehicles and dumped at the working face of the trench. Direct contact between delivery equipment and the loose waste in the trench is minimized to control contaminant track-out problems. The compacted/baled wastes, which have a composition of wood, metal, paper, cardboard, blotter paper, skids, and drums, are transported to the trench by truck and off-loaded. Placement of the baled waste is accomplished by using an off-the-road fork truck in the trench.

All waste types are covered daily with a minimum of 6-12 in. of earth cover. Areas of the trench not used within a 30-day period are covered with an added 12 in. of intermediate cover.

A minimum of 2 ft of clay soil is applied as a final cover over the final lift of earth in the trench. The final lift and daily cover material is obtained from progressive excavation of earth from the trench during the site operations. The top surface of all cover material is sloped to provide positive drainage of surface water away from the waste and working areas of the trench. A vegetative stand is established on the final cover to prevent erosion and surface deterioration.

Currently, trench A-16 receives compacted bales of low-level wastes. These bales are processed in Building 9401-4 at the Y-12 Plant. The size of a compacted bale is 42 in. by 42 in. and in lengths up to 66 in. Warehouse space in the processing building can accommodate up to one year of bale storage. However, bales are usually stored for only two to three days prior to being transported to the burial grounds.

Trench A-17 is currently being used to dispose of low-level loose waste. Wastes generally consist of construction spoils, wood, concrete, asphalt, dirt, and miscellaneous trash that cannot be baled. The trench has been designed to be extended horizontally north to provide additional disposal volume. This area has been designated trench A-17E.

A proposed trench A-18 has been designed to be located on the north side of BCBG across from trench A-17. This trench has been designated for future bulk waste disposal.

Oak Ridge Gaseous Diffusion Plant

Currently, no facilities exist at ORGDP for the general disposal of low-level radioactive waste. One landfill disposal area exists at ORGDP, but it is designated for classified waste only. Solid LLW at ORGDP is currently disposed at the BCBG. ORGDP segregates radioactive waste into three categories. Radioactive materials included in these categories are (1) sanitary (wood, paper, floor sweeping compounds, etc.); (2) radioactive scrap metal; and (3) radioactive asbestos.

The scrap metal is stored on-site at the Hot Scrap Metal Yard. Radioactive sanitary and asbestos are disposed at the BCBG. The generation rates for CY 1986 are:

Solid LLW category	Generation rate (ft^3/year)
Radioactive sanitary	1,000
Radioactive scrap metal	2,000
Radioactive asbestos	0

The generation of radioactive asbestos is associated with nonroutine, construction-related activities.

PROJECTED WASTE CHARACTERIZATION REQUIREMENTS

The Low-Level Waste Disposal Development and Demonstration (LLWDDD) Program has as its ultimate goal the establishment of new, environmentally acceptable LLW disposal facilities to serve the Reservation. A strategy for the disposal of radioactive wastes which reflects present regulatory requirements and future disposal needs has been developed by the LLWDDD Program for the Reservation. As a flexible and adaptive framework for low-level waste management on the Reservation, this strategy relies on waste segregation to provide the needed control of the concentration and isotopic composition of radioactive wastes prior to disposal.

The waste segregation strategy uses four classes of waste. Class I is waste which is suitable for unrestricted burial and which has levels of contamination that would result in doses below the regulatory dose limit at time of disposal. Class II is waste which is suitable for engineered disposal and which has contamination levels that will result in doses below the regulatory limit at the end of a period of institutional control. Class III is waste which is suitable for restricted disposal and which contains isotopes with long half-lives that could result in doses to individuals or intruders that exceed the regulatory dose at the end of institutional control unless intruder protection is provided. Class IV is waste not suitable for disposal on the Reservation and which would require (1) treatment to reduce the level of contamination for disposal as any one of the other disposal classes and (2) shipment to an off-site disposal facility.

Regulatory limits have not been established, but the following limits are being proposed by the LLWDDD Strategy: dose limits = 10 mrem/year and institutional control period of 300 years. The approach followed by the LLWDDD strategy is based on the aggregate performance of the disposal site and the technology associated with the disposal of the waste. Technology is used in this paper in a broader sense to include the combination of the waste form, package, and disposal unit.

An effective means for segregating and certifying wastes is of primary importance to the implementation of the LLWDDD strategy. Waste characterization on a waste stream and package basis will be required. Elements of the waste stream characterization program include data on the volume, weight, isotopes and forms, activity, compactibility, combustibility, source, dates, and the LLWDDD class (I, II, III, or IV).

The definition of the concentration limits for uranium and the broad spectrum of radionuclides generated on the Reservation is needed to distinguish between sanitary waste and class I waste and to determine the need for the development of waste certification techniques.

Presently, the DOE plants of the Reservation are developing and implementing waste stream identification and evaluation plans to characterize the volumes of solid LLW being generated. Waste certification and segregation programs are being developed as technology demonstrations in support of the LLWDDD strategy. The objectives of these planned demonstrations are to gather data on feasibility, performance, and costs of waste monitoring for management under LLWDDD.

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