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# Analysis of Chemical Technology Division Waste Streams

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ORNL/TM-11434

Chemical Technology Division

# ANALYSIS OF CHEMICAL TECHNOLOGY DIVISION WASTE STREAMS

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# ANALYSIS OF CHEMICAL TECHNOLOGY DIVISION WASTE STREAMS

T. J. Abraham, T. L. Donaldson, A. B. Walker, R. L. Cummins
M. E. Reeves, and T. D. Hylton

ABSTRACT

This document is a summary of the sources, quantities, and characteristics of the wastes generated by the Chemical Technology Division (CTD) of the Oak Ridge National Laboratory. The major contributors of hazardous, mixed, and radioactive wastes in the CTD as of the writing of this document were the Chemical Development Section, the Isotopes Section, and the Process Development Section. Since that time (late 1989) two significant occurrences have transpired in the CTD that will primarily impact LLLW generations: (1) placement of the majority of Isotope Area operations in safe standby mode and (2) the currently anticipated August 1 enactment of the Federal Facilities Agreement (FFA). [The FFA will result in closure of several active liquid low-level waste (LLLW) tanks in the near term and will eventually require all LLLW tanks without secondary containment to be removed from service.] The shutdown of isotope operations and, to a lesser extent, ratification of the FFA document are expected to significantly decrease CTD LLLW generations in the near term.

In addition to these impacts on LLLW generation rates in CTD, startup of the Non-Radiological Waste Treatment Plant (NRWTP) in February 1990 resulted in modifications to the flow scheme of the CTD's process waste (PW). Prior to the NRWTP coming on-line, PW from Melton Valley and the 4500 area in Bethel Valley was discharged directly to Melton Branch and White Oak Creek, respectively. Currently, PW originating in the 4500 area is treated at the NRWTP prior to environmental release. PW in Melton Valley is segregated locally. Subsequent to treatment at the Process Waste Treatment Plant and/or the NRWTP, these streams are discharged to White Oak Creek.

## 1. INTRODUCTION

The objectives of this report are to identify the sources and to summarize the quantities and characteristics of hazardous, mixed, gaseous, and solid and liquid radioactive wastes that are generated by the Chemical Technology Division (CTD) of the Oak Ridge National Laboratory (ORNL). This study was performed in support of the CTD

waste-reduction program—the goals of which are to reduce both the volume and hazard level of the waste generated by the division. The sections of CTD discussed in this report are as follows: Chemical Development Section (CDS), Engineering Development Section (EDS), Energy Research Programs (ERP), Isotopes Section (IS), Process Development Section (PDS), Resource Systems Management Section (RSMS), Waste Management Technology Support Group (WMTSG), and Engineering Coordination and Analysis Section (EC&A).

Prior to the initiation of any specific waste-reduction projects, an understanding of the overall waste-generation system of CTD must be developed. Therefore, the general approach taken in this study is that of an overall CTD waste-systems analysis, which is a detailed presentation of the generation points and general characteristics (if known) of each waste stream in CTD. The goal of this analysis is to identify the primary waste generators in the division and determine the most beneficial areas to initiate waste-reduction projects.

## 1.1 DATA SOURCES

The data presented in this report summarize the information that is currently available concerning waste generation in CTD. However, there has been very little direct sampling of the various waste streams. The specific sources of data are as follows:

1. **Liquid Low-Level Waste (LLLW)** - There are several sources of data concerning this system. The waste-volume data have been obtained from the Liquid and Gaseous Waste Operations Group of the Environmental and Health Protection Division.[1] Quantities of the radioactive and nonradioactive contaminants have been obtained from LLLW-generator interviews and, in most cases, are only estimates.

---

[1]This division is now the Office of Waste Management and Remedial Actions.

2. **Process Waste (PW)** - All of the volume-generation data for this waste class were obtained from sources in the Liquid and Gaseous Waste Operations Group of the Environmental and Health Protection Division. Some generator estimates of process waste generation rates are also presented in this report.

3. **Hazardous and Mixed Waste** - Data concerning hazardous waste generation rates were obtained from data bases maintained in the Environmental and Health Protection Division.

4. **Radioactive Solid Waste** - The data concerning the generation rates of solid radioactive waste were obtained from the Solid Waste Information Management Systems (SWIMS) data base.

### 1.2 CTD WASTE SOURCES

The buildings for which CTD maintains responsibility and the connections or contributions of each building to the various waste-treatment systems are summarized in Table 1.1. As illustrated in this table, most of the facilities that are the responsibility of CTD have connections to ORNL off-gas systems and the process-waste system. Many of the CTD facilities contribute substantially to ORNL's LLLW system and to the volume of solid waste generated at ORNL. This description is particularly true of facilities concerned with processing isotopes and the High Flux Isotope Reactor (HFIR) targets.

In general, CTD produces only small amounts of hazardous/mixed wastes, so those streams are not included in this summary. The following sections of this report will describe in detail the generation volumes and characteristics of the various waste streams of CTD.

## 2. LIQUID LOW-LEVEL WASTE

### 2.1 SYSTEM DESCRIPTION

The LLLW at ORNL originates from hot sinks and drains in research and development (R&D) laboratories and from processes such as those in

Table 1.1. Summary of CTD wastes for CY 1988[a]

| Building | Radioactive gaseous waste 3039 stack | | Process waste | LLLW | Radioactive solid waste |
|---|---|---|---|---|---|
| | Cell ventilation | Process off-gas | | | |
| 2024 | No | No | Yes | No | No |
| 2528 | No | No | No | No | Yes |
| 2630 | No | No | No | No | No |
| 3017 | No | No | No | No | No |
| 3019 | 3020 Stack | Yes | Yes | Yes | Yes |
| 3021 | No | No | No | No | No |
| 3026 | Yes | Yes | Yes | Yes | No |
| 3028 | Yes | Yes | Yes | Yes | Yes |
| 3029 | Yes | Yes | Yes | Yes | Yes |
| 3030 | Yes | Yes | Yes | Yes | Yes |
| 3031 | Yes | Yes | Yes | Yes | Yes |
| 3032 | No | No | Yes | No | No |
| 3033 | Yes | Yes | Yes | No | No |
| 3033A | Yes | Yes | Yes | Yes | No |
| 3036 | No | No | No | No | No |
| 3037 | No | No | No | No | Yes |
| 3038 | Yes | Yes | Yes | Yes | Yes |
| 3042 | Yes | Yes | Yes | Yes | No |
| 3047 | Yes | Yes | Yes | Yes | Yes |
| 3091 | No | No | No | No | No |
| 3100 | No | No | No | No | No |
| 3113 | No | No | No | No | No |
| 3118 | No | No | No | No | No |
| 3121 | No | Yes | No | No | No |
| 3136 | No | No | No | No | No |
| 3503 | No | Yes[b] | Yes[b] | Yes[b] | Yes |
| 3505 | Yes | Yes[b] | Yes | Yes | Yes |
| 3517 | Yes | Yes | Yes | Yes | Yes |
| 3525 | Yes | Yes | Yes | Yes | Yes |
| 3541 | No | No | Yes | Yes[b] | Yes |
| 3542 | No | No | No | No | Yes |
| 3543 | No | No | No | No | Yes |
| 3550 | No | No | No | No | No |
| 3592 | No | Yes[b] | Yes[b] | Yes[b] | No |
| 3597 | No | No | No | No | No |
| 4500N | No | Yes | Yes | No | Yes |
| 4501 | Yes | Yes | Yes | Yes | Yes |
| 4505 | Yes | Yes | Yes | No | Yes |
| 4507 | Yes | Yes[b] | Yes | Yes | Yes |

Table 1.1 (continued)

| Building | Radioactive gaseous waste 3039 stack | | Process waste | LLLW | Radioactive solid waste |
|---|---|---|---|---|---|
| | Cell ventilation | Process off-gas | | | |
| 4556 FP | Yes | No | No | No | No |
| 7025 | 7025 Stack | 7025 Stack | No | No | Yes |
| 7920 | 7911 Stack | 7911 Stack | Yes | Yes | Yes |
| 7930 | 7911 Stack | 7911 Stack | Yes | Yes | Yes |
| 7933 | No | No | No | No | No |
| 7957 T | No | No | No | No | No |

[a]Gaseous waste, PW, and LLLW are considered to be active if connection to the respective ORNL waste treatment system exists. Therefore, "yes" does not necessarily indicate a generation point, but rather a potential generation point.

[b]Not used.

radiochemical pilot plants, nuclear reactor facilities (located in Bethel and Melton valleys), and waste-treatment facilities [the Process Waste Treatment Plant (PWTP) and Central Off-Gas System]. In the future, the remedial action cleanup of inactive tanks and facilities will likely be a significant contribution to the LLLW.

The LLLW collection and treatment system is shown schematically in Fig. 2.1. Hot drains discharge to underground collection tanks (Fig. 2.2), and the contents of these tanks are transferred via underground piping to the LLLW Evaporator Facility (Bldg. 2531). The evaporator units are used to reduce the volume of LLLW by a factor of ~15. The concentrate is then transferred to the Melton Valley Storage Tanks, and the evaporator condensate is transferred to the PWTP for polishing.

Information on the waste sources and generators and the composition of wastes from the CTD is summarized below. Further details on wastes generated in other divisions may be found in work by Abraham et al. (1989).

## 2.2 CTD WASTE SOURCES AND GENERATORS

The CTD is responsible for approximately 47% of the dilute LLLW generated at ORNL. Average monthly generation rates for the principal contributing ORNL facilities are shown in Table 2.1 for 1988. The generation rates and distribution among the facilities shown in this table are typical for the Laboratory's generators since 1986. The LLLW generation rates, as a whole, increased during the first 6 months of 1989 (see Table 2.2)—most likely as a result of Technical Safety Assessment (TSA) activities, increased remedial-action activity, and increased rainfall levels. However, the LLLW collection rates from CTD generators through the first 6 months of 1989 remained at approximately the same level as 1988 collections. The reason for the consistent rates for 1988 and 1989 is primarily the result of waste-minimization activities throughout CTD, termination or lack of activity in programs throughout the division, and work stoppages in the Isotopes Area. These events, which have caused a decrease in process related LLLW generation

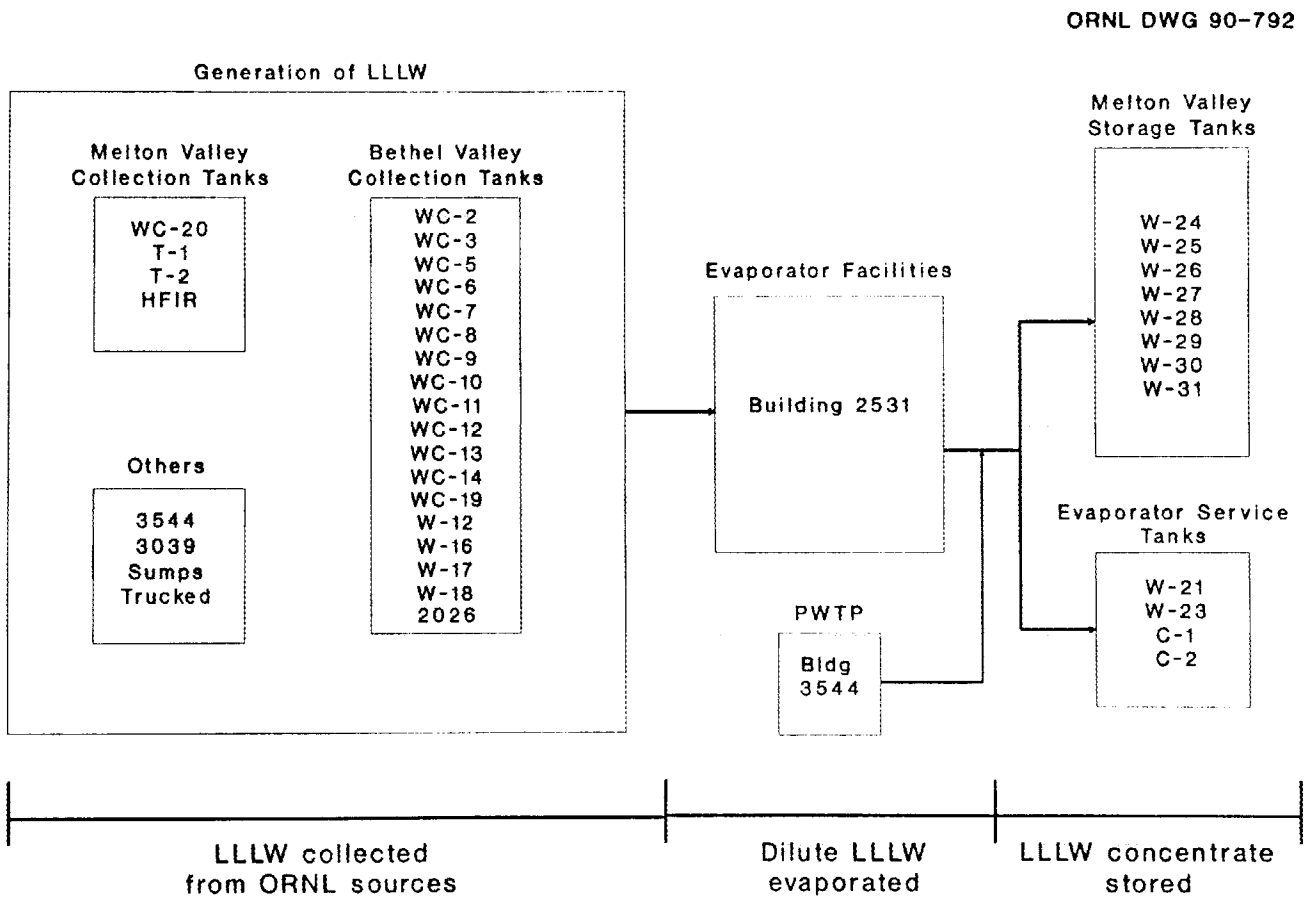


Fig. 2.1. Description of LLLW system.

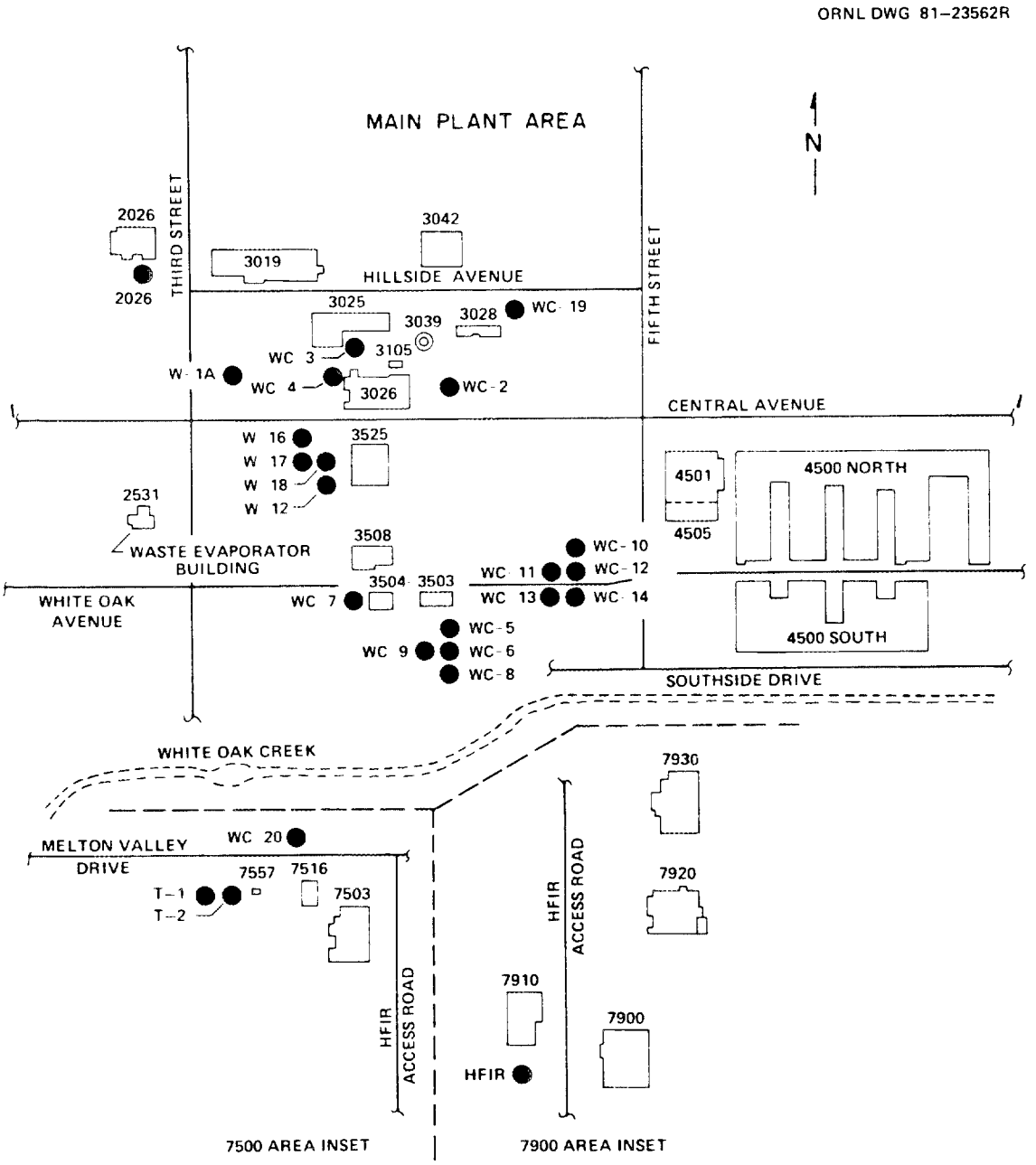


Fig. 2.2. Location of action collection tanks.

Table 2.1. Average monthly generation of dilute LLLW for 1988

| Generator | Monthly generation (gal) | Percent of total |
|---|---|---|
| Isotopes[a,b] | 3766 | 16 |
| 3039 stack area | 3275 | 14 |
| Fission Products Development Lab.[a] | 3150 | 13 |
| HFIR | 2996 | 12 |
| High Radiation Level Examination Lab.[a] | 1857 | 8 |
| REDC[a] | 1742 | 7 |
| 4500 complex[a,c] | 1605 | 7 |
| Reactors[d] | 1378 | 6 |
| Tank W1-A[e] | 1161 | 5 |
| Building 3019[a] | 899 | 4 |
| PWTP spent acid | 652 | 3 |
| Tank WC-8 pump pit | 537 | 2 |
| All others | 1064 | 3 |
| Total | 24,082 | |

[a]Denotes CTD facilities.

[b]Isotopes includes all collections from the Isotopes Area, Building 3026C, and Building 3026D collection tanks.

[c]CTD is responsible for only a small portion of the LLLW generated by the 4500 complex.

[d]Reactors included are the ORR, the BSR, and the Graphite Reactor.

[e]Tank W1-A is abandoned, and the collections are considered to be primarily rainwater.

Table 2.2. Average monthly generation of dilute LLLW for January-June 1989

| Generator | Monthly generation (gal) | Percent of total |
|---|---|---|
| Tank W1-A[a] | 5394 | 18 |
| Isotopes[b] | 5232 | 17 |
| HFIR | 4572 | 15 |
| 3039 Stack Area | 3914 | 13 |
| High Radiation Level Examination Lab. | 3004 | 10 |
| Reactors[c] | 2405 | 8 |
| Fission Products Development Lab. | 1337 | 4 |
| 4500 complex[d] | 1302 | 4 |
| Transuranium Processing Plant (TRU) | 941 | 3 |
| Tank WC-8 pump pit | 816 | 3 |
| PWTP Spent Acid | 620 | 2 |
| Building 3019 | 23 | <1 |
| All others | 1039 | 3 |
| Total | 30,599 | |

[a]Tank W1-A is abandoned, and the collections are considered to be primarily rainwater.

[b]Isotopes includes all collections from Isotopes Area collection tank, Building 3026C collection tank, and Building 3026D collection tank.

[c]Reactors included are the ORR, the BSR, and the Graphite Reactor.

[d]CTD is responsible for only a small portion of the LLLW generated by the 4500 complex.

rates, balance the increased LLLW generation due to rainfall in 1989. A schematic showing how CTD buildings are connected to the active LLLW system is presented in Fig. 2.3.

The principal sources (by building) of CTD LLLW in 1988 are shown in Table 2.3. The largest volume producers of LLLW in CTD are:

| | |
|---|---|
| Bldg. 3517 | 37,800 gal/year |
| Bldg. 3525 | 22,300 gal/year |
| REDC | 20,900 gal/year |
| Isotopes Area | 19,300 gal/year |

Table 2.3 also shows the quantities of LLLW collected in 1988 as reported by the Waste Operations personnel and estimated by the generators. In general, generators are aware of approximately 60% of their LLLW generation. Approximately 20% of the LLLW volume is attributable to rainwater infiltration. The effects of rainfall on LLLW collection rates have been discussed by Abraham et al. (1989). The following sections will describe the functions of major CTD LLLW generators.

### 2.2.1 Fission Products Development Laboratory (FPDL)

The FPDL (Bldg. 3517) processes large quantities of $^{137}Cs$ (~350,000 Ci/year) and $^{90}Sr$ (~500,000 Ci/year). Other materials that are occasionally processed are $^{60}Co$ and $^{192}Ir$. Materials that have been handled in the past include $^{144}Ce$ and $^{147}Pm$.

Building 3517 is the primary source of both cesium and strontium collected in the LLLW system. Estimated losses of each material are on the order of 5000 to 15,000 Ci/year. The building activities that produce LLLW are not directly related to isotope processing but are derived primarily from routine decontamination of the hot cells used in cesium and strontium purification. In addition to the nuclides released to the LLLW system, this routine decontamination also results in the addition of 16 *M* nitric acid (500 gal/year), oxalic acid (500 lb/year), 50% sodium hydroxide (300 lb/year), Turco Decon 4501 (500 lb/year), and various detergents to the LLLW system.

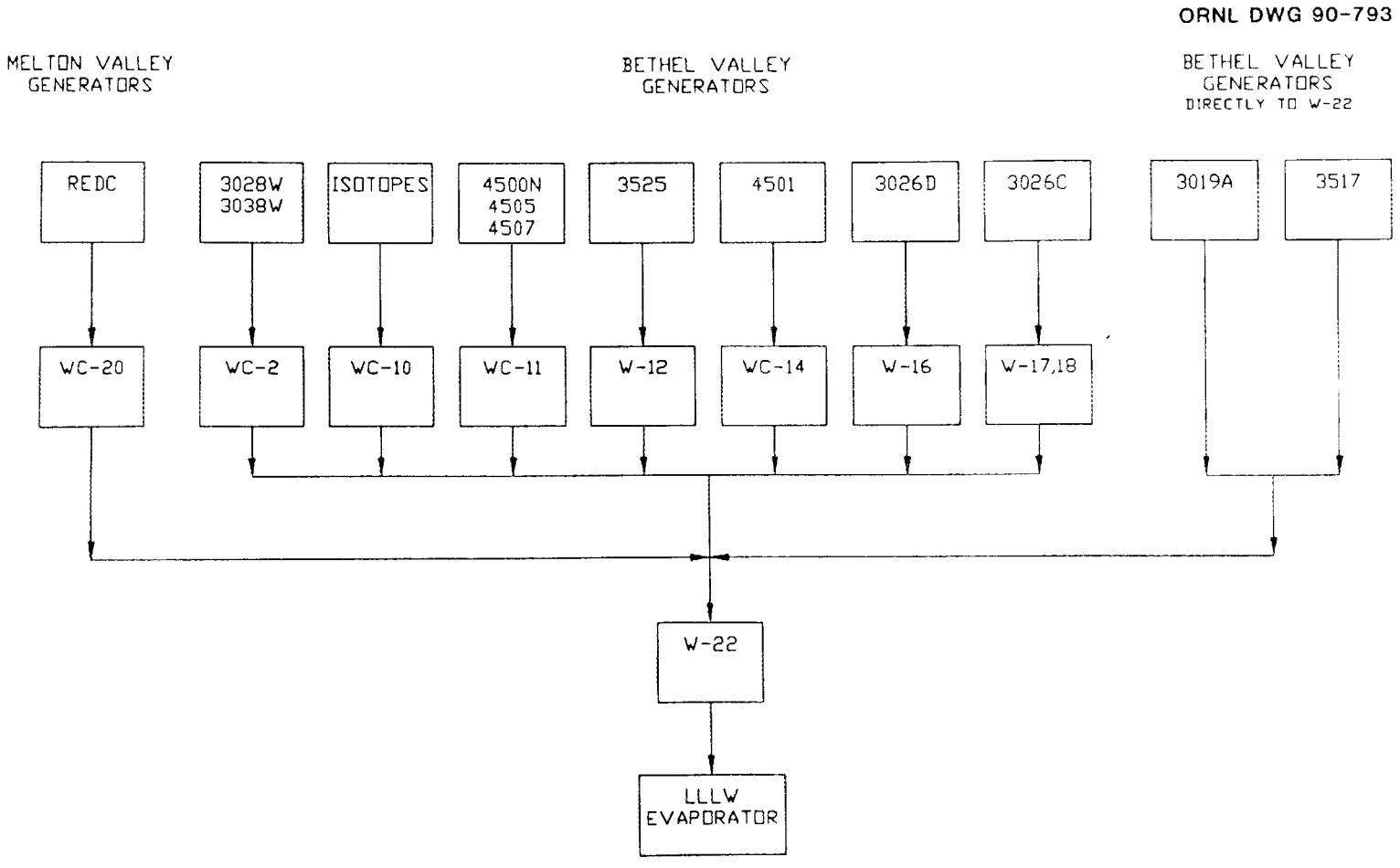


Fig. 2.3. Schematic of CTD LLLW system.

Table 2.3. CTD LLLW summary for 1988

| Building/area served | Tank | Division responsible | Potential waste generator in facility/area | Division charged | Percent charged | 1988 LLLW per Waste Oper. (gal) | 1988 estimate by CTD generator (gal) |
|---|---|---|---|---|---|---|---|
| Bldg. 3517 | W-22 | CTD | CTD | CTD | 100 | 37,800 | 34,032 |
| Isotopes Area[a] | WC-10 | CTD | CTD & H & SRD[b] | CTD | 100 | 19,332 | 10,326 |
| Bldg. 3019[c] | W-22 | CTD | CTD | CTD | 100 | 10,788 | 10,680 |
| 4500 Complex[d] | WC-11 | See note[d] | See note[d] | CTD | 100 | 7,128 | 0 |
| Bldg. 3026D[e] | W-16 | CTD | CTD | CTD | 100 | 4,920 | 0 |
| Bldg. 3074[f] | Trucked | P & E[g] | P & E | CTD | 100 | 4,224 | 0 |
| Bldg. 4501 | WC-14 | CTD | CTD & M & C | CTD | 100 | 1,956 | 492 |
| Bldg. 3028W,3038W | WC-2 | CTD | CTD & H & SRD | CTD | 100 | 1,092 | 0 |
| Bldg. 7920,30 | WC-20 | CTD | CTD & Anal. Chem. | R. Reactors | 100 | 20,904 | 21,060 |
| Bldg. 4505,4507[h] | WC-12 | CTD | CTD | E & HP (RAP) | 100 | 2,160 | 1,560 |
| Bldg. 3026C[i] | W-17,18 | CTD | CTD & H & SRD | H & SRD | 19 | 20,940 | 1,200 |
| Bldg. 3525 | W-12 | CTD | CTD | Central Mngt. | 100 | 22,284 | 10,800 |
| | | | | | | 153,528 | 90,150 |

[a]Isotopes Area includes Bldgs. 3028E, 3029, 3030, 3031, 3032, 3033, 3033A, 3038E, and 3047.

[b]Health and Safety Research Division.

[c]The large waste volume is the result of decontamination in 1988. LLLW generation in 1989 is 22 gal/month as of 6/30.

[d]Buildings 4507, 4505, and 4500N are served by WC-11. Buildings 4505 and 4507 are the responsibility of CTD, while 4500N houses several divisions including, but not limited to, CTD, Analytical Chemistry, and Chemistry.

[e]This facility is scheduled for D&D in the near term.

[f]The reason for charging LLLW from Bldg. 3074, the Interim Manipulator Repair Facility, to CTD is unclear. It may be that the facility repairs manipulators used in isotope operations.

[g]Plant and Equipment Division.

[h]A breakdown of the LLLW charge-back system notes the source of WC-12 waste to be groundwater inleakage pumped from a sump that serves a tank (T-30) known to contain fission products.

[i]There is no charge for the remaining 81%. These tanks are known to be heavily influenced by rainfall.

The LLLW production by Bldg. 3517 since 1986 has averaged ~3100 gal/month, but the level decreased substantially during the period from 1986 to 1989. In fact, the LLLW production rate in 1986 was approximately 4600 gal/month; and, by 1988, that rate had fallen to 3150 gal/month. Temporary shutdown of the facility in early 1989 resulted in even smaller volumes of LLLW (1337 gal/month) being sent to the LLLW system. Recently, improvements made to the building's underground tank vault have reduced groundwater inleakage; consequently, the LLLW generation rates are expected to decrease even further. Waste from Bldg. 3517 is jetted directly to tank W-22.

### 2.2.2 High Radiation Level Examination Laboratory

The High Radiation Level Examination Laboratory (Bldg. 3525) primarily serves as an area where irradiated metallurgical specimens can be examined. The area possesses both hot cells and storage wells for containment of radioactive materials. Currently, the facility is expected to handle a variety of radionuclides, including $^{137}Cs$, uranium, plutonium, and thorium isotopes. It is estimated that 50 Ci/year of $^{137}Cs$ and trace quantities of the various uranium, plutonium, and thorium isotopes escape to the LLLW system via collection and transfer to tank W-12. As is the case for other Isotopes Area generators, LLLW in this facility is mainly created by routine hot cell decontamination. In addition to the above-mentioned isotopes, it is estimated that sulfurous acid (450 lb/year), 15 *M* sodium hydroxide (5 gal/year), 5 *M* nitric acid (5 gal/year), and detergents used in decontamination activities contribute to the LLLW.

The average monthly LLLW generation rate since 1986 has been approximately 2600 gal. The LLLW generation rate decreased from 3770 gal/month in 1986 to 1850 gal/month in 1988. In 1989, the LLLW generation rate increased, as expected, to 3000 gal/month because of nonroutine hot cell revitalization/decontamination activities.

### 2.2.3 Radiochemical Engineering Development Center (REDC)

The REDC recovers a variety of radiochemicals produced by special irradiations of selected isotopes. The REDC has produced approximately 1400 gal of LLLW per month since 1986. This LLLW is primarily generated from the disposal of spent, off-gas scrubber solutions of typically low activity. In addition, small volumes of waste are generated as a direct result of isotope processing from operations conducted at the REDC. These wastes are sent to the LLLW system via tank WC-20. The REDC is the major contributor of the transuranic isotopes collected in the LLLW system.

### 2.2.4 Isotopes Area

The isotopes facilities at ORNL are used primarily for producing and distributing a wide range of radionuclides. Activities include tritium processing, $^{85}Kr$ separation, short-lived fission products processing, $^{137}Cs$ and $^{90}Sr$ source fabrication, $^{60}Co$ storage and irradiation, $^{99}Tc$ processing, and some transuranic isotope processing.

The LLLW collections from the Isotopes Area account for 17% (5061 gal/month) of the total LLLW collections. The LLLW generation from the Isotopes Area decreased dramatically from 1986 (7466 gal/month) to 1987 (3779 gal/month) and remained approximately at 3800 gal/month in 1988. However, through the first half of 1989, LLLW generation increased to 5232 gal/month due to rainfall inleakage into tanks W-17 and W-18. Collection tanks in the Isotopes Area are WC-10, W-16, W-17, and W-18.

While the Isotopes Area is primarily a production facility, very little LLLW is generated as a direct result of processing activities. Most of the waste production is the result of routine and nonroutine hot cell decontamination. The primary radionuclides expected to be in the waste streams generated from these facilities are $^{137}Cs$ and $^{90}Sr$; however, smaller quantities of many other radionuclides may also be present.

## 2.3 COMPOSITION OF CTD LIQUID LOW-LEVEL WASTE

CTD is the primary contributor of TRU components to the LLLW system. Almost all of the cesium, strontium, and TRU components collected in the LLLW system are generated from Bldg. 3517 and the REDC. Data on the various radionuclides, quantities, and sources for 1988 are shown in Table 2.4. Tables 2.5 and 2.6 summarize the radionuclides generated by the REDC and the Isotopes Area, respectively.

# 3. PROCESS WASTE

## 3.1 SYSTEM DESCRIPTION

Process waste (PW) consists of (1) liquid wastes that are not normally contaminated with radionuclides but have the potential to become contaminated, (2) groundwater that may be slightly contaminated, (3) the condensate from the LLLW evaporator, and (4) liquid wastes that may contain small quantities of metals, anions, and organics. Liquids enter the collection system through many drains throughout ORNL. The majority of the PW then flows through buried clay pipes to storage tanks or ponds. The PW, which is collected in the Bethel Valley Storage Tanks and includes contaminated groundwater, the condensate from the LLLW evaporators, and other process water that is collected primarily from the 3000 area (Isotopes Area and the Reactors), is fed to the PWTP for processing prior to discharge. Wastes from the 4500 area are collected in the 190 ponds, sampled, and then discharged to White Oak Creek if the radioactivity level is below discharge limits. Process wastes from the Melton Valley area are collected in four storage tanks and then discharged to Melton Branch if the level of radioactivity meets the discharge limits. Otherwise, the liquid is pumped to the Bethel Valley Storage Tanks.

The contents of the Bethel Valley Storage Tanks are treated in the Process Waste Treatment Plant (PWTP) to remove radionuclides before release to White Oak Creek. Treatment at the PWTP includes softening, clarification, filtration, and ion exchange. Sludge from the softener is dewatered by filtration and drummed for storage. Contaminated

Table 2.4. CTD radionuclides: Quantities and sources for 1988

| Building/area served | Tank | Nuclide of CTD origin in waste stream | Quantity of nuclide[a] (Ci) | Pretreatment at source | Influenced by rainfall[b] |
|---|---|---|---|---|---|
| Bldg. 3517 | W-22 | Cs-137 | 15,000 | No | Yes |
| | | Sr-90 | 20,000 | | |
| Isotopes Area[c] | WC-10 | | | No | No |
| Bldg. 3029 | | Co-60 | <3 | | |
| | | Cs-137 | <30 | | |
| | | I-129 | <3 | | |
| | | Ir-192 | <3 | | |
| | | Pm-147 | <3 | | |
| | | Sr-90 | <30 | | |
| | | Tc-99 | <3 | | |
| Bldg. 3030 | | Ag-110m | 0.8 | | |
| | | Co-56 | Trace | | |
| | | Co-60 | Trace | | |
| | | Ir-192 | Trace | | |
| | | Ni-63 | Trace | | |
| | | Sr-90 | 1.0 | | |
| Bldg. 3031 | | Eu-152 | Trace | | |
| | | Eu-154 | Trace | | |
| | | Gd-153 | Trace | | |
| Bldg. 3033A | | Am-241 | Trace | | |
| | | Am-243 | Trace | | |
| | | Cf-252 | Trace | | |
| | | Cm-244 | Trace | | |
| | | Pu-239 | Trace | | |
| | | U-235 | Trace | | |
| Bldg. 3038E | | Pu-238 | Trace | | |
| | | U-234 | Trace | | |
| Bldg. 3047 | | Co-60 | Trace | | |
| | | Eu-152 | Trace | | |
| | | Eu-154 | Trace | | |
| | | Gd-153 | Trace | | |

Table 2.4 (continued)

| Building/area served | Tank | Nuclide of CTD origin in waste stream | Quantity of nuclide[a] (Ci) | Pretreatment at source | Influenced by rainfall[b] |
|---|---|---|---|---|---|
| Bldg. 3019 | W-22 | Cs-137 | Trace | No | No |
| | | Sr-90 | Trace | | |
| | | U-233 | 9.6 | | |
| | | U-235 | Trace | | |
| | | U-238 | 6.7E-4 | | |
| 4500 Complex[d] | WC-11 | None | - | No | Yes |
| Bldg. 3026D[e] | W-16 | Co-60 | Trace | No | No |
| | | Fe-55 | Trace | | |
| | | Fe-59 | Trace | | |
| | | Mn-54 | Trace | | |
| Bldg. 3074 | Trucked | Variable | Trace | No | No |
| Bldg. 4501 | WC-14 | Am-241 | Trace | No | No |
| | | Am-243 | Trace | | |
| | | Cs-134 | 0.7 | | |
| | | Cs-137 | 7 | | |
| | | Eu-152 | Trace | | |
| | | Pu-238 | Trace | | |
| | | Pu-239 | Trace | | |
| | | Pu-242 | Trace | | |
| | | Th-232 | 2.2E-6 | | |
| | | U-238 | 3.3E-5 | | |
| Bldgs. 3028W, 3038W | WC-2 | None | - | No | No |
| Bldgs. 7920, 7930[f] | WC-20 | Am-241 | 1.7 | Yes | No |
| | | Am-242 | Trace | | |
| | | Am-243 | 0.1 | | |
| | | Cf-252 | 1.6 | | |
| | | Other Cf | Trace | | |
| | | Cm-244 | 78.2 | | |
| | | Cm-246 | 0.2 | | |
| | | Other Cm | Trace | | |
| | | MFP | 42,000 | | |
| | | Mixed Pu | 0.5 | | |

Table 2.4 (continued)

| Building/area served | Tank | Nuclide of CTD origin in waste stream | Quantity of nuclide[a] (Ci) | Pretreatment at source | Influenced by rainfall[b] |
|---|---|---|---|---|---|
| Bldgs. 4505, 4507[g] | WC-12 | None | - | No | Yes |
| Bldg. 3026C | W-17,18 | H-3 | 1.2E-4 | No | Yes |
| Bldg. 3525 | W-12 | Cs-137 | 50 | No | No |
| | | Kr-85 | Trace | | |
| | | Pu-239 | Trace | | |
| | | Th-232 | Trace | | |
| | | U-233 | Trace | | |
| | | U-235 | Trace | | |
| | | U-238 | Trace | | |

[a]"Trace" quantities are considered to be <1 mCi. Nuclides with half-lives less than 60 d were excluded from this table.

[b]As per statistical analysis.

[c]Isotopes Area includes Buildings 3028E, 3029, 3030, 3031, 3032, 3033, 3033A, 3038E, and 3047.

[d]Buildings 4507, 4505, and 4500N are served by WC-11. Buildings 4505 and 4507 are the responsibility of CTD, while 4500N houses several divisions including, but not limited to, CTD, Analytical Chemistry, and Chemistry.

[e]This facility is scheduled for D&D in the near term.

[f]Total curies of mixed fission products (MFP) assumes one HFIR target campaign (7,000 Ci/year) and one Mark 42 assembly campaign (35,000 Ci/year) annually.

[g]A breakdown of the LLLW charge-back system notes the source of WC-12 waste to be groundwater inleakage pumped from a sump that serves a tank (T-30) known to contain fission products.

Table 2.5. Annual LLLW stream components for the REDC

| Nuclide | Annual quantity (Ci) | Other stream component | Annual quantity (kg)[a] |
|---|---|---|---|
| Am-241 | 1.7 | Acidified butyrates | 1 |
| Am-242 | Trace | Adogen-hydrochloric acid | 24 |
| Am-243 | 0.1 | AMSCO (petroleum naphtha) | 768 |
| Cf-252 | 1.6 | 2,5-dibutylhydroquinone | 1 |
| Cm-244 | 78.2 | Diisoprophylbenzene (DIPB) | 24 |
| Cm-246 | 0.2 | 2-ethylhexanol | 48 |
| MFP | 42,000 | HDEHP extractant | 151 |
| Mixed Pu | 0.5 | Hydrochloric acid | 146 |
| Other Cf | Trace | Lithium chloride | 123 |
| Other Cm | Trace | Lithium nitrate | 1 |
| | | Mercury(II) nitrate | 3 |
| | | Nitric acid | 1 |
| | | Potassium carbonate | 9686 |
| | | Potassium hydroxide | 2089 |
| | | Sodium aluminate | 115 |
| | | Sodium hydroxide | 284 |
| | | Sodium thiosulfate | 1 |

[a]For purposes of this report, "other stream component" quantities are considered to be 1 kg when estimated quantities are less than 1 kg. All others are rounded to the nearest kilogram.

Table 2.6. Annual LLLW stream components for the Isotopes Area

| Nuclide[a] | Annual quantity (Ci) | Other stream component | Annual quantity (kg)[b] |
|---|---|---|---|
| Ag-110m | 0.8 | AHIB (organic acid) | 1 |
| Am-241 | Trace | Ammonium hydroxide | 2 |
| Am-243 | Trace | Citric acid | 11 |
| Cf-252 | Trace | Hydrochloric acid | 2 |
| Cm-244 | Trace | Methyl isobutyl ketone | 1 |
| Co-56 | Trace | Nitric acid | 104 |
| Co-60 | 3 | Oxalic acid | 33 |
| Cs-137 | 30 | Potassium hydroxide | 2 |
| Eu-152 | Trace | Potassium permanganate | 27 |
| Eu-154 | Trace | Sodium hydroxide | 4 |
| Fe-55 | Trace | Sulfurous acid | 90 |
| Fe-59 | Trace | Detergents | 210 |
| Gd-153 | Trace | | |
| H-3 | 1.2E-4 | | |
| I-129 | 3 | | |
| Ir-192 | 3 | | |
| Mn-54 | Trace | | |
| Ni-63 | Trace | | |
| Pm-147 | 3 | | |
| Pu-238 | Trace | | |
| Pu-239 | Trace | | |
| Sr-90 | 30 | | |
| Tc-99 | 3 | | |
| U-234 | Trace | | |
| U-235 | Trace | | |

[a]Nuclides with a half-life less than 60 d were excluded from this table.

[b]For purposes of this report, "other stream component" quantities are considered to be 1 kg when estimated quantities are less than 1 kg. All others are rounded to the nearest kilogram.

solutions from regeneration of the ion exchange columns are either evaporated to about 45% dissolved solids and then transferred to storage tank W-21 at the LLLW evaporator facility or fed to the LLLW evaporator via tank W-22.

### 3.2 CTD WASTE SOURCES AND GENERATORS

CTD is a significant generator of process waste. A schematic of CTD buildings contributing to the PW system is shown in Fig. 3.1. Approximately 9 million gallons of PW are estimated to be produced by the CTD annually by the Liquid and Gaseous Wastes Operations Group of the Environmental and Health Protection Division. The primary process waste generators in the division are:

| | |
|---|---|
| Isotopes Area | 8,100,000 gal/year |
| Bldg. 3026 | 330,000 gal/year |
| Bldg. 3019 | 225,000 gal/year |

Generation of process waste by all CTD facilities in 1988 is shown in Table 3.1. The quantities of process waste produced by CTD, as reported by the Gaseous Waste Operations Group of the Environmental and Health Protection Division and as estimated by the generators, are also listed. It can be seen from these data that the generators are aware of only about 12% of the total process waste chargeable to CTD facilities.

## 4. RADIOACTIVE GASEOUS WASTE

### 4.1 SYSTEM DESCRIPTION

Radioactive gaseous waste at ORNL falls into three basic categories: (1) cell ventilation, (2) process off-gas, and (3) small-scale laboratory-type streams. The cell ventilation category consists of high-volume, low-activity streams from various containment or confinement areas, limited-access areas, and hot cells. These streams are typically filtered by means of roughing and high-efficiency particulate air (HEPA) filters prior to discharge to the environment. The process off-gas category consists of typically low-volume streams from areas where the release of radioactivity may be routine and of

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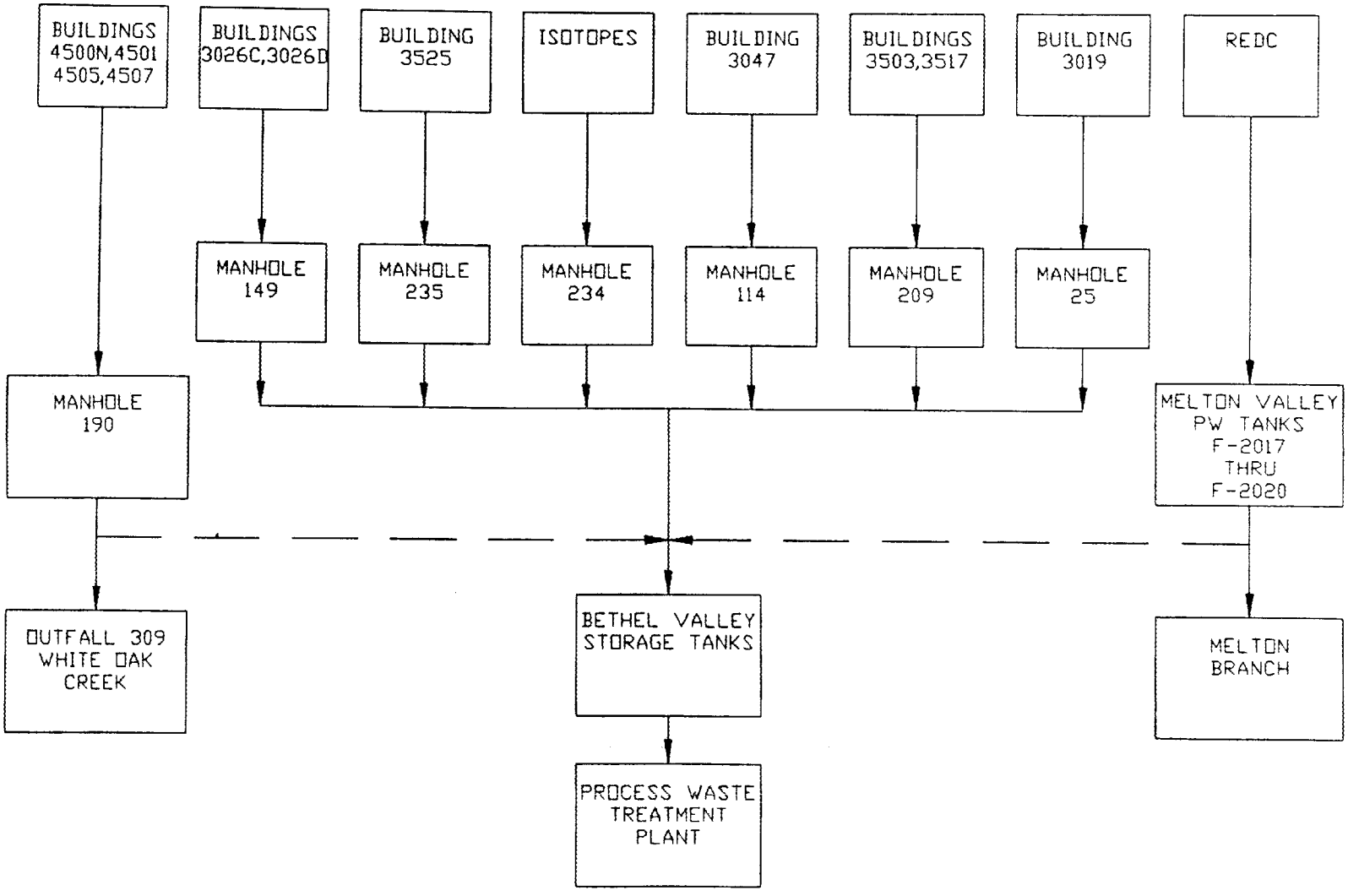


Fig. 3.1. Schematic of CTD PW system.

Table 3.1. CTD PW summary for 1988

| CTD building/area served | Manhole number | Division charged | Percent charged to CTD | 1988 PW generated per Waste Operations (kgal) | PW chargeable to CTD per Waste Operations (kgal) | 1988 estimate by CTD generator (kgal) |
|---|---|---|---|---|---|---|
| Isotopes Area[a] | 234 | CTD | 100 | 8089.47 | 8089.47 | 47.8 |
| Bldgs. 3025,3026[b] | 149 | CTD & M & C | 5 | 6654.14 | 332.71 | 284.7 |
| Bldg. 3019[c] | 25 | CTD | 17.55 | 1279.72 | 224.59 | 36.5 |
| Bldgs. 3505,3517 | 209 | No charge | NA | Not reported | 0.00 | 445.3 |
| Bldgs. 3525,3550 | 235 | Central Management | 0 | 4074.58 | 0.00 | 248.2 |
| Bldg. 3047 | 114 | E & HP | 0 | 1820.47 | 0.00 | 3.7 |
| Total | | | | 21918.38 | 8646.77 | 1066.2 |

[a]Isotopes Area includes Bldgs. 3028, 3029, 3030, 3031, 3032, 3033A, 3038E, and 3038W.

[b]CTD occupies Bldgs. 3026C and 3026D. M & C is now in Bldg. 3025.

[c]Although the Weekly Summary of Liquid Waste Systems reports 24,610 gal based on "historical data," CTD is only charged a fraction of that amount.

relatively high concentration. Since these streams have potentially higher activity and may contain acidic vapors, they are passed through caustic scrubbers or charcoal absorbers in addition to roughing and HEPA filters prior to release. The third type of radioactive gaseous waste consists of small-scale laboratory-type streams that are discharged at the source via HEPA filters and short stacks located above roof level. Cell ventilation and process off-gas streams will be the focus of this report since the majority of the CTD's radioactive gaseous waste falls into one of these two categories.

## 4.2 CTD SOURCES AND GENERATORS

Seven major stacks currently provide for radioactive gaseous waste disposal of cell ventilation and process off-gas streams at ORNL. Of these seven, four (3020, 3039, 7025, and 7911) provide service to CTD. In Bethel Valley, most of the gaseous waste (both cell ventilation as well as process off-gas) from CTD facilities is discharged through the 3039 stack, also called the Central Radioactive Gaseous Disposal Facility. A notable exception is that cell ventilation for Building 3019 is provided by the 3020 stack. The 7025 and 7911 stacks are located in Melton Valley. The 7025 stack provides service for only one building, 7025, which is a CTD facility; the 7911 stack handles gaseous waste from CTD Buildings 7920 and 7930. Table 4.1 summarizes CTD's gaseous waste status by building. As illustrated in the table, most of the CTD gaseous waste sources are in the Isotope Areas.

At present, only the CTD facilities serviced in some capacity by the 3039 stack are charged for gaseous waste disposal. As Table 4.1 demonstrates, 22 CTD facilities are currently serviced in some capacity by the 3039 stack. This represents approximately half of CTD the facilities.

Table 4.1. Summary of CTD radioactive gaseous wastes

| Building | Cell ventilation (3039 Stack)[a] | Process off-gas (3039 Stack)[a] |
|---|---|---|
| Bethel Valley: | | |
| 2024 | No | No |
| 2528 | No | No |
| 2630 | No | No |
| 3017 | No | No |
| 3019 | 3020 Stack | Yes |
| 3021 | No | No |
| 3026 | Yes | Yes |
| 3028 | Yes | Yes |
| 3029 | Yes | Yes |
| 3030 | Yes | Yes |
| 3031 | Yes | Yes |
| 3032 | No | No |
| 3033 | Yes | Yes |
| 3033A | Yes | Yes |
| 3036 | No | No |
| 3037 | No | No |
| 3038 | Yes | Yes |
| 3042 Hot Cells | Yes | Yes |
| 3047 | Yes | Yes |
| 3091 | No | No |
| 3100 | No | No |
| 3113 | No | No |
| 3118 | No | No |
| 3121 | No | Yes |
| 3136 | No | No |
| 3503 | No | Yes[b] |
| 3505 | Yes | Yes[b] |
| 3517 | Yes | Yes |
| 3525 | Yes | Yes |
| 3541 | No | No |
| 3542 | No | No |
| 3543 | No | No |
| 3550 | No | No |
| 3550 Trailer | No | No |
| 3592 | No | Yes[b] |

Table 4.1 (Continued)

| Building | Cell ventilation (3039 Stack)[a] | Process off-gas (3039 Stack)[a] |
|---|---|---|
| 3597 | No | No |
| 4500N | No | Yes |
| 4501 | Yes | Yes |
| 4505 | Yes | Yes |
| 4507 | Yes | Yes[b] |
| 4556 Filter Pit | Yes | No |
| Melton Valley: | | |
| 7025 | 7025 Stack | 7025 Stack |
| 7920 | 7911 Stack | 7911 Stack |
| 7930 | 7911 Stack | 7911 Stack |
| 7933 | No | No |
| 7957 Trailer | No | No |

[a]Unless otherwise indicated.

[b]Not used.

# 5. SOLID WASTE

## 5.1 SYSTEM DESCRIPTION

Solid waste at ORNL is classified as (1) radioactive, (2) hazardous/mixed, or (3) conventional (Bates et al. 1988). Category 1 is further distinguished as low-level waste (LLW) or transuranic waste. LLW is presently collected in designated receptacles throughout ORNL, and disposal is by shallow-land burial. Several disposal techniques are being implemented to provide greater confinement of the radionuclides buried onsite. TRU waste management is presently based on retrievable-storage technology in preparation for eventual shipment to the Waste Isolation Pilot Plant.

Hazardous/mixed waste is covered in Sect. 6 of this document. Conventional wastes are those wastes which are not radioactively contaminated or chemically hazardous. They include materials such as construction debris and general refuse collected in trash cans and dumpsters around the site. These wastes are taken to the Y-12 Sanitary Landfill for disposal and will not be considered in this report.

## 5.2 CTD WASTE SOURCES AND GENERATORS AND WASTE COMPOSITION

Estimates of the solid LLW generated in CTD in 1988 are summarized in Tables 5.1 and 5.2. A breakdown by building and isotope is given in Table 5.1, and the total quantity of each isotope is summarized in Table 5.2. The CTD facilities producing the greatest amount of radioactive solid waste in 1988 were:

| | | |
|---|---|---|
| Isotopes | (Bldg. 3029) | 4460 Ci |
| | (Bldg. 3047) | 4200 Ci |
| FPDL | (Bldg. 3517) | 3520 Ci |
| Bldg. 3019 | | 170 Ci |

All other buildings/facilities produced less than 100 Ci of solid LLW in 1988.

The isotope in greatest abundance in the CTD solid LLW for 1988 was $^{137}Cs$ (4100 Ci), followed by $^{152}Eu$ (2690 Ci), $^{192}Ir$ (2230 Ci), $^{90}Sr$ (1830 Ci), and $^{154}Eu$ (1370 Ci). All other isotopes were 100 Ci ($^{60}Co$) or less. The amount of solid LLW disposed of in the burial grounds at ORNL

Table 5.1. CTD solid LLW for 1988

| Location | Isotope | Radioactivity (Ci) |
|---|---|---|
| Building 2528 | U-238 | <0.1 |
| Building 3019 | Am-241 | 0.1 |
| | C-14 | <0.1 |
| | Cm-244 | <0.1 |
| | Cs-137 | 34.1 |
| | Eu-154 | 0.1 |
| | Gd-153 | 0.1 |
| | I-125 | <0.1 |
| | Ir-192 | <0.1 |
| | Pm-147 | 48.0 |
| | Pu-239 | 0.4 |
| | Pu-241 | <0.1 |
| | Sr-90 | 42.0 |
| | Th-232 | <0.1 |
| | U-233 | 2.3 |
| | U-234 | <0.1 |
| | U-235 | <0.1 |
| | U-238 | <0.1 |
| | Y-90 | 42.0 |
| Building 3028 | Cm-244 | <0.1 |
| | Cs-137 | 0.1 |
| | I-131 | <0.1 |
| | Ir-192 | 0.1 |
| | Pm-147 | <0.1 |
| | Pu-239 | <0.1 |
| | Sr-90 | <0.1 |
| | Tc-99 | <0.1 |
| Building 3029 | C-14 | <0.1 |
| | Cm-244 | <0.1 |
| | Cs-137 | 2230.2 |
| | Eu-152 | <0.1 |
| | Ir-192 | 2230.3 |
| | Ni-63 | <0.1 |
| | Sr-90 | <0.1 |
| | Tc-99 | <0.1 |

Table 5.1. (continued)

| Location | Isotope | Radioactivity (Ci) |
|---|---|---|
| Building 3030 | Ag-110m | 0.1 |
| | Ag-111m | 1.1 |
| | Bi-207 | 0.5 |
| | Cs-137 | 0.3 |
| | Gd-153 | 0.3 |
| | Ir-192 | 1.6 |
| | Pd-103 | 1.5 |
| | Pd-107 | 0.1 |
| | Sr-90 | 5.5 |
| | Y-90 | 9.0 |
| Building 3031 | Eu-152 | 0.2 |
| | Ni-63 | 0.1 |
| Building 3037 | Cs-137 | <0.1 |
| | Sr-90 | <0.1 |
| Building 3038 | Am-241 | <0.1 |
| | Cm-244 | <0.1 |
| | H-3 | <0.1 |
| | Np-237 | <0.1 |
| | Pu-238 | 0.1 |
| | Sr-90 | 8.2 |
| | Y-90 | 0.4 |
| Building 3047 | C-14 | <0.1 |
| | Co-60 | 100.0 |
| | Cs-137 | 6.7 |
| | Eu-152 | 2693.2 |
| | Eu-154 | 1374.2 |
| | Gd-153 | <0.1 |
| | Sr-90 | 11.7 |
| | Zn-65 | 15.0 |
| Building 3503 | Cs-137 | <0.1 |
| | Sr-90 | <0.1 |
| | Th-232 | <0.1 |
| | U-238 | <0.1 |
| Building 3505 | Am-241 | <0.1 |
| | Cs-137 | 0.4 |
| | Pu-239 | <0.1 |
| | Sr-90 | 0.4 |
| Building 3517 | Cs-137 | 1760.6 |
| | Sr-90 | 1766.1 |
| | U-233 | <0.1 |

Table 5.1. (continued)

| Location | Isotope | Radioactivity (Ci) |
|---|---|---|
| Building 3525 | Cs-137 | 62.0 |
| | Sr-90 | 0.1 |
| Building 3541 | Cs-137 | <0.1 |
| | Sr-90 | <0.1 |
| Building 3542 | Tc-99 | <0.1 |
| Building 3543 | U-238 | <0.1 |
| Building 4500N | U-238 | <0.1 |
| Building 4501 | Cs-134 | 0.7 |
| | Cs-137 | 1.3 |
| | Pu-239 | 2.0 |
| | U-235 | <0.1 |
| | U-238 | <0.1 |
| Building 4505 | H-3 | <0.1 |
| | U-238 | 0.1 |
| Building 4507 | Cs-134 | <0.1 |
| | Cs-137 | <0.1 |
| Building 7025 | U-235 | <0.1 |
| Building 7920 | Cf-252 | <0.1 |
| | Cm-244 | 0.1 |
| | Pu-239 | <0.1 |
| Building 7930 | Cf-252 | <0.1 |

Table 5.2. CTD solid LLW for 1988 summarized by nuclide

| Nuclide | Radioactivity (Ci) |
|---|---|
| Ag-110m | 0.1 |
| Ag-111m | 1.1 |
| Am-241 | 0.1 |
| Bi-207 | 0.5 |
| C-14 | <0.1 |
| Cf-252 | <0.1 |
| Cm-244 | 0.1 |
| Co-60 | 100.0 |
| Cs-134 | 0.7 |
| Cs-137 | 4095.7 |
| Eu-152 | 2693.4 |
| Eu-154 | 1374.3 |
| Gd-153 | 0.4 |
| H-3 | <0.1 |
| I-125 | <0.1 |
| I-131 | <0.1 |
| Ir-192 | 2232.0 |
| Ni-63 | 0.1 |
| Np-237 | <0.1 |
| Pd-103 | 1.5 |
| Pd-107 | 0.1 |
| Pm-147 | 48.0 |
| Pu-238 | 0.1 |
| Pu-239 | 2.4 |
| Pu-241 | <0.1 |
| Sr-90 | 1834.0 |
| Tc-99 | <0.1 |
| Th-232 | <0.1 |
| U-233 | 2.3 |
| U-234 | <0.1 |
| U-235 | <0.1 |
| U-238 | 0.1 |
| Y-90 | 51.4 |
| Zn-65 | 15.0 |

is between 12,000 and 20,000 Ci annually (Baldwin 1989). It should be noted that this total is exclusive of any solids produced by solidification campaigns. The amount of solid LLW disposed of by CTD is on the order of 12,000 Ci annually. Thus, CTD accounts for the majority of all solid LLW buried at ORNL. In terms of the gross volume of solid LLW buried at ORNL, CTD accounted for approximately 56% in 1988.

# 6. HAZARDOUS/MIXED WASTE

## 6.1 SYSTEM DESCRIPTION

Hazardous waste is corrosive, reactive, toxic, or ignitable as defined in 40 CFR 261. A waste will also be classified as hazardous if it is included in the extensive list of hazardous materials in 40 CFR 261. Hazardous wastes are subject to cradle-to-grave manifest systems; detailed records must be kept to track the waste from its origin to its ultimate disposal.

Mixed wastes are LLW that also contain a hazardous component. At ORNL, mixed wastes are presently being packaged and stored until regulations are clarified to allow its disposal.

## 6.2 CTD WASTE GENERATORS AND SOURCES AND WASTE COMPOSITIONS

Data summarizing the generation rates of hazardous waste by CTD in 1988, tabulated by section, are presented in Table 6.1. Both quantities and disposal costs are shown. The total amount of hazardous waste disposed of by CTD in 1988 was 20,719 lb at a cost of $27,000.

The greatest amount of wastes were contributed by the CDS (8,100 lb, ~$10,500; 39% of total mass and 38% of total cost) and the PDS (7400 lb, ~$9,600; 36% of total mass and 35% of total cost). Only the EC&A section had no hazardous waste disposal during this period.

Disposal of hazardous waste during the first 6 months of 1989 has increased dramatically over the levels of 1988. Table 6.2 summarizes the hazardous waste generation by the individual sections of CTD from January through June 1989. Both quantity and cost data are shown. The total disposal for CTD during this period was about 13,600 lb of waste

Table 6.1. CTD hazardous waste generation for 1988

| Section | Weight (lb) | Disposal cost ($) |
|---|---|---|
| CDS | 8,094.49 | 10,526.11 |
| EDS | 3,199.85 | 5,247.25 |
| ERP | 134.17 | 559.98 |
| IS | 242.33 | 239.60 |
| PDS | 7,397.59 | 9,614.70 |
| RSMS | 1,616.77 | 1,342.64 |
| WMTSG | 34.43 | 61.97 |
| Total | 20,719.63 | 27,592.25 |

Table 6.2. CTD hazardous waste generation for January-June 1989

| Section | Weight (lb) | Disposal cost ($) |
|---|---|---|
| CDS | 2,178.11 | 4,845.65 |
| EDS | 308.62 | 619.06 |
| ERP | 908.46 | 2,079.39 |
| IS | 4,159.70 | 9,647.56 |
| PDS | 5,651.90 | 13,516.95 |
| RSMS | 375.00 | 507.45 |
| WMTSG | 36.03 | 340.87 |
| Total | 13,617.82 | 31,556.93 |

classified as hazardous at a cost of approximately $31,557. The reason for the increase in hazardous waste generation and disposal during 1989 is probably related to TSA preparation activities and disposal of old, unwanted chemicals.

## 7. CONCLUSIONS AND RECOMMENDATIONS

Upon review of the data presented in this report, several waste reduction projects are immediately obvious. The specific project recommendations will be summarized in terms of the type of waste-collection system.

### 7.1 GENERAL PROJECT RECOMMENDATIONS

A data base should be created that tracks the generation and final disposal of all waste generated in CTD. Also, a team should be appointed to analyze the data and recommend waste-reduction projects.

Currently, waste-generation data are very difficult to obtain through the central waste data bases. In fact, the data presented in this report represent approximately 9 man-months of effort. A CTD waste-generation data base would require approximately 3 to 4 man-months to program and approximately 2 to 3 man-months per year to update and maintain. A network of area waste-information coordinators would have to be appointed to aid in data acquisition and coordination of waste reduction projects in each section or area. These coordinators would be responsible for providing data to the data-base effort and coordinating waste-reduction projects in their respective areas.

Once the data base is complete, a technical review team needs to be appointed to systematically review the CTD waste-generation data and evaluate, both economically and technically, waste-reduction opportunities in CTD.

A second general need to be addressed is that of improved decommissioning and decontamination (D&D) technology. Waste generated from D&D activities throughout the division will increase in future years, and systems need to be developed to allow a minimal volume of

waste to be generated from these operations. Decontaminating only one facility could generate 50,000 gal of LLLW (Abraham et al., 1989) with a resulting cost of $300,000 (in 1988 dollars). It is estimated that for only $400,000 (Mason, 1989), a liquid-recycle decontamination system could be demonstrated at ORNL.

## 7.2 LIQUID LOW-LEVEL WASTE PROJECTS

The LLLW produced by CTD is primarily derived from two sources, the FPDL and the REDC. In 1988, the cost of LLLW disposal from these two areas totaled approximately $340,000. A technical team needs to be appointed to study the applicability of source-treatment technologies at these facilities. Technical alternatives for source treatment and the cost associated with each option will need to be defined.

## 7.3 PROCESS WASTE

CTD personnel can account for only 12% of the process waste that is currently billed to the division. A team needs to be appointed to identify process waste sources in the division and minimize the process waste discharged to the process waste system. This effort will require approximately a 6-man-month effort. If only one-half of the process waste generation is eliminated from the Isotopes Area, a savings of approximately $250,000 could be realized annually.

## 7.4 GASEOUS WASTE

The only way to reduce the gaseous-waste emissions from CTD facilities is to eliminate buildings from the central off-gas system. A management team needs to be formed to study the status of each CTD building and determine whether elimination of its off-gas systems would be feasible and could be safely achieved.

# 8. REFERENCES

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