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INTEGRATED DATA BASE: STATUS AND WASTE PROJECTIONS

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ABSTRACT

The Integrated Data Base (IDB) is the official U.S. Department of Energy (DOE) data base for spent fuel and radioactive waste inventories and projections. As such, it should be as convenient and available to utilize as is practical. DOE low-level waste (LLW) is just one of the many waste types that are documented with the IDB. Summary-level tables and figures are presented illustrating historical and projected volume changes of DOE LLW. This information is readily available through the annual IDB publication. Other presentation formats are also available to the DOE community through a request to the IDB Program.

INTRODUCTION

The Integrated Data Base (IDB), a U.S. Department of Energy (DOE) Program jointly sponsored by the Office of Environmental Restoration and Waste Management and the Office of Civilian Radioactive Waste Management, maintains the official data base for spent fuel and radioactive waste inventories and projections through the year 2020. The purpose of the IDB Program is to create and maintain a reliable baseline of quality data and information to be used for national program planning, decision making, and other management activities. As the official data base for the DOE, the IDB is readily available to the DOE community and to DOE-sponsored contractors.

The IDB Program provides access to information on spent fuel and radioactive waste inventories and characteristics, including volume and/or mass, age, radioactivity, heat generation, chemical and physical properties, location, packaging, and nuclide composition. Utilizing a modular system of computer codes, the IDB also provides projections based on anticipated growth rates, schedules for new facilities, waste generation factors, and treatment assumptions. Projections for commercial waste are based on official Energy Information Administration (EIA) electrical growth projections.

The program's annual report, *Integrated Data Base for 19XX: U.S. Spent Fuel and Radioactive Waste Inventories and Projections* (1), presents summary-level tables and figures and compare volumes and radioactivity of all forms of spent fuel and radioactive waste [high-level waste (HLW), transuranic (TRU) waste, low-level waste (LLW) and mixed waste]. These materials are generated by commercial fuel cycles [including decontamination and decommissioning (D&D) activities, defense programs, remedial action programs, and institutional and industrial operations.

Figure 1 illustrates the primary sources of data that are included in the IDB. A major program function is to translate the various inputs from the numerous sources into a common and internally consistent data base. Data are collated and integrated to ensure that all forms are counted once and only once.

The IDB Program encompasses three major technical areas: data collection and processing, calculation of isotope generation and depletion, and data base

development and user access. The steps involved in the flow of data from input to output, including data processing, are shown in Fig. 2.

The usefulness of the IDB is inherent in its summation tables and figures, in which data for all waste forms are listed and displayed in a self-consistent manner. For example, Fig. 3 presents the radioactivities of commercial and DOE/defense wastes and spent fuel accumulated through 1988 in a pie chart that provides a clear pictorial overview of the relative amounts of this country's radioactive wastes. It is apparent that, on a radioactivity basis, spent fuel dominates the total. In Fig. 4, the volumes of the same wastes are presented in a similar fashion. On this basis, LLW comprises more than 85% of the volume to be disposed. It is obvious from these two figures why spent fuel and LLW are the major areas of concern in recent discussions on the storage and disposal of radioactive waste. With DOE/defense LLW comprising over half this country's total radioactive waste, it is also readily apparent why a complete session is here being dedicated to the DOE Low-Level Radwaste Program.

DOE/DEFENSE LOW-LEVEL WASTE

As used in this paper, LLW means those radioactive wastes containing source, special nuclear, or by-product materials that are acceptable for disposal in a land disposal facility. This definition is the same as that in 10 CFR 61.2 which specifies that LLW is radioactive waste not classified as HLW, TRU waste, spent nuclear fuel, or by-product material specified as uranium or thorium tailings and waste. The nuclear accelerator-generated radioactive materials (NARM) and naturally occurring radioactive materials (NORM) that are disposed of at a DOE site are not broken out as separate entities. Mill tailings and "mixed" waste that contains chemically hazardous constituents as well as radioactivity are treated separately. Mixed waste will be mentioned briefly later in this paper. The DOE generates LLW through defense activities, uranium enrichment operations, the naval nuclear propulsion program, and various research and development (R&D) activities.

Prior to October 1979, some LLW generated by DOE contractors was shipped to commercial disposal sites. Currently, all LLW generated by DOE/defense activities is buried at DOE sites (Figs. 5 and 6). For a summary of historical additions and accumulated volumes of solid LLW buried at all DOE sites through 1988 see Tables 1 and 2. Table 2 specifically provides a breakout of the historical disposals at the DOE sites. The data in these tables are derived from information provided by the National LLW Management Program (2).

There are small quantities of DOE/defense LLW that have been disposed of by sea dumping or by hydrofracture. These wastes are not included in the tables and figures presented here. Sea dumping of LLW was halted by the United States in 1970 and hydrofracture in 1983. In all, some 89,000 waste containers were buried at sea and 17,000 cubic meters of grout injected in the hydrofracture facility.

Representative data for buried DOE/defense LLW are given for each site according to physical characteristics in Table 3. This information is obviously somewhat subjective, and the significant places of the data do not reflect the accuracy of the percentages.

The projections developed for the generation of DOE/defense LLW are reviewed annually by the LLW generators. These projections are applied to current operating conditions, any changes in mission, and evolutionary developments in LLW handling technology to develop near-term LLW generation

forecasts. The forecasts are stated in terms of volume and waste type and represent the levels of LLW generation anticipated for the next year. One of the assumptions used in this report is that the level of DOE/defense waste burial activities will remain approximately constant through 2020. Low-activity waste stream projections for burial of DOE/defense LLW are presented in Table 1. Not included are the drums of cemented LLW to be generated at West Valley as a result of the vitrification of HLW or the grout-immobilized LLW derived from processing double-shell waste at Hanford. These wastes are excluded from the projections because the schedule and formulation for solidification are not yet firmly defined.

As a guide to the accuracy of the annual projections of DOE LLW, Table 4 presents the annual projected LLW generation rates for the last nine editions of the IDB Program's annual inventory report. Also included are the actual amounts buried for that year from the next year's report. Generally, actual buried LLW volumes have been within 30% of projections; however, for the last three year's actual values have narrowed to within 10% of projected numbers. It is optimistic assumption that this indicates the accuracy of LLW projections for the DOE sites has been steadily increasing.

DOE MIXED LOW-LEVEL WASTE

Mixed LLW includes mixtures low-level radioactive materials and (chemically and/or physically) hazardous materials. The hazardous components of all mixed wastes are subject to the Resource Conservation and Recovery Act (RCRA), as amended (3), which is administered by the Environmental Protection Agency (EPA). Thus, the treatment, handling, and disposal of mixed wastes are subject to he regulations of the EPA (4), as well as those of DOE. For this reason, mixed LLW is considered separately from the purely radioactive LLW discussed earlier. Inventories of mixed LLW presently stored at DOE sites are in the process of being thoroughly characterized. As a result, the waste at some sites could require reclassification, thereby causing significant changes in the inventories reported.

Typically, mixed LLW at DOE sites includes a broad spectrum of contaminated materials, such as air purifiers, cleaning solutions and cleanup materials, engine oils and grease, epoxies and resins, gravel, laser dyes, paint residues, photographic materials, soils, asphalt, roofing compounds and wall materials, water treatment chemicals, and decommissioned weapons manufacturing chemicals.

Currently, generic characterization of mixed wastes is difficult, but general categories of mixed wastes based on their hazardous compounds, as regulated by the EPA, include the following:

- Ignitable materials including liquids with a flashpoint of 60°C or less.
- Corrosive materials including acids, bases, and crystalline solids.
- EP toxic materials: solids and liquids, designated by the EPA in Subpart C (Part 261.24) of ref. 5 as being toxic.
- Spent solvents: polychlorinated compounds listed in Subpart D (Part 261.31) of ref. 5.
- Spent solutions of sludges as specified in Subpart D of ref. 5, including various plating waste sludges.
- Discarded chemicals as specified in Subpart D (Part 261.33) of ref. 5, including discarded chemical products which are container and spill residues.
- Polychlorinated biphenyls (PCBs).

DOE site mixed LLW cumulative volume inventories are reported in Table 5. Values do not reflect any treatment that may occur prior to or subsequent to interim storage. Until recently, many DOE sites have tracked and reported their mixed waste streams in mass unit. However, for disposal considerations, DOE is now requiring these sites to report their mixed waste inventories in units of (packaged) disposal volume.

CONCLUSION

In summary, the IDB provides, in a wide variety of formats, technical information of LLW and mixed LLW in terms of inventories, projections, and characteristics. This information is useful in various programmatic planning exercises and in response to requests for data by DOE, state and local governments, and interested third parties.

As the IDB is the official DOE data base, it would behoove those with the DOE community to utilize the IDB as much as is practical. This is especially true of those doing waste analysis in the present critical time frame. Frequently, more complex data bases than the IDB are needed, but in these cases, it would also be necessary to ensure that, at the very least, consistency is maintained between data bases. Even for those outside the official DOE community, it would seem reasonable that any analysis or independent assessment should be undertaken from the same initial starting point. This can easily be accomplished by referencing the IDB.

REFERENCES

1. U.S. Department of Energy, *Integrated Data Base for 1989: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, DOE/RW-0006, Rev. 5, Oak Ridge National Laboratory, Oak Ridge, Tennessee, Nov. 1989.

2. U.S. Department of Energy, Solid Waste Information Management System (SWIMS), electronic transmission from computerized data base maintained by the Waste Reduction Operations Complex at EG&G/Idaho, Inc, Idaho Falls, Idaho, to A. H. Kibbey, Oak Ridge National Laboratory, Oak Ridge, Tennessee, Aug. 24, 1989.

3. U.S. Congress, Resource Conservation and Recovery Act of 1979, Pub. L. 94-580, Oct. 21, 1976, as amended by the Hazardous and Solid Waste Amendments Acts of 1984, Pub. L. 98-616, Nov. 9, 1984.

4. U. S. Environmental Protection Agency, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, 40 CFR Part 261, Subparts C and D, 1986.

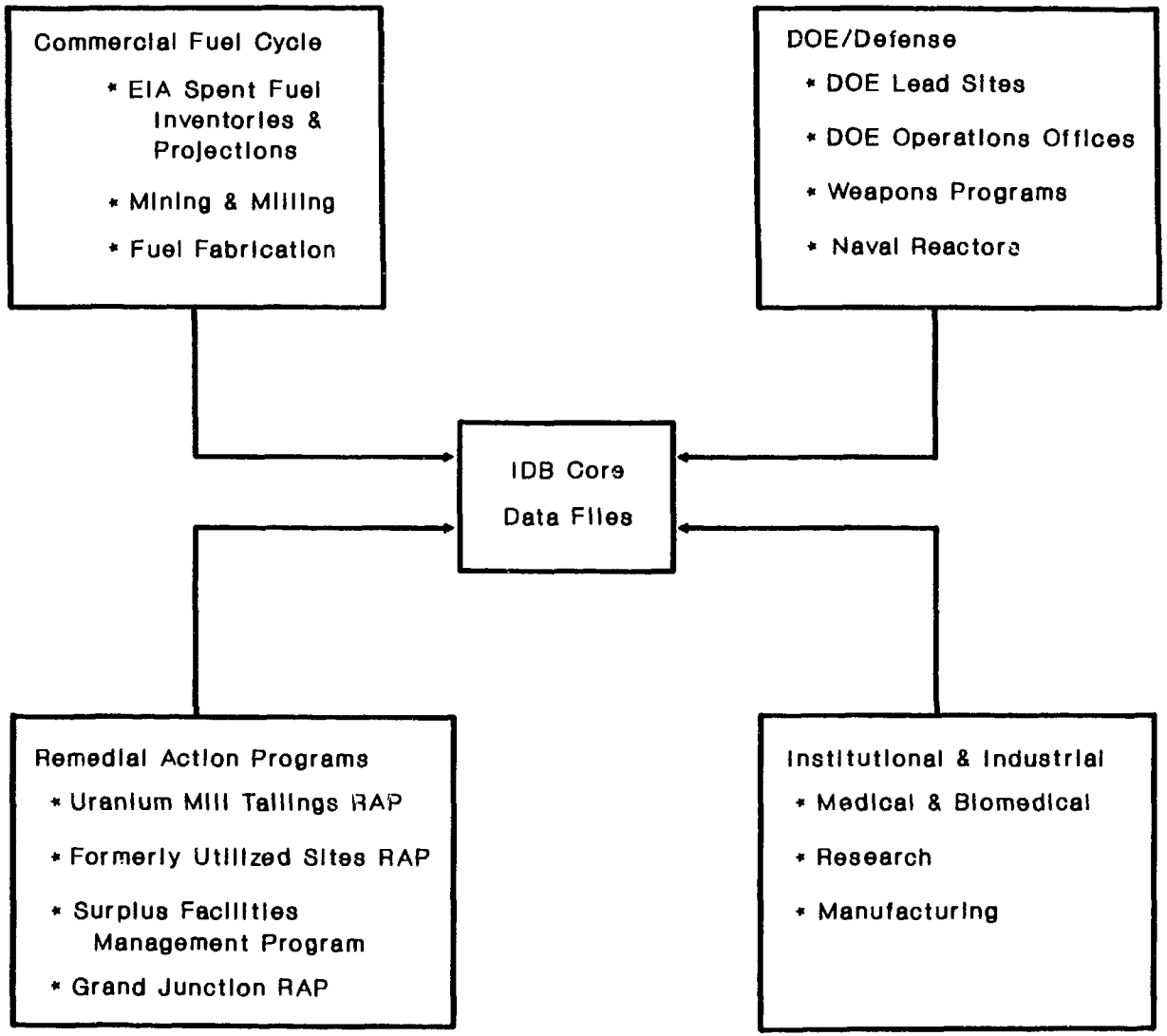


Fig. 1. Sources of IDB data.

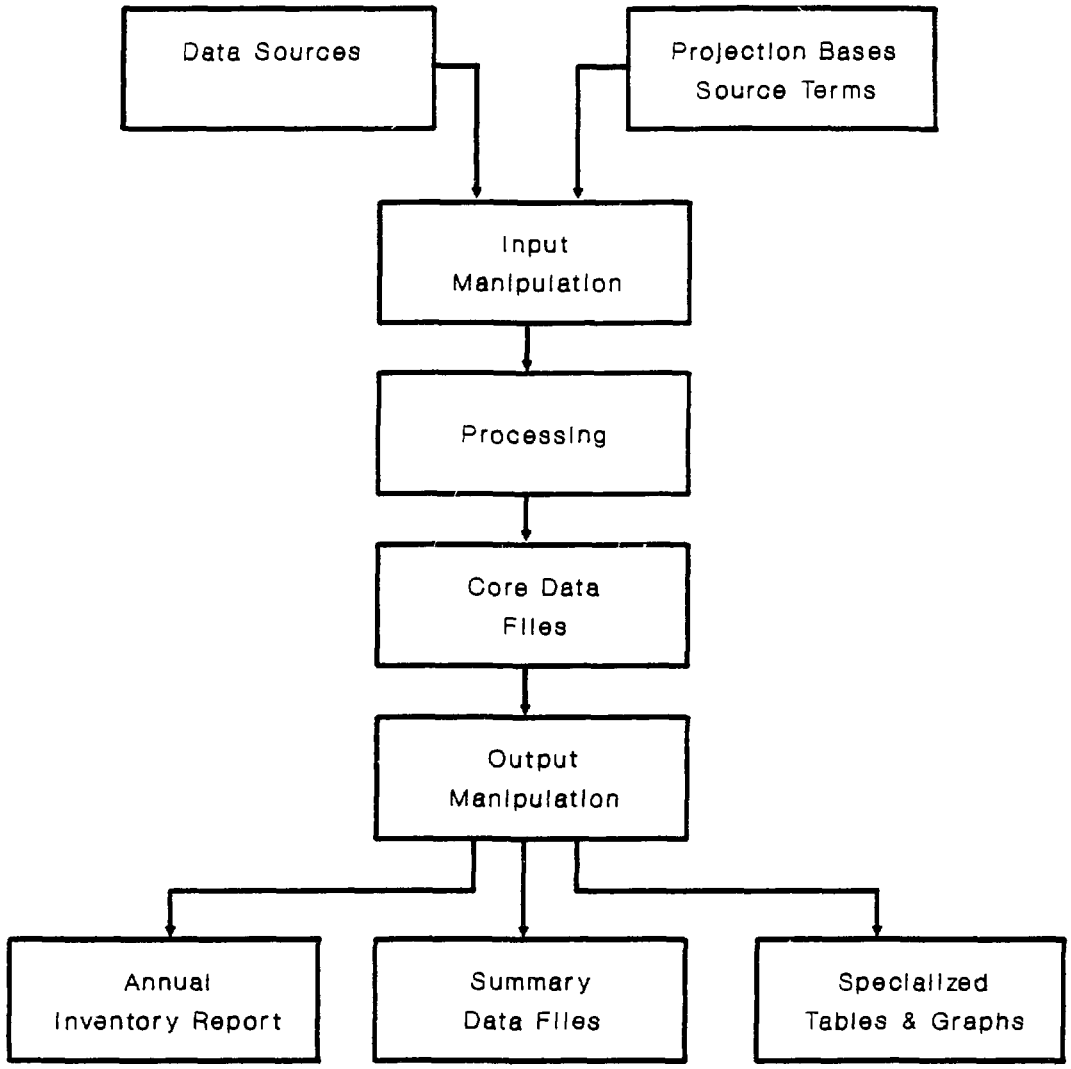
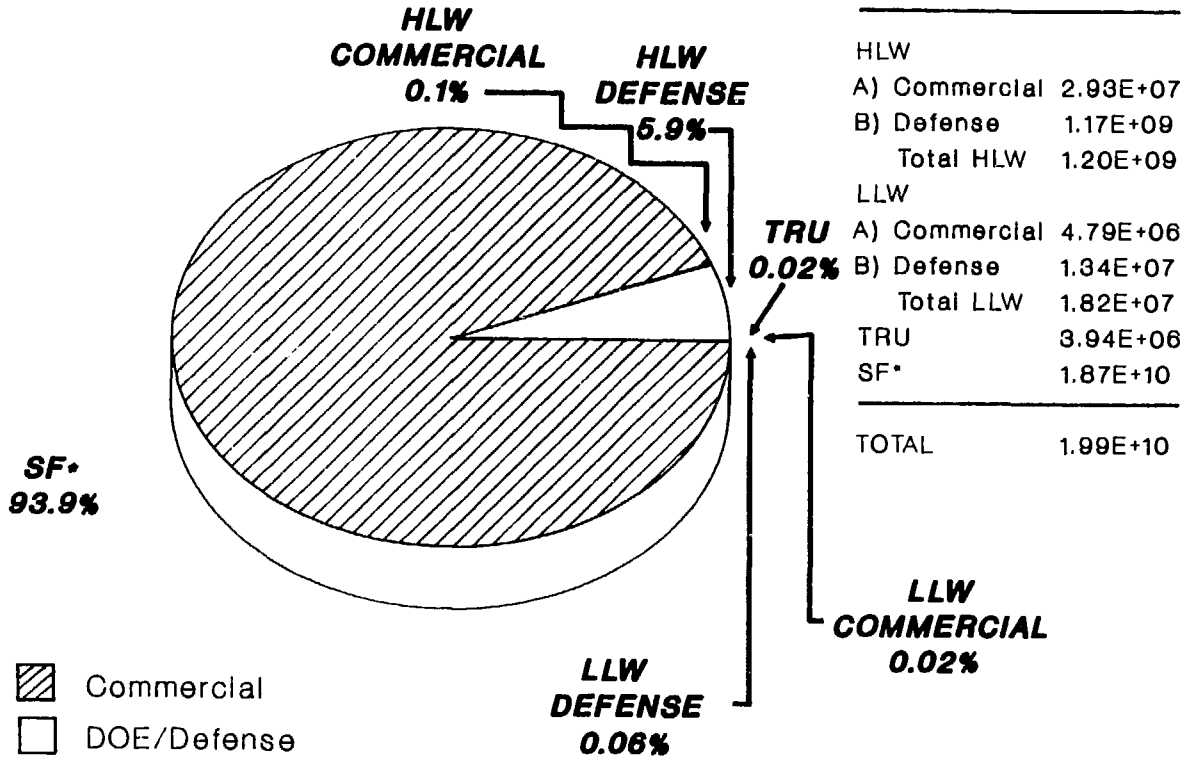


Fig. 2. Data manipulation in the IDB Program.

ORNL DWG 89-7964

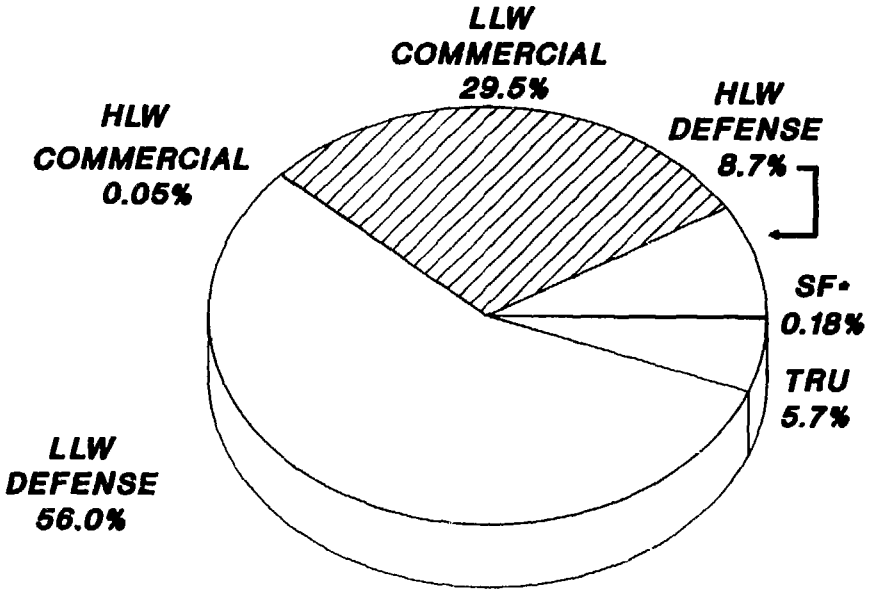


WASTE	CURIES
HLW	
A) Commercial	2.93E+07
B) Defense	1.17E+09
Total HLW	1.20E+09
LLW	
A) Commercial	4.79E+06
B) Defense	1.34E+07
Total LLW	1.82E+07
TRU	3.94E+06
SF*	1.87E+10
TOTAL	1.99E+10

*Does not include DOE/Defense spent fuel to be reprocessed.

Fig. 3. Radioactivities of commercial and DOE/defense wastes and spent fuel accumulated through 1988.

ORNL DWG 89-7963



WASTE	CUBIC METERS
HLW	
A) Commercial	2.13E+03
B) Defense	3.83E+05
Total HLW	3.85E+05
LLW	
A) Commercial	1.30E+06
B) Defense	2.47E+06
Total LLW	3.77E+06
TRU	2.51E+05
SF*	7.97E+03
TOTAL	4.41E+06

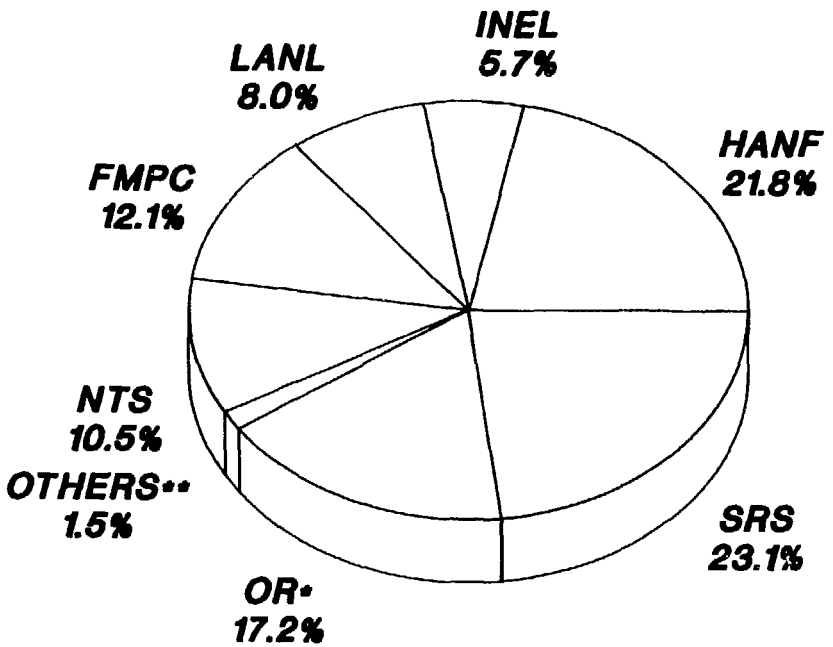
Commercial

DOE/Defense

*Includes spacing between fuel assembly rods.
Does not include DOE/Defense spent fuel to be reprocessed.

Fig. 4. Volumes of commercial and DOE/defense wastes and spent fuel accumulated through 1988.

ORNL DWG 89-7986

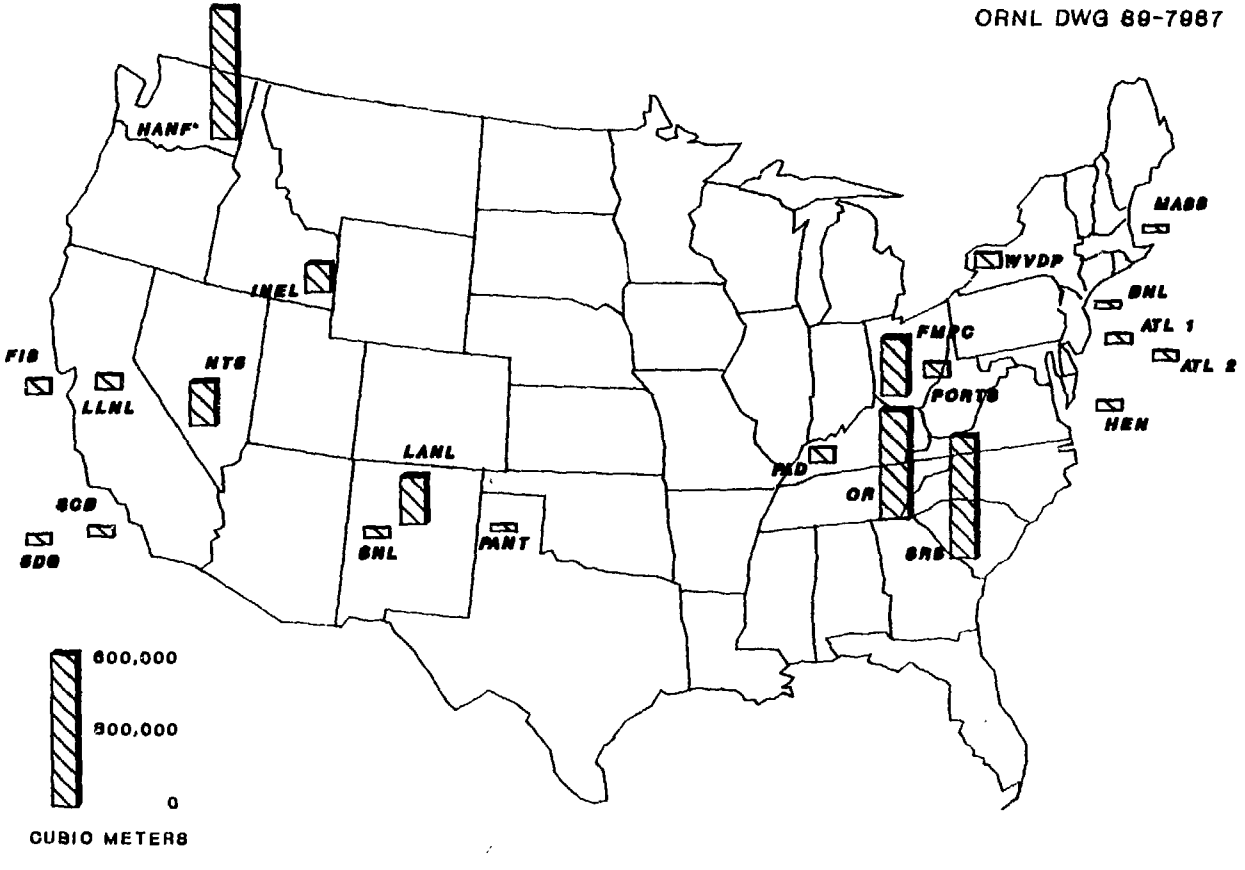


SITE	CUBIC METERS
HANF	5.40E+05
INEL	1.42E+05
LANL	1.99E+05
FMPC	2.99E+05
NTS	2.59E+05
OR*	4.25E+05
SRS	5.72E+05
OTHERS**	3.67E+04
TOTAL	2.47E+06

*Includes contributions from ORNL, Y-12, and ORGDP.

**Includes contributions from PANT, SNL, LLNL, BNL, PAD, PORTS, and WVDP.

Fig. 5. Total volume of buried DOE/defense LLW through 1988.



*1988 data is being updated.

Fig. 6. Locations and total volumes of buried DOE/defense LLW through 1988.

Table 1. Historical and projected volume and radioactivity of DOE/defense LLW

End of calendar year	Volume (10^3 m^3)		Radioactivity (10^3 Ci)	
	Annual rate	Accumulation	Annual rate	Accumulation
1980	57.8	1,948	442	9,250
1985	121.2	2,185	1,009	12,165
1988	90.2	2,472	809	13,416
1990	156.4	2,728	1,488	14,286
1995	155.1	3,498	1,497	16,110
2000	140.6	4,250	1,483	17,564
2005	138.5	4,991	1,494	18,776
2010	116.6	5,591	1,491	19,722
2015	129.8	6,246	1,490	20,526
2020	122.3	6,869	1,486	21,172

Table 2. Historical annual additions and total volume of LLW buried at DOE/defense sites

Year	Volume of waste buried annually, 10^3 m^3										
	LANL	INEL	NTS	ORNL	HANF	SRS	FMPC	Y-12	All other[a]	Total annual addition	Total volume accumulated
1975[b]	131.6	85.2	8.3	181.5	349.9	269.1	264.8	58.4	81.5	1,430.3	1,430
1976	8.8	6.2	2.9	3.8	4.7	8.1	14.4	2.7	0.9	52.6	1,483
1977	3.6	6.5	0.9	2.4	10.8	14.7	2.8	1.5	1.1	44.3	1,527
1978	7.5	6.7	13.0	2.0	9.9	15.5	1.9	1.4	3.2	61.1	1,588
1979	4.9	5.3	34.0	2.1	15.8	18.2	1.6	1.1	1.1	84.1	1,672
1980	4.8	5.1	12.4	2.0	10.6	19.6	1.3	1.4	0.7	57.8	1,730
1981	5.5	3.1	14.6	1.4	12.9	20.1	1.5	1.2	1.5	61.9	1,792
1982	4.5	3.0	39.2	1.3	11.7	22.4	2.8	2.2	2.6	89.7	1,882
1983	3.2	5.4	26.6	1.8	18.0	26.7	3.4	3.4	2.8	91.3	1,973
1984	5.4	3.8	12.1	2.2	18.7	26.1	3.5	7.2	11.6	90.6	2,064
1985	6.7	3.1	39.4	2.2	17.0	30.5	0.6	18.7	3.0	121.2	2,185
1986	4.5	3.4	17.9	1.8	21.2	30.1	0	15.0	3.0	96.9	2,282
1987	3.7	3.0	19.5	0.5	21.5	34.2	0	16.2	0.9	99.5	2,382
1988	4.3	2.0	18.5	0.6	16.7	36.7	0	10.5	1.0	90.2	2,472
Total	199.0	141.8	259.3	205.6	539.5	571.9	298.5	140.8	115.3	2,472.	

[a]Includes ORGDP, PAD, PORTS, PANT, SNL, LLNL, BNL, and WVDP.
[b]Values for 1975 are cumulative volumes to this date.

Table 3. Physical characteristics of LLW generated by major DOE/defense sites for 1984–1988

Generation site	Relative waste volumes, % of total						
	Biological	Contaminated equipment	Decontamination debris	Dry solids	Solidified sludge	Other	Total
LANL	0	0.63	1.00	2.75	0.14	0.01	4.54
INEL	0	0.53	0.17	2.39	0.09	0	3.15
NTS	0	0.11	1.57	21.72	0.03	0	23.43
ORNL	0.02	0.39	0.44	0.75	0.05	0.07	1.73
HANF	0	0	0	0	0	14.52	14.52
SRS	0	8.99	0	18.66	0	0	27.65
ANL	0	0	0.16	1.67	0	0	1.87
LLNL	0	0.39	0.12	0.65	0.11	0	1.27
SNL	0	0.07	0.02	0.03	0	0.15	0.26
FMPC	0	0	0	2.96	0.42	0	3.38
RFP	0	0	0	4.60	0.39	0	4.99
MOUND	0	0	0	4.16	0.23	0	4.39
ORGDP	0	0.06	0	0	0	0	0.06
Y-12	0	0	0	0	0	4.79	4.79
PNRO	0	0.46	0.19	1.17	0.03	0	1.85
KAPL	0	0.11	0.22	0.10	0.01	0	0.42
AI	0	0.02	0.18	0.13	0.03	0	0.36
All others	0.02	0.39	0.08	0.84	0.01	0.01	1.35
Total	0.04	12.15	4.15	62.58	1.53	19.55	100.

Table 4. Projections of DOE LLW generation rates

Year of Projection	Projected Amount ($1,000 m^3/yr$)	Actual Amount ($1,000 m^3/yr$)
1981	84.1	62.0
1982	70.0	89.1
1983	70.7	89.5
1984	76.5	92.6
1985	78.3	119.8
1986	90.1	96.9
1987	98.0	99.5
1988	99.7	90.4
1989	99.7	

[a]As projected early in the given year for that year's amount as of 12/31.

Table 5. Cumulative volume (m^3) inventories of DOE site mixed LLW, by hazard category, through 1988[a]

Site	Ignitable	Corrosive	EP toxic	Spent solvents	Spent sludges	Discarded chemicals	PCBs	Other[b]	Total
PAD[c]	0	2.5	5.6	4.2	0	0	1,056.9	0	1,069.2
ORGDP[c]	24.4	50	80.4	274.6	9,039.3	0	959	0	10,427.7
PORTS[c]	3.2	4	224.3	1,799	0	0.1	149	0	2,179.6
ORNL[c]	10.3	3.8	0.2	8.0	0	0.7	3	61.4	87.4
Y-12[c]	8.7	0	7,171.4	104	3,054	0	533	0	10,871.1
HANF[c]	895.11	20.34	115.17	9.27	0	304.75	0	32.96	1,377.60
SRS	3	0	214.2	51	14,430.1	0	0	0	14,698.3
LLNL	0.16	0.14	36.06	62.02	0	0	0	31.02	129.40
SNLL	1.2	0	0.2	0	0.03	0	0	0	1.43
LANL	27.8	1.75	17.9	47.1	0	0.07	0	119.78	214.40
RFP	0	6.3	30	9,300	0.7	0.5	18	0	9,355.5
MOUND	13	0	2.1	0	0	26	7	0	48.1
PANT	0	0	32	0	0	54	0	0	86
SNL	0	0	35	0	0	0	0	35	70
Allied-Signal	0	0	2.65	0	0	0	0	0	2.65
ITRI	28.8	0	0	0	0	0	0	0	28.8
Pinellas	0	0	6.47	0	0	0	0	0	6.47
INEL	1.46	0	41.88	0	0	0	0	2.96	46.30
NTS	0	0	0	22.1	0	0	0	0	22.1
FMPC	11	1	167	89	0	1	0	2	271
Ames	0	0	0	0	0	0	0	0	0
ANL-E	1.8	0	35.9	34.9	0	0	0	0	72.6
ANL-W	0	0	0.93	0.1	0	0	0	12.2	13.23
BNL	0	1,061	0	0	0	0	0	0	1,061
Total	1,029.93	1,150.83	8,219.36	11,805.29	26,524.13	387.12	2,725.9	297.32	52,139.88

[a]Material may be in interim storage awaiting treatment.

[b]Other refers to mixed wastes whose major hazardous component is not otherwise categorized. Examples are reactives, poisons, and carcinogens.

[c]Densities of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solids, sludges, and others were assumed to calculate volumes.