0. OVERVIEW

0.1 INTRODUCTION

This report is an update of the previous document[1] on spent nuclear fuel (SNF) and radioactive waste inventories and projections that was prepared for use in the planning and analysis of various SNF and waste management functions. Quantities of SNF and radioactive wastes produced from both commercial and U.S. Department of Energy (DOE)-sponsored activities are reported.

Previous issues of this report had reported SNF and waste information on a calendar-year (CY) basis. However, this report documents DOE site waste quantities on a fiscal-year (FY) basis in order to provide a consistent format with the information associated with the DOE Office of Environmental Management (DOE/EM) Ten Year Plan (TYP). In general, total radioactive waste inventories for DOE sites are reported as of the end-of-fiscal-year (EOFY) 1996 (i.e., as of September 30, 1996). Information on annual commercial SNF and commercial uranium mill tailings inventories, provided by the DOE Energy Information Administration (DOE/EIA), are reported on an end-of-calendar-year (EOCY) basis.

Projections of future SNF and radioactive wastes are generally reported for the FY period 1997–2030. Such projections may change in future revisions of this report as waste minimization (WMin), environmental restoration, and decontamination and decommissioning (D&D) programs and activities at various government and commercial sites are defined and become operative. In general, the tables of this document use a horizontal line to mark the point in time when past history ends and future projections begin. Because historical radioactive waste inventories are generally reported as EOFY 1996, the line is drawn between the data entries for FY 1996 and FY 1997. Data reported for either FY or CY 1997 in this document are regarded as projected numerical information.

This document contains information that has been assembled as a part of the Integrated Data Base (IDB) Program at Oak Ridge National Laboratory (ORNL), which has the lead responsibility for maintaining and reporting summary files of pertinent data on current and projected inventories and characteristics of permanently discharged domestic SNF and radioactive wastes. While this report documents inventories and projections of radioactive wastes from commercial and DOE site activities, estimates for certain other waste categories are not fully reported because of the current unavailability of data. These categories include naturally occurring and accelerator-produced radioactive material (NARM), discussed in Sect. 0.2, and wastes from U.S. Department of Defense (DOD) activities, particularly those resulting from the cleanup of military sites contaminated with significant amounts of radioactive waste. A study[2] by the U.S. General Accounting Office indicates that as many as 420 DOD locations could be contaminated with radioactive wastes. Future updates of this report will report information and data on NARM and DOD site radioactive wastes as they become available.

This report also does not report inventories of nonradioactive materials. These include hazardous wastes, sanitary wastes, and materials not categorized as waste (MNCAW), such as uncontaminated scrap metal. Preliminary estimates of inventories of MNCAW are reported in ref. 3.

Except for some NARMs, most radioactive waste originates from five major sources: (1) the commercial nuclear fuel cycle; (2) DOE-related activities; (3) institutions such as hospitals, universities, and research foundations; (4) industrial uses of radioisotopes; and (5) mining and milling of uranium ore. The waste is broadly categorized as SNF, high-level waste (HLW), transuranic waste (TRUW), low-level waste (LLW), and uranium mill tailings (UMTs). Large quantities of radioactive waste also result from DOE site environmental restoration activities and the D&D programs of DOE and commercial nuclear facilities. This report also documents inventories and projections of mixed low-level waste (MLLW), which is both hazardous and radioactive.

The primary purpose of this document is to report U.S. SNF and radioactive waste inventories, projections, and characteristics. The data presented were obtained through the cooperation and assistance of the offices and programs that were established by DOE to oversee the management of the various radioactive wastes and SNFs. In addition, the recent literature was reviewed to aid in selecting the data that are presented herein and to help establish a basis for many of the calculated radioactivity levels and heat-generation rates that are included. In this report, SNF and radioactive wastes are characterized from the standpoint of their volumes (or masses) and their nuclear, physical, and chemical properties. The data reported are selected from more extensive information. That information is available upon request.

This annual inventory report contains summarized data of types found to be useful for programmatic planning purposes within the DOE community. The data are intended to provide a common basis for both DOE management-level planning and for more detailed analyses of the waste management system that are conducted by DOE contractors and field offices. However, this report is not intended to present the detailed types of information required as input to such analyses. The best sources of such information are the appropriate DOE operations offices, waste sites, or relevant documents previously issued, some of which may be referenced in this report.

This report does not address the programmatic implications of the data presented, such as the possible future need for interim SNF storage facilities. Discussion of the data is minimized to explain mainly what the data represent. Major DOE data sources providing information and data for this report are identified in a table following the preface. Likewise, discussions of packaging details, shielding and transportation requirements, health and environmental effects, and costs are purposely avoided. Questions regarding the information and data presented may be addressed to the IDB Program.

The DOE waste information and data contained in this report are furnished by the DOE contractor sites listed in Table 0.1. This table indicates also the types of radioactive waste managed at each site. The DOE site data (waste inventories, projections, and characteristics) are used by DOE-Headquarters (DOE-HQ), operations offices, and operating contractors for the management and strategic planning of various waste programs. The objective of this report is to provide waste information that is consistent, reflects current inventories and projections, and includes the types of basic data best suited to meet DOE waste program planning needs.

Information for this report is provided by a variety of sources. The DOE site waste data reported were received from DOE contractors through DOE operations offices. DOE-HQ assigns to selected organizations major responsibilities for providing information on particular topics involving SNF and radioactive waste management. Further detailed information is generally available from data bases maintained at the specific DOE and commercial sites. Additional information on the reference sites and facilities referred to in this report is provided in Appendix C.

0.2 CHARACTERIZATION OF WASTE FORMS

The major characteristics of radioactive materials and wastes are described in the following:

! **Spent Nuclear Fuel (SNF)**

SNF consists of irradiated fuel discharged from a nuclear reactor. Unless otherwise identified, all SNFs discussed in this report are assumed to be permanently discharged and eligible for repository disposal. Three categories of permanently discharged SNF are considered: (1) fuel from commercial light-water reactors (LWRs); (2) fuel from non-LWR commercial reactors [e.g., the Fort St. Vrain high-temperature, gas-cooled reactor (HTGR)]; and (3) special fuels associated with government-sponsored research and demonstration programs, universities, and private industries. This report does not track the inventories of government production reactor SNFs that have been reprocessed in the manufacture of nuclear weapons for national defense. However, the inventories of HLW resulting from the reprocessing of these fuels are reported in Chapter 2. Also, Chapter 1 reports quantities of DOE SNF.

Currently, most LWR SNF assemblies are stored in pools at the reactor sites. The bulk of the remainder is in storage at the West Valley Demonstration Project (WVDP) site at West Valley, New York; the Idaho National Engineering and Environmental Laboratory (INEEL) at Idaho Falls, Idaho; and the Midwest Fuel Recovery Plant (MFRP) at Morris, Illinois. The WVDP facility is currently being decommissioned. All utility-owned SNF assemblies previously stored there have been returned to the utilities, and the fuel remaining is DOE-owned material.

SNFs discharged from a variety of reactors are currently stored at the Hanford Site (Hanford) and INEEL. Hanford contains inventories of fuel from the N Reactor, the Fast Flux Test Facility (FFTF), and pressurized-water reactor (PWR)–Core II fuel from Shippingport. Fuel from the damaged Three Mile Island (TMI)–Unit 2 reactor, as well as some of the SNF from the Fort St. Vrain high-temperature, gas-cooled reactor (HTGR), are stored at INEEL. Some special SNFs are stored at the Savannah River Site (SRS) and at INEEL. These special fuels are government owned and are not scheduled for reprocessing in support of DOE activities.

- **High-Level Waste (HLW)**

For this report, HLW means the highly radioactive material resulting from the reprocessing of SNF. This material includes mainly the liquid wastes remaining from the recovery of uranium and plutonium in a fuel reprocessing plant. This HLW may also be in the form of sludge, calcine, or other products into which such liquid wastes are converted to facilitate their handling and storage. Such waste contains fission products that result in the release of considerable decay energy.[4] For this reason, heavy shielding is required to absorb penetrating radiation, and provisions (e.g., cooling systems) are needed to dissipate decay heat from HLW.

- **Transuranic Waste (TRUW)**

TRUW refers to radioactive waste that contains more than 100 nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years.[5,6] Such waste results primarily from fuel reprocessing and from the fabrication of plutonium weapons and plutonium-bearing reactor fuel. Generally, little or no shielding is required ["contact-handled" (CH) TRUW], but energetic gamma and neutron emissions from certain transuranic (TRU) nuclides and fission-product contaminants may require shielding or remote handling ["remote-handled" (RH) TRUW].

- **Low-Level Waste (LLW)**

Several statutes (refs. 4, 6, and 7) define LLW not by what it is, but by what it is not. In general, LLW is radioactive waste not classified as SNF, HLW, TRUW, nor by-product materials such as UMT or thorium mill tailings. However, there are slight differences between the specific regulatory definitions of DOE-generated LLW and commercial LLW.

The definition of DOE LLW is based on DOE Order 5820.2A,[6] which specifies DOE's policy for radioactive waste management. According to this order, LLW includes all radioactive waste not classified as either HLW, TRUW, SNF, or the bulk of the by-product tailings containing uranium or thorium and their decay products from processed ore. The DOE policy, as stated in Order 5820.2A, allows small volumes of fissionable material to be irradiated for research and development (R&D) only—but not for the production of power or plutonium—and small concentrations of TRU (<100 nCi/g) radionuclides to be managed as LLW. The same DOE policy allows small volumes of DOE waste containing by-product material [specified in Sect. 11e(2) of the Atomic Energy Act of 1954 (AEA)][8] or NARM to be managed as LLW. Any LLW that also contains hazardous chemicals covered by either the Resource Conservation and Recovery Act (RCRA)[9] or the Toxic Substances Control Act (TSCA)[10] requires management as a "mixed waste."

The definition of commercial LLW is based on two statutes, the Nuclear Waste Policy Act (NWPA)[4] and the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA).[7] According to both the NWPA and the LLRWPAA, commercial LLW is radioactive material that (a) is not HLW, SNF, TRUW, or by-product material as defined in Sect. 11e(2) of the AEA, and (b) is consistent with existing law, is classified by the U.S. Nuclear Regulatory Commission (NRC) as LLW.

The radiation level from LLW may sometimes be high enough such as to require shielding for handling and transport. For commercial LLWs, the NRC has defined, in ref. 11, four disposal categories of LLW that require differing degrees of confinement and/or monitoring: classes A, B, C, and Greater-Than-Class-C (GTCC). The NRC excludes NARM from the LLW category. DOE LLWs are classified by groupings of disposal categories that are site specific, yet similar to the NRC categories. This report documents inventories of solid LLW either destined for disposal or awaiting treatment prior to its disposal. It includes no liquid or gas waste in storage.

- **Uranium Mill Tailings (UMT)**

Uranium mill tailings (UMT) are the earthen residues that remain after the extraction of uranium from ores. Tailings are generated in very large volumes and contain low concentrations of naturally occurring radioactive materials. These materials comprise a potential health hazard; the isotopes of major concern are ^{226}Ra and its daughter, ^{222}Rn.

- **Naturally Occurring and Accelerator-Produced Radioactive Material (NARM)**

NARM wastes include both accelerator wastes (LLW) and naturally occurring radioactive material (NORM) that contain radionuclides (e.g., ^{226}Ra, ^{222}Rn, ^{232}Th, ^{238}U) existing throughout the earth's crust. Accelerator wastes include accelerator targets, wastes from accelerator maintenance or D&D, and wastes from radiopharmaceutical manufacture. NORM wastes are classified according to their specific activity as either discrete or diffuse. Discrete NORM wastes have a relatively small volume but large radioactivity and include industrial gauges, old radium watch and industrial dials, radium needles in medical equipment, resins (filters) that remove radioactive radium from public drinking water, and some radiopharmaceutical waste. Diffuse NORM wastes are characterized by a relatively large volume with small radioactivity. These materials result from industrial processes and include:

- coal ash and slag from utility electrical generation;
- solid wastes from geothermal energy production;
- slag, leachate, and tailings from the mining and processing of metals other than uranium or thorium (e.g., copper);
- sludge from drinking water treatment;
- scale, sludge, produced water, and equipment from oil and natural-gas production containing NORM; and
- wastes (phosphogypsum and slag) from mining phosphate ores for fertilizer (ammonium phosphate) production.[12,13]

Current inventories of total domestic NARM wastes are not known. Future updates of this document will include additional information on NARM waste inventories, projections, and characteristics as they become available.

! **Mixed Low-Level Waste (MLLW)**

MLLW contains concentrations of both low-level radioactive materials and hazardous chemicals. The hazardous component of mixed waste has characteristics identified by any or all of the following statutes: the RCRA, as amended;[9] the TSCA;[10] and state regulations. Typically, MLLW from activities supporting DOE programs includes a variety of contaminated materials, such as air filters, cleaning solutions, engine oils and grease, paint residues, soils, construction and building materials, water-treatment chemicals, and decommissioned plant equipment. This report documents inventories and generation rates of various types of mixed wastes stored at DOE sites based on updated information and data from the DOE Office of Waste Management Technical Information Collection Database.[14]

! **Generated, Treated, Stored, and Disposed Wastes**

It should be emphasized that all of the types of radioactive materials and wastes discussed in this report can exist either as material generated, treated, stored, or disposed. The distinctions among these various waste conditions or "states" are as follows:

— *Generated waste*. A material recently discharged from a facility production process or operation that can be regarded as a waste because it has no economic value. In this report, quantities of generated waste are measured in units of volume [cubic meters (m^3)] or mass (kg) produced during a fiscal year.

— *Treated waste*. A waste that, following generation, has been altered chemically or physically to reduce its toxicity or prepare it for storage or disposal on- or off-site. Waste treatment can include volume-reduction activities, such as incineration or compaction, which may be done prior to either storage or disposal or both (discussed next).

— *Stored waste*. A waste that, following generation (and usually some treatment), is being (temporarily) retained and monitored in a retrievable manner pending disposal. In this report, inventories and projections of stored radioactive materials or wastes are reported in volume (m^3) or mass (kg) units or both.

— *Disposed waste*. A waste that has been put in final emplacement to ensure its isolation from the biosphere and for which there is no intention of retrieval. Deliberate action is required to regain access to the waste. Disposed waste includes materials placed in a geologic repository, buried underground in shallow pits, dumped at sea, or discarded by hydrofracture injection. The latter two techniques were past practices and are no longer performed.

Throughout this report, the reader is urged to note the distinctions among these waste conditions. Such conditions have a great impact on the regulatory status of the waste materials considered in this report.

0.3 METHODS AND ASSUMPTIONS USED IN REPORT PREPARATION

This report consolidates a large amount of information from many sources. Some of these data are historical in nature, some are current, and some are projected. Of the latter, some have been calculated or estimated, and some have been measured. Over the years, waste regulations have been revised, waste category definitions have changed, measurement instruments and calibration methods have been improved, and record-keeping has been upgraded at all waste-generating and -receiving sites. In preparing this report, a major effort has been made to integrate waste data from many sources and to strive for a consistent and technically rational approach for the entire scope of coverage. Our primary sources of data are referenced, and, for calculated values (e.g., decayed radioactivity and thermal power), the bases for the calculations are identified. To achieve adequate integration of data, numerous factors had to be considered; these are cited in footnotes that generally accompany the tables and figures of this report. In some cases, a more thorough explanation is provided in the text.

Each chapter details the assumptions on which its waste inventories and projections are based. The broader assumptions are mentioned here and are listed in Table 0.2. These include the projected time frame and specific assumptions used for estimating commercial and government (DOE) waste projections. The commercial SNF projections reported in this document assume a reference projection of nuclear power growth and no SNF reprocessing. The reference nuclear power electrical growth projection (and associated discharged SNF schedule) used throughout this report is the 1997 DOE/Energy Information Administration (EIA) Reference Case.[15] Throughout this report, this case will be referred to as the Reference Case. The Reference Case SNF and power-capacity projection cases are based on a set of assumptions involving nuclear electricity generation growth, reactor fuel burnup levels, reactor construction schedules, and reactor operating lifetimes and capacity factors. These assumptions are documented by DOE/EIA in ref. 15. In particular, the Reference Case assumes that no new advanced LWRs will become operational before the year 2015 and that all current nuclear units are retired on the dates when their initial license-terms expire.

Detailed information about reactors already built, being built, or planned in the United States for domestic use or export as of December 31, 1995, is provided in report DOE/OSTI-8200-R59 (ref. 16), which contains a comprehensive listing of all domestic reactors categorized by primary function or purpose: civilian, production, military, export, and critical assembly.

The data for total waste inventories (which comprise historical data) are obviously less accurate than the values recorded for recent waste additions. The number of digits used in reporting these values is generally greater than justified in terms of numerical significance, but this proves useful and necessary for bookkeeping purposes. In some cases, the values cited are significantly different from those previously reported. This is generally a result of improved estimates, new measurements, or redefinition of terms. Explanations are given in such cases. Many of the comments received during the final review stage of this report deal with changes that have occurred after September 30, 1996—some as recently as November 1997. These changes are generally cited in footnotes.

For the sake of brevity, many of the figures and tables of this report use the exponential (E) notation. As examples of this notation, the constant 1.234E+2 means 1.234×10^2, or 123.4; and 1.234E−4 means 1.234×10^{-4}, which is 0.0001234.

0.4 WASTE CHARACTERISTICS AND UNITS REPORTED

Principal characteristics reported for most radioactive wastes discussed in this report include volume, radioactivity, and thermal power. All characteristics are reported in metric units and, depending on the waste form, can be significant considerations in meeting the requirements for waste treatment, storage, and disposal. Waste volume is reported in cubic meters (m^3) and generally reflects the amount of space occupied by the waste and its container. Radioactivity represents the rate of spontaneous disintegration of the radionuclides comprising the waste. In this report, radioactivity is measured by a unit called a curie (Ci), which is 3.7×10^{10} nuclear disintegrations per second. Over time, radionuclides decay to nonradioactive, stable isotopes. As an example, the short-lived radionuclides found in SNF rapidly decay during the first few years after the fuel is removed from a reactor.

It should be noted that while waste volumes accumulate with time by conventional addition, total radioactivity does not. Because of radioactive decay, cumulative activity cannot be based on reported annual additions; rather it must be estimated from knowledge of the waste composition, which includes the radionuclides comprising the waste, their concentrations, and decay attributes (e.g., half-lives and decay schemes). In this report, decayed radioactivity is generally estimated for some wastes by an abridged version of the ORIGEN2 code (ref. 17). Annual levels of radioactivity (Ci) reported in this document include contributions from both parent and daughter decay products.

Thermal power is a measure of the rate of heat-energy emission resulting from the decay of radionuclides in a waste. Like radioactivity, thermal power is not cumulative by conventional addition because of radioactive decay. Information on thermal power is needed in the design of shipping casks, storage facilities, and repositories where temperature rise, especially with regard to SNF and HLW, is an important concern. Thermal energy generation rates are highest for SNF, HLW, and RH TRUW. They may also be important for certain types of LLW. The unit of thermal power used in this report is the watt (W), which represents

1 joule (J) of thermal energy emitted per second. Estimates of thermal power are based on radionuclide composition as well as total activity. While levels of thermal power may not be significant for certain waste forms (particularly some types of LLW), they are nevertheless reported for the major radioactive waste categories referenced in this report to provide a standard for comparison.

For SNF and TRUW, mass is reported to provide better assurances of accountability. SNF is reported in units of metric tons of *initial* heavy metal (MTIHM) to avoid difficulties and confusion arising from the need to estimate ranges of varied heavy-metal content (MTHM) that result from different levels of enrichment and reactor fuel burnup. Mass is reported in kilograms (kg) for the TRU radionuclides comprising TRUWs.

In this report, quantities of generated wastes are expressed in terms of either the amount of mass (kg) or volume (m^3) produced in a given fiscal year. Thus, generation rates for wastes are expressed in either kilograms per year (kg/year) or cubic meters per year (m^3/year), depending on the availability of site information. Annual generation rates are reported in this document for SNF, TRUW, LLW, and MLLW. No HLW from SNF reprocessing was generated during FY 1996. In previous issues of this document, annual generation rates have not been reported for HLW in part because there are problems in accurately estimating HLW generation levels. One major difficulty is accounting for net waste-quantity changes caused by the combined effects of various modes of site waste management operations such as evaporation and calcination.

Quantities of wastes can also be reported in terms of the number and types of waste containers. LWR SNF inventories and projections can be expressed in terms of the number of permanently discharged boiling-water reactor (BWR) and PWR fuel assemblies. HLW will be immobilized in either borosilicate glass or a glass/ceramic matrix solidified in stainless steel canisters. Quantities of LLW and stored TRUW can be based on the number and types of drums, boxes, or containers used or scheduled for use.

Waste characteristics are also identified by waste composition. Throughout this report, waste composition is expressed in terms of the following:

- radioactivity (Ci) or specific-activity (Ci/m^3) breakdown by radionuclide (with accompanying daughter products) and

- physical form (solid, liquid, gas, or sludge) or chemical content (by chemical component), expressed in terms of either volume (m^3) or mass (kg) or as a percentage of total weight (wt %), volume (vol %), or radioactivity (Ci %).

0.5 CHAPTER OVERVIEWS

A brief summary of each chapter in this report is presented in the following paragraphs.

0.5.1 Spent Nuclear Fuel (SNF)

Chapter 1 of this report presents national data on the quantities of permanently discharged SNF from commercial nuclear power reactors. Historical data on commercial SNF inventories are reported along with 1997 DOE/EIA projections for the Reference Case.[15] The Reference Case is the baseline commercial scenario used throughout this report to make waste projections. For the projection period considered in this report (CYs 1997–2030), the Reference Case assumes that no new reactors will be ordered.

DOE SNF inventories are also reported in Chapter 1. These include various types of research reactor SNFs which are stored at the SRS and the INEEL.

In this report, the mass of discharged SNF is generally measured in MTIHM. The term “initial heavy metal” refers to the original mass of the actinide elements of the fuel, most of which is uranium. (Elements of the actinide group are those with atomic numbers greater than 89.)

0.5.2 High-Level Waste (HLW)

The inventories of HLW in storage at the end of FY 1996 and projected through FY 2030 are given in Chapter 2. The waste forms include liquid, sludge, salt cake, slurry, calcine, precipitate, zeolite, glass, and capsules of separated strontium and cesium. Inventories and projections of vitrified defense HLW are reported for Hanford, INEEL, and the Defense Waste Processing Facility (DWPF) at SRS. In addition, inventories and projections of vitrified HLW from commercial reprocessing activities are given for the WVDP. Projections recently made of the number of canisters containing the final immobilized form for the DOE HLW at Hanford and the INEEL are also reported. In addition, Chapter 2 gives the locations, volumes, and radioactivities of HLW.

In 1992, DOE decided to phase out the reprocessing of its production-reactor SNFs. Until then, the reprocessing activities recovered enriched uranium and plutonium which were used to support nuclear weapons production. As a consequence of ceasing to reprocess reactor SNFs, little additional HLW is expected to be generated at DOE sites in the future.

0.5.3 Transuranic Waste (TRUW)

The locations, inventories, and projections of TRUW buried and stored at DOE sites are presented in Chapter 3. Inventories of TRUW are reported as of September 30, 1996, and are virtually all derived from government operations. The inventories documented in this report are based on data provided by the sites and include waste volumes and the masses and radioactivities of contained radionuclides. Projected future TRUW volumes through FY 2022 were also requested from the sites, but the sites were not able to make such estimates in all cases. Projections are reported through FY 2022 for those sites that provided estimates.

In 1984, DOE (with input from other federal agencies) revised the minimum radioactivity concentration level for defining TRUW from greater than 10 nCi/g to greater than 100 nCi/g.[18] Consequently, some waste currently in the inventory may contain wastes stored under both criteria. This redefinition, as well as the development of instrumentation to detect these low levels of radioactivity, may reduce the volume of TRUW. As the waste is assayed, that portion of it which is greater than 10 nCi/g and less than 100 nCi/g will be reclassified to other waste categories.

0.5.4 Low-Level Waste (LLW)

Data for LLW from commercial and government activities are given in Chapter 4 and Appendix A. Commercial fuel-cycle LLW is generated from the conversion of yellowcake to uranium hexafluoride (UF_6), enrichment, fuel fabrication, and reactor operation. LLW also results from commercial operations by private organizations that are licensed to use radioactive materials. These include institutions and industries engaged in research and various medical and industrial activities. DOE LLW is similar in nature to the commercial industrial and institutional (I/I) waste and the commercial fuel cycle LLW.

A wide variety of radionuclides are found in LLW. Uranium isotopes and their daughters dominate in the conversion, enrichment, and fuel-fabrication steps of the nuclear fuel cycle. Reactor operations produce LLW containing mostly activation products and fission products. A significant fraction of institutional LLW that is shipped to disposal sites is contaminated with small quantities of ^{3}H and ^{14}C.

By the end of FY 1996, approximately 66% of the total cumulative volume of disposed LLW resulted from various DOE activities. The remaining 34% resulted from domestic commercial activities. About 29% of the volume of LLW disposed during FY 1996 resulted from commercial activities.

0.5.5 Uranium Mill Tailings (UMT)

Current inventories and projections of tailings from commercial uranium mill operations are summarized in Chapter 5. Twenty-six licensed uranium mills have accumulated tailings from their operations. Half of these mills have accumulated both commercial and government tailings. During CY 1996, only one NRC-licensed mill was operational. To date, almost all domestic uranium has been produced by conventional mining and milling methods from which these tailings derive. A small portion has been obtained via in situ leaching, recovery from mine water, recovery from copper/vanadium dump leach liquor, and recovery from wet-process phosphoric acid effluents. Tailings from the now inactive mills that produced uranium only for government operations are being stabilized under DOE's Environmental Restoration Program (see Chapter 6).

0.5.6 Environmental Restoration Program

The mission of the DOE Office of Environmental Restoration (EM-40) is to protect human health and the environment from risks posed by inactive and surplus facilities and contaminated areas by remediating sites and facilities in the most cost-efficient and responsible manner possible in order to provide for future beneficial use. An overview of the Environmental Restoration Program is given below. Further details are provided in Chapter 6. The scope of Chapter 6 is limited to radioactive and mixed (radioactive and chemically hazardous) wastes that could be generated by environmental restoration activities. Nonradioactive hazardous and sanitary wastes are outside the scope of this report.

The Environmental Restoration Program includes a bias for action to expedite actual cleanup wherever and whenever possible. Activities are prioritized based on factors such as the need to eliminate risks at sites not controlled by the federal government, the goal of reducing risks at all sites, and compliance with various laws, regulations, and agreements. Most actions are designed to either remove or contain contamination in the environment or to decommission contaminated structures. Related activities include treatment of contaminated materials and wastes, transportation of these materials and wastes to storage and disposal facilities, and disposal of wastes in permitted facilities.

The total volume of solid radioactively contaminated material being addressed by the Environmental Restoration Program is approximately 57 million m^3. About 70% of this volume is expected to be managed in-situ using remedies such as capping, monitoring, and retention of land-use controls. The total volume of radioactive waste resulting from ex-situ remedies is approximately 17 million m^3. About one-half of this volume is LLW and most of the remainder is mill tailings and debris being managed under the Uranium Mill Tailings Remedial Action Program (UMTRAP). An additional 27 million m^3 of mill tailings and debris has already been disposed of in engineered containment cells under UMTRAP. Strategies for managing the radioactive wastes associated with the Environmental Restoration Program are presented in Chapter 6.

0.5.7 Naturally Occurring and Accelerator-Produced Radioactive Material (NARM)

Chapter 7 describes the characteristics of NARM (and NORM). Some inventories and projections of these materials, based on information currently available, are also reported.

0.5.8 Mixed Low-Level Waste (MLLW)

Current inventories and generation rates of MLLW from both DOE and commercial sources are summarized in Chapter 8. These wastes are contaminated with both low-level radioactivity and chemically hazardous substances. The radioactive components are defined by the AEA,[8] while the hazardous components are defined by the RCRA,[9] the TSCA,[10] and pertinent state regulations. As of the end of FY 1996, inventories of MLLW at DOE sites totaled about 76,240 m^3.

0.5.9 Appendixes

Several appendixes are included in this report. Appendix A is a compilation of source terms and characteristics used for waste projections. Source terms include both quantitative and descriptive characteristics used to describe radioactive wastes. As developed and used in the IDB Program, the source term for a particular waste is comprised of two components unique to that waste: (1) the number of curies of radioactivity, expressed either per unit of facility production or per unit of waste volume or mass, and (2) a listing of the relative contributions of component radioisotopes per curie of radioactivity of the waste. A tabulation of the properties of important radionuclides is given in Appendix B. Appendix C lists the sites and facilities referred to in this report.

0.6 SUMMARY DATA

A few graphical presentations and summary tables are included in this chapter to provide a broad overview. Figures 0.1 and 0.2, respectively, show the volumes and decayed radioactivities of commercial and DOE wastes and SNF accumulated through both CY and FY 1996.

Summaries of SNF and radioactive waste inventories and projections are provided in Tables 0.3 and 0.4. In general, material to be sent to R&D facilities or to the proposed national geologic repository for SNF and HLW is still listed in each individual site's inventory.

DOE waste volume summaries for specific sites are given in Tables 0.5–0.7. Waste generation for FY 1996 is presented in Table 0.5, and total FY 1996 inventories for stored and buried wastes are provided in Tables 0.6 and 0.7, respectively.

0.7 REFERENCES

1. U.S. Department of Energy, *Integrated Data Base Report—1995: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, DOE/RW-0006, Rev. 12, Oak Ridge National Laboratory, Oak Ridge, Tennessee (December 1996).

2. U.S. General Accounting Office, *Environmental Cleanup—Better Data Needed for Radioactively Contaminated Defense Sites*, GAO/NSIAD-94-168, Washington, D.C. (August 1994).

3. Coreen Casey and Beth A. Heath, EG&G Idaho, Inc., Radioactive Waste Technical Support Program, *Material Not Categorized as Waste (MNCAW) Data Report*, DOE/LLW-93, predecisional draft, Idaho National Engineering Laboratory, Idaho Falls, Idaho (November 1993).

4. U.S. Congress, Nuclear Waste Policy Act of 1982, Pub. L. 97–425, Jan. 7, 1983, as amended by the Budget Reconciliation Act for Fiscal Year 1988, Title V—Energy and Environment Programs, Pub. L. 100–203, Dec. 22, 1987.

5. U.S. Environmental Protection Agency, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," *Code of Federal Regulations*, 40 CFR Part 191 (July 1, 1996).

6. U.S. Department of Energy, DOE Order 5820.2A, *Radioactive Waste Management*, Washington, D.C., Sept. 26, 1988.

7. U.S. Congress, The Low-Level Radioactive Waste Policy Amendments Act of 1985, Pub. L. 99–240, Jan. 15, 1986.

8. U.S. Congress, Atomic Energy Act of 1954, Pub. L. 83–703, Aug. 15, 1954.

9. U.S. Congress, Resource Conservation and Recovery Act of 1976, 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.

10. U.S. Congress, Toxic Substances Control Act of 1976, Pub. L. 94–469, Oct. 11, 1976.

11. U.S. Nuclear Regulatory Commission, "Licensing Requirements for Land Disposal of Radioactive Waste—Waste Classification," *Code of Federal Regulations*, 10 CFR Part 61, Sect. 61.55 (Jan. 1, 1996).

12. The League of Women Voters Education Fund, *The Nuclear Waste Primer*, Lyons & Burford, New York, 1993.

13. K. P. Smith, *An Overview of Naturally Occurring Radioactive Materials (NORM) in the Petroleum Industry*, ANL/EAIS-7, Argonne National Laboratory, Argonne, Illinois (December 1992).

14. U.S. Department of Energy, Office of Environmental Restoration, Office of Waste Management, *Technical Information Collection Database*, updated through Oct. 30, 1997.

15. U.S. Department of Energy, Energy Information Administration, *Nuclear Power Generation and Fuel Cycle Report 1997*, DOE/EIA-0436(97), Washington, D.C. (September 1997).

16. U.S. Department of Energy, Office of Scientific and Technical Information, *Nuclear Reactors Built, Being Built, or Planned: 1996*, DOE/OSTI-8200-R60, Oak Ridge, Tennessee (August 1997).

17. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, Oak Ridge, Tennessee (July 1980).

18. U.S. Department of Energy, DOE Order 5820.2, *Radioactive Waste Management*, Washington, D.C., Feb. 6, 1984 [updated by DOE Order 5820.2A (ref. 6)].

CHAPTER 0 — OVERVIEW

Proposed figures:

Proposed tables:

Table 0.1. Types of radioactive wastes managed at DOE sites referenced in this report[a]

Site(s)	Symbol/label	SNF	HLW	TRUW	LLW	MLLW	UMT
Ames Laboratory	Ames			X[a]	X	X	
Argonne National Laboratory–East	ANL–E	X		X	X	X	
Argonne National Laboratory–West	ANL–W	X		X	X	X	
Atlantic Richfield (Medical Products) Company	ARCO			X			
Battelle Columbus Laboratories	BCL			X	X		
Brookhaven National Laboratory	BNL	X			X	X	
East Tennessee Technology Park	ETTP				X	X	
Energy Technology Engineering Center	ETEC			X	X	X	
Fermi National Accelerator Laboratory	FNAL				X		
Fernald Environmental Management Project	FEMP				X	X	
Hanford Site[b]	Hanford	X	X	X	X	X	
Idaho National Engineering and Environmental Laboratory[c]	INEEL	X	X	X	X	X	
Inhalation Toxicology Research Institute[d]	ITRI				X	X	
Kansas City Plant	KCP				X	X	
Laboratory for Energy-Related Health Research	LEHR					X	
Lawrence Berkeley National Laboratory	LBNL			X	X	X	
Lawrence Livermore National Laboratory	LLNL			X	X	X	
Los Alamos National Laboratory	LANL	X		X	X	X	
Missouri (Univ. of) Research Reactor	MURR			X			
Mound Plant	Mound			X	X	X	
Naval Reactors Facilities and Shipyards[e]	NR Sites			X	X	X	
Nevada Test Site	NTS			X	X	X	
Oak Ridge Institute of Science and Education	ORISE				X		
Oak Ridge National Laboratory	ORNL	X		X	X	X	
Paducah Gaseous Diffusion Plant	PAD			X	X	X	
Pantex Plant	PANT			X	X	X	
Pinellas Plant	Pinellas				X	X	
Portsmouth Gaseous Diffusion Plant	PORTS				X	X	
Princeton Plasma Physics Laboratory	PPPL				X	X	
Reactive Metals, Inc. Site	RMI				X	X	
Rocky Flats Environmental Technology Site	RFETS			X	X	X	
Sandia National Laboratory/California	SNL/CA				X	X	
Sandia National Laboratory/New Mexico	SNL/NM	X		X	X	X	
Savannah River Site	SRS	X	X	X	X	X	
Stanford Linear Accelerator Center	SLAC				X		
Teledyne Brown Engineering	TBE			X			
Uranium Mill Tailings Remedial Action Project Sites[f]	UMTRAP						X
U.S. Army Material Command	USAMC			X			
West Valley Demonstration Project	WVDP	X	X	X	X	X	
Y-12 Plant (Oak Ridge)	Y-12				X	X	

[a]An "X" entry in this table indicates that the listed site manages waste of the category indicated. General site information is given in Appendix C.

[b]Includes Pacific Northwest National Laboratory (PNNL).

[c]Includes the Idaho Chemical Processing Plant (ICPP); excludes ANL–W.

[d]Also referred to as the Lovelace Biomedical and Environmental Research Institute.

[e]These sites are listed in Table C.2 of Appendix C.

[f]These sites are listed in Chapter 6.

Table 0.2. Major assumptions used in this report

Inventory/projection basis

- Inventories (except where indicated) are reported as of the end of FY 1996 (September 30, 1996)
- Projections are generally reported for the FYs 1997–2030

HLW solidification activities

- For Hanford, HLW solidification (borosilicate glass production) starts in 2002 and concludes in 2028
- For INEEL, HLW solidification (immobilization) starts in 2019 and continues through 2034
- For SRS, HLW solidification (glass production) at the Defense Waste Processing Facility (DWPF) started in 1996 and continues through 2019
- For WVDP, HLW solidification (glass production) started in 1996 and will be completed in 2001

Commercial activities

- DOE/EIA projections of installed net LWR electrical capacity for the Reference Case[a] of ref. 15:

Reference Case

CY	1997	2000	2005	2010	2015	2020	2025	2030
GW(e)	101	99	95	89	63	49	22	2

- DOE/EIA assumptions for LWR fuel enrichment and design burnup:

LWR fuel	CY fuel is loaded	Fuel enrichment (% ^{235}U)	Design burnup (MWd/MTIHM)
BWR	1993	3.14	36,000
	1996	3.12	40,000
	2000	3.47	43,000
	2010	3.58	46,000
PWR	1993	3.84	42,000
	1997	4.11	46,000
	2001	4.38	50,000
	2008	4.74	55,000

- SNF from commercial reactors is not reprocessed. Thus, a fuel cycle without reprocessing is assumed for all commercial projections

[a]This case assumes that each reactor will be retired when the expiration date specified in its operating license is reached.

WE DELETED THIS PART OF TABLE
****

The MRS facility is planned for startup in 2003. This facility will have a design spent fuel receipt rate of 2,700 MTIHM/year and a total spent fuel peak storage of 5,200 MTIHM. The MRS receipt rate (calendar year) schedule is:

1,200 MTIHM/year for 2003–2004,
2,000 MTIHM/year for 2005–2006, and
2,700 MTIHM/year for 2007–2020

A commercial repository is planned for startup in 2003. The repository will have a design spent fuel receipt rate of 3,000 MTIHM/year and a total capacity of 70,000 MTIHM. The repository spent fuel receipt rate (calendar year) schedule is:

400 MTIHM/year for 2003–2005,
900 MTIHM/year for 2006,
1,800 MTIHM/year for 2007, and
3,000 MTIHM/year for 2008–2020

1993	99
1995	100
2000	101
2005	104
2010	102
2015	108
2020	113
2025	116
2030	119

Table 0.3. Total SNF and radioactive waste inventories[a]

Waste category	Mass (MTIHM)	Volume (m^3)	Radioactivity[b] (10^6 Ci)	Thermal power (10^3 W)
SNF				
Commercial				
BWRs	12,105	4,880[c]	d	d
PWRs	22,148	8,928[c]	d	d
DOE	2,483	1,091	d	d
HLW[e]				
Hanford (DOE)[f]		207,300	332.1	954.1
Idaho (DOE)		10,550	48.4	143.6
Savannah River (DOE)		127,500	498.0	1,402.7
West Valley (commercial)		2,000	23.6	70.5
TRUW (DOE)[g]				
Buried		141,400	>0.14	d
Stored (site operations)[h]		96,600	2.60	d
Stored (environmental restoration activities)		42	d	d
LLW				
DOE sites				
Generated		30,764	d	d
Stored (site operations)		d	d	d
Stored (environmental restoration activities)		290,000	d	d
Disposed[i]		3,068,000	12.1	22.0
Commercial sites				
Major disposal facilities		1,551,000	5.1	19.9
Other disposal facilities		199,988	d	d
UMT (commercial licensed mill sites)[j]		118,700,000	d	d
11e(2) by-product material (from DOE environmental restoration)[k]	d	28,000,000	d	d
MLLW				
DOE sites				
Stored (site operations)	d	76,240	d	d
Stored (environmental restoration activities)	d	40,000	d	d
Commercial generator sites	d	d	d	d
Commercial disposal facilities	d	31,014	d	d

[a]Commercial inventories are reported as of December 31, 1996 (EOCY 1996); and DOE site inventories are reported as of September 30, 1996 (EOFY 1996).
[b]Except for TRUWs, radioactivity data are calculated decayed values as of September 30, 1996.
[c]Includes volume of spacing between the fuel rods of each assembly.
[d]Information not available.
[e]Includes contributions (if any) from both tank waste and canister material.
[f]Hanford tank wastes consist of HLW, TRUW, and LLW. However, in the interim storage mode, the tank wastes are managed as if they contain HLW and, therefore, are included in the HLW inventory.
[g]Data as of September 30, 1996.
[h]As-generated wastes, mixed and nonmixed.
[i]Includes contributions of LLW from HLW immobilization activities.
[j]Includes contributions from 26 NRC-licensed mills.
[k]Includes contributions from mixed as well as radioactive wastes.

Table 0.4. Current and projected total quantities of radioactive waste and SNF

[Quantities are expressed as volume (10^3 m^3) unless otherwise indicated]

Source and type of material	End of FY				
	1996	2000	2010	2020	2030
DOE sites					
SNF, mass, MTHM[a]	2,483	b	b	b	b
HLW					
Interim storage	347.3	310	244	96	3
Glass or glass/ceramic[c]	0.06	0.7	2.9	11.1	18.5
TRUW					
Buried	141[d]	141	141	141	141
Stored (as generated from site operations)	96.6[d]	b	b	b	b
Stored (environmental restoration activities)	0.042	b	b	b	b
LLW					
Buried[e]	3,068	3,277	3,791	4,361	4,577
Stored (site operations)	b	b	b	b	b
Stored (environmental restoration activities)	290	b	b	b	b
MLLW					
Stored (site operations)	76.2	b	b	b	214
Stored (environmental restoration activities)	40	b	b	b	b
11e(2) by-product material					
Stored (environmental restoration activities)	28,000	b	b	b	b
Commercial sites					
LWR SNF, mass, MTIHM[a,f,g] (no reprocessing)					
Reference Case	34,252	43,300	63,400	78,500	86,700
HLW (WVDP)					
Interim storage	2.0	0.2	0.0	0.0	0.0
Glass	0.02	0.22	0.24	0.24	0.24
LLW buried[e] (no reprocessing)	1,551	1,588	b	b	b
UMT[g]	118,700	b	b	b	b
MLLW	b	b	b	b	b
Other commercial disposal facilities[h]					
LLW	200.0	b	b	b	b
MLLW	31.0	b	b	b	b
NARM	296.7	b	b	b	b
11e(2) by-product	168.6	b	b	b	b

[a]Historically, spent nuclear fuel has been measured in units of mass rather than units of volume.

[b]Information not available.

[c]Includes projections for glass at SRS and glass/ceramic at INEEL.

[d]Includes mixed and nonmixed wastes.

[e]Projections include contributions of LLW from HLW immobilization activities.

[f]The 1996 discharged spent nuclear fuel mass is a BWR and PWR mass sum rounded to the nearest metric ton. Such rounding may result in slight differences between the spent nuclear fuel inventories and projections reported in this document and those reported by DOE/EIA.

[g]End of CY data.

[h]Includes wastes from DOE-, commercial-, DOD-, and EPA-sponsored activities.

Table 0.5. Volume (m³) of DOE site wastes generated during FY 1996

Site(s)	HLW	TRUW		LLW[b]	MLLW		Total (site)
		CH[a]	RH[a]		RCRA	TSCA	
Ames		0	0		2		2
ANL–E		8	0	211	c	70	289
ANL–W		0	0	270	c		270
BNL				416	2		418
ETEC		0	0	925	9		934
ETTP					d	d	c
FEMP				c	c	c	c
FNAL				30	c	c	30
Hanford		34	0	3,922	318		4,274
INEEL				6,791	c		6,791
ITRI					c		c
KCP							
LANL		138	0	4,022	54		4,214
LBNL		0	0	23	1		24
LEHR				308			308
LLNL		16		279	116		411
Mound		0	0	749			749
NR sites[e]		0	0	789	16	3	808
NTS		0	0	6	c		6
ORISE							
ORNL		16	12		d	d	28
PAD		0	0				0
PANT		0	0	174	28		202
Pinellas							
PORTS							
PPPL				34	<1		35
RFETS		37	0		c		37
SLAC							
SNL/CA				1	c		1
SNL/NM		2	0		c	c	2
SRS		171	0.6	8,195	61	<<1	8,428
WVDP		0	0	444	2		446
Y-12					d	d	c
Others		<<1		3,173[f]	881[g]		4,054
Total	0[h]	422	13	30,764	1,489	73	32,761

[a]Projected annual addition to as-generated waste stored inventory during FY 1996. Information for FY 1996 was not available. Includes contributions from both mixed and nonmixed wastes.

[b]Excludes wastes from DOE environmental restoration activities.

[c]Information unavailable or unknown.

[d]Included in 880 m³ reported as RCRA and non-RCRA PCB MLLW for the Oak Ridge Reservation (ORR).

[e]Includes contributions from Bettis Atomic Power Laboratory, Knolls Atomic Power Laboratory, and naval shipyards.

[f]Includes 3,159 m³ from ORR.

[g]Includes 880 m³ reported as both RCRA and TSCA wastes for the ORR.

[h]From SNF reprocessing. (No SNF was reprocessed during FY 1996.)

Table 0.6. Volume (m^3) inventory of stored DOE site SNF and radioactive wastes as of EOFY 1996

Site(s)	SNF	HLW	TRUW[a]		LLW[b]	MLLW[c]		Total (site)
			CH	RH		RCRA	TSCA	
Ames					18			18
ANL–E	0.1		81		564	51	70	766
ANL–W	9		7	22		390		428
BNL	7				297	4	<<1	308
ETEC			2	5	425	39		471
ETTP					13,638	22,237	4,001	40,876
FEMP					140,000			140,000
FNAL					91			91
Hanford	260	207,300	11,008	203		8,018	102	226,891
INEEL	469	10,550	64,760	62	18,634	846		95,321
ITRI					50			50
KCP					<<1			<<1
LANL			8,610	93		765		9,468
LBNL			<<1		35	7		42
LLNL			240		644	493		1,377
Mound			236		3,392	37	<1	3,666
NR sites[d]	80			3	3	68	19	173
NTS			618		301	25		944
ORISE					<<1			<<1
ORNL	17		921	1,283	1,842	2,843	9	6,915
PAD			4		110,000	147		110,151
PANT			<1		208			208
Pinellas					124			124
PORTS					13,000			13,000
PPPL								
RFETS			1,889		5,463	19,730		27,082
SLAC					174			174
SNL/CA					26	e		26
SNL/NM	6		8		360	e		374
SRS	89	127,500	6,034	1	1,616	7,717	3	142,960
WVDP	11	2,000	37	484	14,936	27		17,495
Y-12					2,934	7,262	325	10,521
Others	143		4		27,000	4		27,151
Total	1,091	347,350	94,459	2,156	355,775	71,710	4,530	877,071

[a]Includes both mixed and nonmixed as-generated wastes.

[b]Inventory as of the end of CY 1995 for EM-30 sites. Does not apply to FEMP, PAD, PORTS, and sites included in "Others" (FUSRAP sites, GA, GJPO Site, and RMI).

[c]Excludes about 40,000 m^3 of MLLW from environmental restoration activities (see Table 6.8 in Chapter 6).

[d]Includes contributions from Bettis Atomic Power Laboratory, Knolls Atomic Power Laboratory, and naval shipyards.

[e]Information unavailable or unknown.

Table 0.7. Volume (m^3) inventory of buried DOE site wastes as of EOFY 1996[a,b,c]

Site(s)	TRUW	LLW[d]	Total (site)
Ames		e	e
ANL–E			
ANL–W			
BNL		839	839
ETEC			
ETTP		81,048	81,048
FEMP		343,220	343,220
FNAL			
GJPO			
Hanford	63,600	639,948	703,548
INEEL	57,000	150,234	207,234
ITRI			
KCP			
LANL	14,000	228,220	242,220
LBNL			
LLNL		9,102	9,102
Mound			
NR sites			
NTS		514,055	514,055
ORISE			
ORNL	572	210,360	210,932
PAD		7,613	7,613
PANT			
Pinellas			
PORTS		12,110	12,110
PPPL			
RFETS			
SLAC			
SNL/CA			
SNL/NM	1	3,218	3,219
SRS	4,870	693,487	698,357
WVDP	1,350	f	1,350
Y-12		151,343	151,343
Total	141,393	3,044,797	3,186,190

[a]Excludes 89,472 containers (94,273 Ci, undecayed) of LLW in 50- and 80-gal drums disposed of by sea dumping.

[b]Excludes 17,300 m^3 (1,300,000 Ci, undecayed) of LLW grout injected into shale underlying the ORNL site.

[c]Excludes wastes from environmental restoration activities.

[d]The data listed for LLW represent disposed inventories and include materials that are not buried.

[e]Wastes from the Chemical Disposal Site at Ames were excavated and shipped to a commercial disposal facility in 1995.

[f]Only commercial LLW is buried at WVDP.

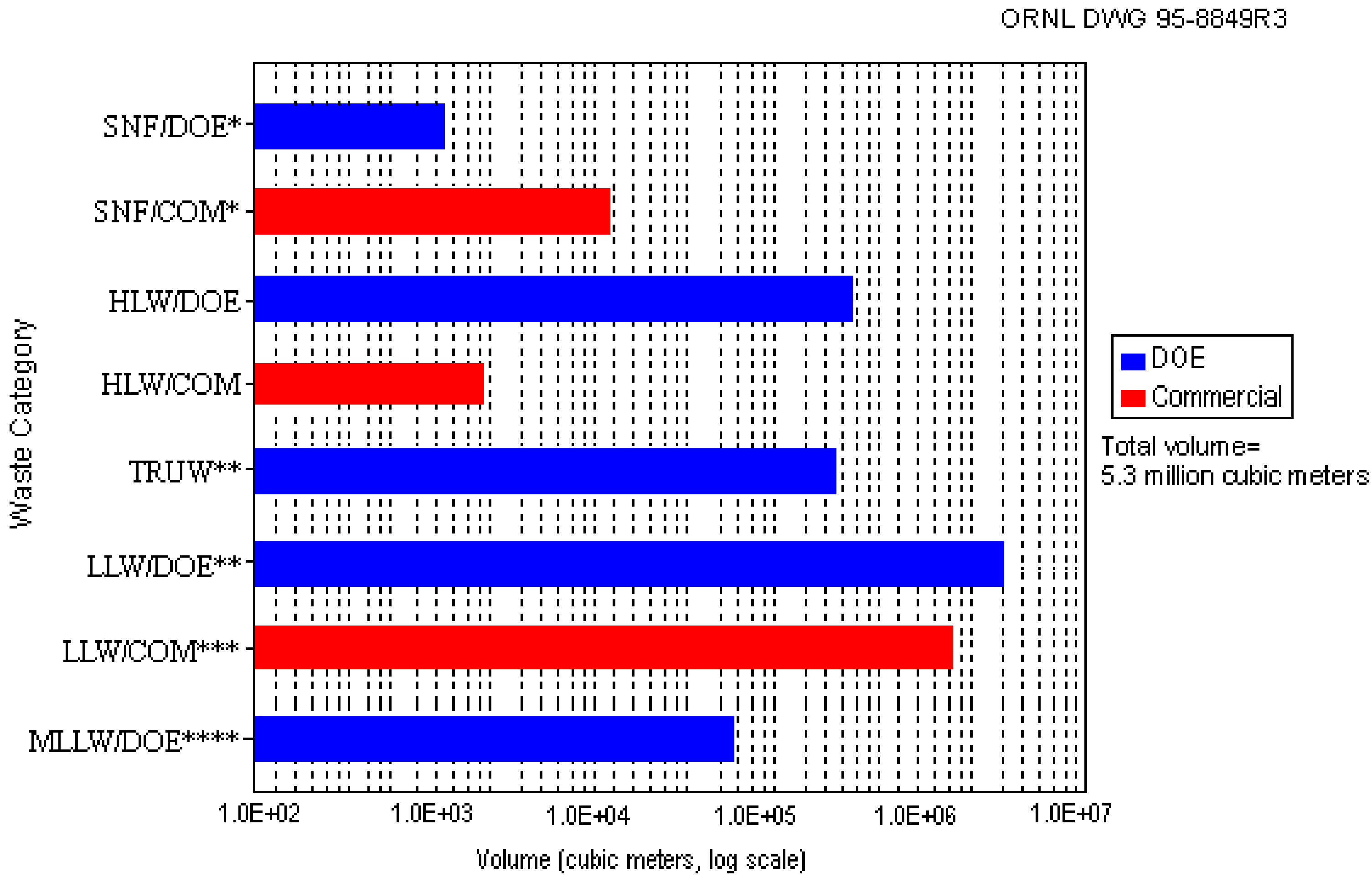
Integrated Data Base Report: DOE/RW-0006, Rev. 13

CHAPTER 0: TABLE 0.7 ERRATA

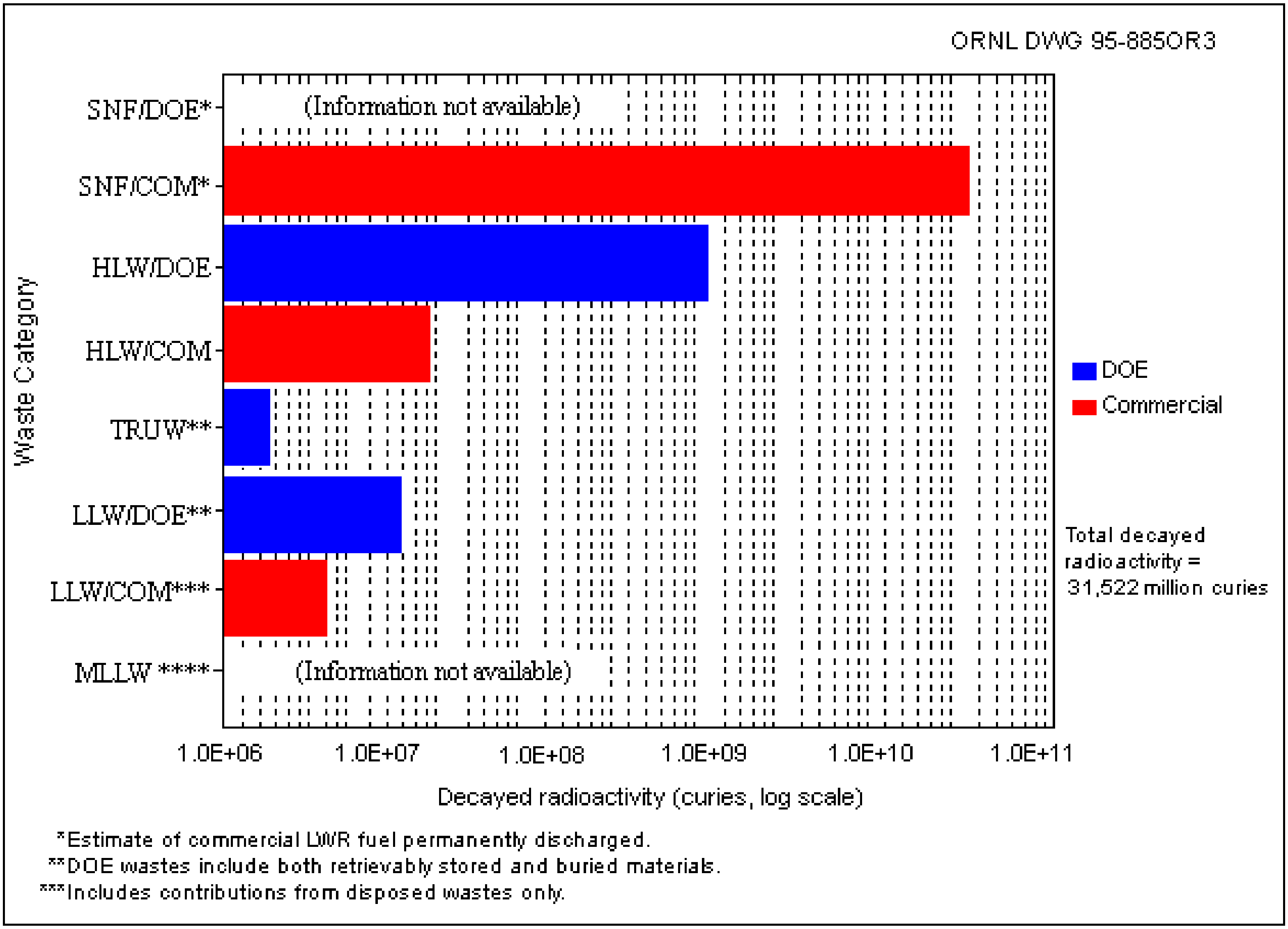
NOTE: Table 0.7 was revised to show that the Pantex Plant (PANT) has no land-disposed low-level waste (LLW). The table was revised on March 25, 1999, and the justification for the revision is as follows:

The inventory of disposed LLW previously reported for PANT in the Integrated Data Base Report was waste that had been placed in retrievable storage in a trench and pit located in the Nuclear Weapons Accident Residue Storage Unit at PANT. In the 1980s, all radioactive waste in this storage unit was removed and the site was remediated and closed. The LLW was ultimately shipped for disposal at the Nevada Test Site (NTS). Since the time of this remediation, PANT has not land disposed any LLW on-site. Presently, there is no land-disposed LLW at PANT, and the U.S. Department of Energy (DOE) has no plans to dispose of such waste at PANT in the future.*

***Source*: Jerry S. Johnson, DOE Amarillo Area Office, Amarillo, Texas, correspondence to Mavis Belisle, The Peace Farm, Panhandle, Texas, dated June 19, 1998.



*Permanently discharged reactor fuel. Includes spacing between fuel assembly rods.
**DOE wastes include both retrievably stored and buried materials.
***Includes contributions from disposed wastes only.
****Includes retrievably stored RCRA and TSCA materials only.


ORNL DWG 95-885OR3
SNF/DOE*
(Information not available)
SNF/COM*
HLW/DOE
HLW/COM
TRUW**
LLW/DOE**
LLW/COM***
MLLW ****
(Information not available)
Waste Category
1.0E+06
1.0E+07
1.0E+08
1.0E+09
1.0E+10
1.0E+11
Decayed radioactivity (curies, log scale)
DOE
Commercial
Total decayed radioactivity = 31,522 million curies
*Estimate of commercial LWR fuel permanently discharged.
**DOE wastes include both retrievably stored and buried materials.
***Includes contributions from disposed wastes only.