



Department of Energy

Washington, DC 20585

October 7, 1996

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

Enclosed is the "Low-Level Waste System Description Document" dated September 1996. This document is a deliverable pursuant to the commitment in Task Initiative IV.B.3. identified in the Department of Energy's Implementation Plan, Revision 1, for the Defense Nuclear Facilities Safety Board Recommendation 94-2. This document was developed as part of the Systems Engineering task for low-level waste management.

This System Description Document describes the Department of Energy's complex-wide low-level radioactive waste system. The document includes system requirements, functions, and interfaces for complex-wide management of low-level waste and documents the basis for the Low-Level Waste Program Management Plan deliverable. This system description, by definition, is a snapshot in time and thus does not include some recent policy statements and guidance. Once the Department's Waste Management Order is revised, it is the Department's intent to update the System Description Document to include the revised Order requirements, all Recommendation 94-2 results, policy, and guidance.

The Department has completed the actions identified under this commitment and proposes closure of this commitment.

Sincerely,

A handwritten signature in black ink, appearing to read "Alvin L. Alm".

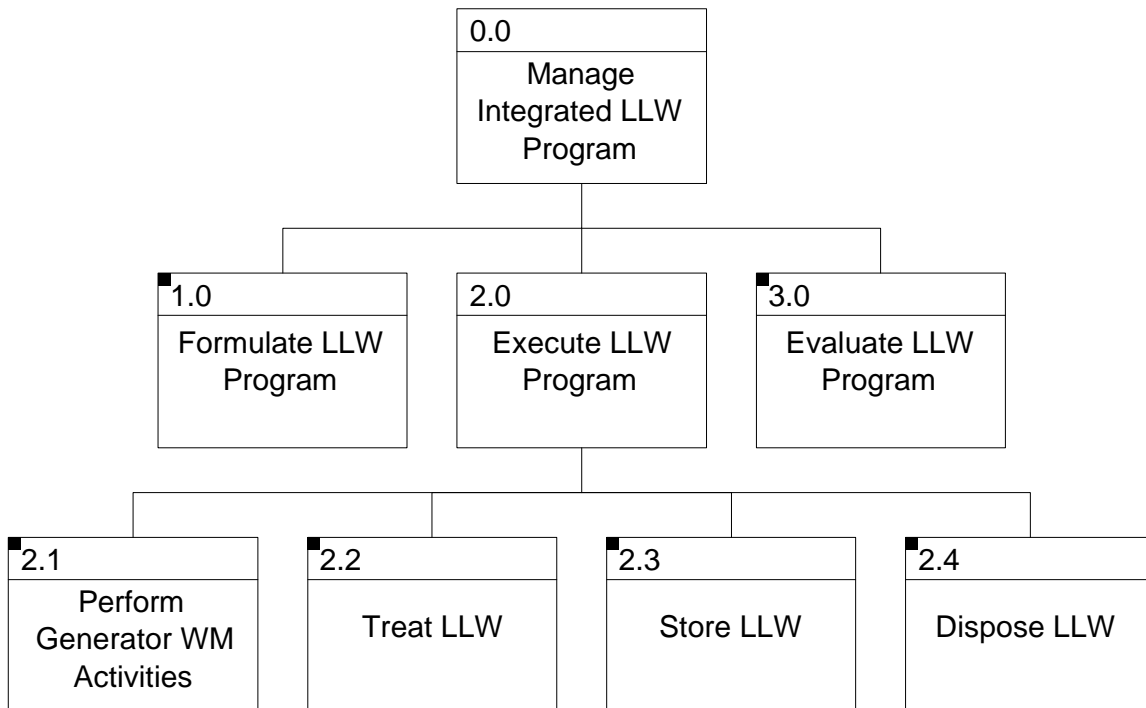
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Enclosure





DOE Low-Level Waste System Description Document



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This volume contains output from the system engineering software used to document results of the DOE Low-Level Waste (LLW) system functional analysis.

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CHAPTER 2. DOE LLW System Performance Measures

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A. Description of DOE LLW System Interface with MLLW

FOREWORD

This LLW System Description Document has been developed to describe the Department of Energy (DOE) complex-wide low-level radioactive waste (LLW) system. The detailed system description provided in this document will be used as a basis for program planning documents and complex-wide management of DOE's LLW.

The Department committed in its Implementation Plan¹ for Defense Nuclear Facility Safety Board (DNFSB) Recommendation 94-2, to prepare a LLW System Description Document. This document meets that commitment. As requirements, functions, and interfaces change, this document will be updated.

Volume 1 of the System Description Document provides a summary description of the complex-wide DOE LLW system. This includes background information to provide an understanding of the current and future states of the DOE LLW system, the system boundaries and interfaces, information on DOE LLW system-specific requirements, a description of the DOE LLW system functions, and measures established to evaluate performance against the system requirements.

Volume 2 of the System Description Document contains the detailed systems engineering analysis of the complex-wide DOE LLW system. This includes requirements extracted from source documents specific to the DOE LLW system; performance measures for those requirements; descriptions of each DOE LLW system function, including functional flow block diagrams and N-square diagrams; and descriptions of items that describe the interfaces (inputs and outputs) of the system functions.

Defining the DOE LLW system, establishing its boundaries, and identifying the pertinent policy, requirements, and guidance is an iterative process. This version of the LLW System Description Document is one of the first steps in the iterative process. This System Description Document describes an enhanced system based on current requirements and understanding. The process of developing the document has improved our understanding of how the existing system functions, enabling improved evaluation of the requirements leading to changes that will improve performance of the system. This improved understanding will help us identify current requirements that may be unnecessary and where additional requirements are necessary. As changes in policy, requirements, and guidance are made, they will be factored into a revised System Description Document that will provide the technical basis for an improved and well integrated DOE LLW system.

1. "Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 94-2, Conformance with Safety Standards at Department of Energy, Low-Level Nuclear Waste and Disposal Sites," Revision 1, April 1996.

This document is one of a series of inter-related documents that will:

- describe the DOE LLW system;
- establish the pertinent set of environmental, safety, and health policy and requirements; and
- provide management guidance to better integrate the DOE LLW system performance.

The inter-relationship of these documents is illustrated in Figure F.1 and discussed below.

Figure F.1: Top-Level DOE LLW System Documents

As illustrated in the table, content from the first two documents is used as input in developing the succeeding documents in the series (e.g., requirements from the LLW System Requirements Document are inputs into development of the LLW System Description Document which, in turn, is an input to the revision of DOE's Waste Management Order and the LLW Program Management Plan). Equally important, is that content from later documents in the series are

inputs that will be used to update and revise earlier documents in the series (e.g., new or revised policy, requirements, and guidance from the revised DOE Order 5820.2A and the LLW Program Management Plan are inputs back to the LLW System Description Document).

The LLW System Description Document and the LLW Program Management Plan provide the scope baseline for the DOE LLW system. They will be used to integrate system activities and to establish basic requirements for DOE LLW system-related work scope. These documents will be updated, as needed, to incorporate future revisions to DOE's Waste Management Order and Department policy. Future revisions to Department policy could result from:

- streamlining of the complex-wide disposal configuration;
- greater use of privatization and commercial facilities;
- impacts of external regulation; and
- Department and Waste Management re-engineering and performance measure initiatives.

In addition to reflecting policy changes, the next iteration of the System Description Document will incorporate results of program risk evaluation and strategic planning activities performed as part of developing the first issue of the Program Management Plan. The LLW System Requirements Document is superseded by the LLW System Description Document. The Complex-Wide Review Report is a one-time report and does not require updating.

CHAPTER 1. DOE LLW SYSTEM OVERVIEW

LLW MISSION

The mission of the DOE LLW system is to develop and implement a nationally integrated program for low-level waste management using a combination of Federal and private facilities to meet the needs of waste generators while fully protecting workers, the public, and the environment.

[LLW System Future State Document, December 31, 1993]

LLW VISION

The vision of the future DOE LLW system is of a nationally integrated, cost-effective program based on acceptable risk and sound planning which results in public confidence and support. This management and operations program will isolate and dispose of all legacy and D&D waste while also managing and disposing of newly generated wastes at the same rate it is being generated.

[LLW System Future State Document, December 31, 1993 and DOE Implementation Plan for Recommendation 94-2, Rev. 1, April 1996]

The Department of Energy (DOE) committed in its Implementation Plan for Defense Nuclear Facility Safety Board (DNFSB) Recommendation 94-2 (April 1996, Revision 1) to apply a systems engineering approach with the goal of creating a comprehensive, structured technical basis with clearly identified interfaces for the management of DOE's low level radioactive waste (LLW). This document describes a complex-wide system that will accomplish the LLW mission and reach the vision of its future state. It describes the system requirements, functions, and interfaces for management of the DOE's LLW and establishes a basis for program planning.

In addition to describing the current and future states of the DOE LLW management system, this chapter describes the approach used to integrate the system. Successful integration is dependent on a solid understanding of the DOE LLW system, including:

- DOE LLW system interfaces with other systems as represented in the DOE LLW system boundary description;
- requirements that the DOE LLW system must satisfy from Federal laws and regulations as well as DOE policy and orders;
- functions (tasks, actions or activities) that the DOE LLW system performs to satisfy the requirements; and
- means to determine if the requirements have been satisfied and to measure how well the DOE LLW system is performing.

Each of the above elements are discussed in this chapter and in subsequent chapters of this System Description Document.

1.1 System Description

Three of the elements described above (boundaries, requirements, and functions) establish the DOE LLW system scope. The system boundaries set the scope of the system's operations envelope and establish the need for physical and programmatic interfaces between the DOE LLW system and other operating systems both within and external to DOE. The system functions set the work scope necessary to accomplish the system mission and satisfy the DOE LLW system requirements. The DOE LLW system functions are performed within the operations envelope established by the DOE LLW system boundaries.

Figure 1.1 illustrates the life-cycle for management of DOE LLW. The LLW life-cycle is initiated at the point of generation once the waste is characterized and identified as LLW. New LLW follows the waste flow path which may include both treatment and/or storage prior to permanent disposal. Permanent disposal is the final step in the DOE LLW management life-cycle. LLW may be permanently disposed of at either a DOE facility or a commercial facility. However, it is currently DOE's policy to prefer permanent disposal of its LLW at either the facility at which it is generated or at another DOE facility.

Waste input to the DOE LLW system includes all DOE generated LLW and LLW assigned to the Department by interagency agreement or law, including classified LLW and commercial Greater-Than-Class-C (GTCC) LLW (see Chapter 2). Sources of new waste include DOE's Defense Programs, Energy Research, Nuclear Energy, Environmental Restoration, Waste Management operations, other government agencies, commercial enterprises with GTCC waste, and abandoned commercial sealed sources. Sites at which DOE manages LLW are shown in Figure 1.2.

1.2 A Systems Approach

As stated previously, a systems engineering approach has been used to describe the DOE complex-wide LLW management system and to establish a basis for program planning. The approach used follows the processes described in two nationally recognized industry standards: Institute of Electrical and Electronics Engineers P1220, Standard for Application and Management of the Systems Engineering Process, Final Draft, dated September 26, 1994, and Electronics Industries Association Engineering Standard IS-632, System Engineering, Final Draft, dated December 1994. Figure 1.3 depicts the application of these processes to the DOE LLW management system.

As shown in Figure 1.3, the systems engineering approach involved identifying requirements specific to DOE LLW across the complex, identifying the system functions and interfaces, and

Figure 1.1: DOE Low-Level Waste Management Life-Cycle

Figure 1.2: DOE Low-Level Waste Management Sites

Figure 1.3: Application of Systems Engineering Approach to DOE LLW Management System

establishing measures for assuring that system activities satisfy the DOE LLW system requirements. The resulting system description defines the current technical baseline for the DOE LLW management system and the work activities necessary to transition to the future state consistent with the LLW vision. The implementation strategy for completing the work activities and integrating the DOE LLW system will be incorporated in the Program Management Plan. The Program Management Plan will also establish program responsibilities and processes necessary to achieve the future state integrated program. As the technical baseline solutions progress toward the future state vision, verification activities will be performed to assure the system requirements are satisfied.

1.3 System Current State

This section discusses the current state of DOE's LLW management system. It provides a baseline for determining the system boundaries, requirements, and functions as well as measuring system performance. A clear description of the current state is also necessary to understand the envisioned future state.

The administrative processes, physical facilities, and organizational elements for managing DOE LLW are maintained by the Field Elements as necessary to meet their LLW objectives. Administrative processes include the activities necessary to verify waste as acceptable for treatment, storage, and disposal (T/S/D) as well as record keeping. The physical facilities include T/S/D facilities and any dedicated facilities needed to support the operation of the T/S/D facilities. Currently, DOE generally disposes of LLW as it is produced, although some LLW is stored on site awaiting treatment and/or disposal. Treatment of LLW occurs at DOE sites, although some sites are using commercially available treatment capabilities, to reduce the volume of waste requiring storage or disposal. The Department currently disposes of most of its LLW in six DOE-owned LLW disposal facilities operated at the Hanford Site, Idaho National Engineering Laboratory, Los Alamos National Laboratory, Nevada Test Site, Oak Ridge Reservation, and the Savannah River Site. A portion of the LLW generated from cleanup of DOE-contaminated sites is also being disposed at commercially available LLW disposal sites.

The most recent data available indicate that in 1994, DOE sites generated about 40,000 m³ of LLW, containing about 8.5 x 10⁵ Ci of radioactivity.² Although the Department currently generates LLW at more than 36 sites (see Figure 1.2), eight sites or programs accounted for about 90% of the total LLW volume generated by DOE sites. These sites include Hanford, the Idaho National Engineering Laboratory (INEL), Los Alamos National Laboratory (LANL), the Naval Reactors Program (NR) Sites, K-25 Site (K-25), Oak Ridge National Laboratory (ORNL), Y-12 Plant (Y-12), and Savannah River Site (SRS) (see Figure 1.4).

2. Source: "Integrated Data Base Report - 1994: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections and Characteristics," DOE/RW-0006, Rev. 11, September 1995.

Figure 1.4: DOE LLW Generation

Beginning early in the 1990s, development and testing to support nuclear weapons production and nuclear research activities have decreased while the focus on the cleanup of past contamination has increased. Consequently, the sources and types of waste now being generated are primarily associated with waste management activities, environmental restoration, and decommissioning. Because many environmental restoration and decommissioning sites are still being assessed, it is difficult to project the volumes of LLW that will be generated from those activities. LLW generation projections in the environmental restoration and decommissioning areas are based on preliminary remedial investigations and do not include those projects that have not yet been adequately investigated. The Department is currently implementing a process to allow routine evaluation of projected waste volumes against disposal capacity.

Treatment of LLW is primarily carried out for one of two purposes: making the waste acceptable for disposal and/or to reduce the waste's volume. Treatment processes include concentration or dewatering of dilute liquids, solidification, incineration, and compaction. Waste is either treated on site or transported for treatment at commercial facilities and then returned to DOE for disposal.

DOE low-level waste may be stored pending treatment or disposal in a variety of facilities at DOE sites. A number of situations may result in a waste being stored instead of being directly disposed. These include storage for decay, the need for an approved waste generator certification program, inability of the waste to meet waste acceptance criteria, or temporary non-availability of treatment or disposal capacity. At the end of 1995, about 170,000 m³ of DOE LLW was being stored.³ Facilities used for storage of LLW include conventional buildings, fabric-covered buildings, above-ground vaults, below-ground vaults, and outdoor pads. Contact-handled LLW (less than 100-200 mrad/hr) is generally stored on indoor and outdoor pads in an unshielded configuration, while remote-handled LLW (greater than 100-200 mrad/hr) is stored in shielded weather-protected vaults. Much LLW stored on outdoor pads is packaged in Department of Transportation (DOT) Specification 7A containers and may also be stored in cargo containers. Large volumes of uncontainerized bulk contaminated wastes such as soil and scrap metal are also stored outdoors.

As noted, disposal of DOE-generated LLW currently occurs at six DOE-owned sites (Hanford, INEL, LANL, NTS, ORNL, and SRS), and to a lesser extent, at a commercial bulk LLW disposal facility (Envirocare of Utah). In 1995, about 48,000 m³ of DOE-generated LLW was disposed of at DOE sites.^{2,4} This amount is representative of the annual volume of LLW that has been disposed during each of the last five years. In general, the other DOE sites transport their LLW

3. Source: "Current and Planned Low-Level Waste Disposal Capacity Report," July 30, 1996.

4. This volume represents what is commonly thought of as solid LLW; it does not include the volume of solidified liquid waste disposed of as saltstone at the Savannah River Site. A total of 22,400 m³ of saltstone had been disposed of through the end of 1994.

to one of these facilities for disposal (see Table 1-1 for generator-disposal facility configuration). Three of these sites (INEL, LANL, and ORNL) currently accept only LLW generated on-site for disposal. SRS disposes LLW generated on-site and also accepts limited quantities of LLW from Pinellas and Naval Reactor Program sites. Hanford and NTS are the only two of the six DOE LLW disposal sites that currently accept significant quantities of LLW generated off-site. In addition to disposal in DOE-owned facilities, some LLW is disposed of at the state-licensed Envirocare facility in Utah. In 1995, about 12,000 m³ of DOE LLW was disposed of at Envirocare.⁵ As discussed below, there are currently plans to establish additional DOE operated facilities for the disposal of LLW arising from cleanup activities at various DOE sites.

Table 1-1: Disposal Sites for Off-Site Generators of Low-Level Waste⁶

Disposal Site	Offsite Generators	
Hanford Site	Ames Laboratory, IA Argonne National Laboratory, IL Battelle Columbus Laboratory, OH* Bettis Atomic Power Laboratory, PA Bonneville Power Administration Brookhaven National Laboratory, NY Environmental Measurements Laboratory, NY Energy Technology Engineering Center, CA Fermi National Accelerator Laboratory, IL General Atomics, CA* Knolls Atomic Power Laboratory, NY Lawrence Berkeley Laboratory, CA	Laboratory for Energy-Related Health Research, CA Massachusetts Institute of Technology, MA* Mare Island Naval Shipyard, CA** National Renewable Energy Laboratory, CO Paducah Gaseous Diffusion Plant, KY Pearl Harbor Naval Shipyard, HI** Pittsburgh Energy Technology Center, PA Portsmouth Gaseous Diffusion Plant, OH Princeton Plasma Physics Laboratory, NJ Puget Sound Naval Shipyard, WA** Rocky Flats Environmental Technology Site, CO Stanford Linear Accelerator Laboratory, CA
Nevada Test Site	Aberdeen Proving Ground, MD** Army Industrial Operations Command** Defense Nuclear Agency** Energy Technology Engineering Center, CA Fernald Environmental Management Project, OH General Atomics, CA* Grand Junction Project Office, CO Inhalation Toxicology Research Institute, NM Kansas City Plant, MO	Lawrence Livermore National Laboratory, CA Mound Plant, OH Oak Ridge Reservation, TN Pantex Plant, TX Pinellas Plant, FL Reactive Metals Inc., OH* Rocky Flats Environmental Technology Site, CO Sandia National Laboratory, CA Sandia National Laboratory, NM
Savannah River Site	Bettis Atomic Power Laboratory, PA Knolls Atomic Power Laboratory, NY Newport News Shipbuilding, VA**	Norfolk Naval Shipyard, VA** Pinellas Plant, FL Portsmouth Naval Shipyard, ME**
* Non-government facilities that generate waste for which DOE is responsible for disposal.		
** Facilities managed by other government agencies that generate waste for which DOE is responsible for disposal.		

5. Source: Letter, A. Rafati (Envirocare), to S. Storch (ORNL), August 8, 1996.

6. After The Current and Planned Low-Level Waste Disposal Capacity Report, July 30, 1996.

1.4 System Future State

DOE's expectation for the LLW management system's future state is expressed in the vision statement noted at the beginning of this chapter. The future-state vision is that all activities are conducted in a safe and environmentally acceptable manner. It is expected that DOE's LLW system will be regulated by an external organization at some point in the future. However, for the near-term, the Department will continue to have oversight responsibilities for most LLW management activities at DOE. It is also assumed that DOE's LLW management activities will continue to be accomplished with stakeholder input to improve confidence that the system is progressing in an acceptable manner, both in terms of risk management and cost-effectiveness.

The envisioned DOE LLW management system will be comprised of facilities operating in compliance with a revised DOE Order on waste management. Department personnel will execute an oversight program to ensure compliance with established requirements, standards, and guidance. Near-term activities to accomplish the vision include development of essential requirements for characterization, certification, treatment, packaging, storage, transportation, and disposal, and adoption of strategies for moving all LLW management facilities towards compliance with the new requirements. Emphasis will be placed on optimizing the treatment and disposal capabilities across the complex based on numerous factors such as minimizing the DOE LLW system life-cycle cost, transportation risks, and worker health and safety concerns. Taking into account these factors that affect disposal configuration decisions, additional disposal facilities may be constructed for on-site disposal of Environmental Restoration (ER) wastes. Long-term LLW isolation will be accomplished by disposal of LLW as dictated by the waste characteristics, geologic performance, and stakeholder input. Long-term public protection will be ensured by continued institutional control of disposal facilities.

To support achievement of the future state, a number of goals have been established and assumptions of future conditions have been made.

Future State Goals

The system goals describe future expectations for the DOE LLW system and will be combined with the system requirements and other stakeholder inputs in a set of criteria for decision making. These goals were taken from DOE Order 5820.2A and the DOE's Implementation Plan in response to DNFSB Recommendation 94-2. The goals for the system as it transitions to the future state are listed in Appendix C.

Future State Assumptions

In developing the vision and goals of the future state of the DOE LLW system, assumptions were made concerning major programmatic issues which the Department could face. System assumptions are conditions or characteristics impacting the DOE LLW management system that

have not yet been proven or demonstrated. The DOE LLW management system assumptions are listed in Appendix D.

Risks to System Performance

Because the system assumptions result in risk to system performance, they should be tracked until they are proven, demonstrated, or revised. A good example of this is the assumption that the Department will continue to be self-regulating. As a result of recent initiatives by the Secretary of Energy, it is probable that this assumption will become invalid. When sufficient detail is available concerning external regulation, the impact and risk to the system and future state will require evaluation and management action.

System assumptions are not the only risks associated with achieving the desired future state. Other areas of risk include: obtaining required funding, change of key program personnel, and changes in the rate of waste volume generated due to changes in the Department's schedule for waste clean-up activities. These risks and the risks related to assumptions will be further evaluated in developing DOE's Program Management Plan for the LLW system.

1.5 Integration of System Activities

As previously discussed, integration is fundamental to achieving the mission and the vision for the future state of the DOE complex-wide LLW management system. To accomplish this, the Department has:

- committed to use a systems engineering approach to integrate its LLW activities and program planning;
- restructured management of the LLW program at Headquarters, and elevated the priority of LLW management; and
- initiated tasks to move DOE LLW disposal facilities towards compliance with the existing DOE Waste Management Order and to clarify LLW policies to ensure consistent management implementation.

The results of these efforts to improve technical strategy, management, and implementation will be combined in a Program Management Plan for the DOE LLW management system.

Technical Strategy

The capability to treat, store, and dispose of DOE LLW may be provided by a number of alternatives including: existing DOE facilities, new DOE facilities, or privately operated commercial facilities. As stated in the vision for the DOE LLW system (reference Section 1), an

objective of the LLW management and operations program is to provide capability to dispose of DOE LLW as it is generated. To meet this objective, a DOE complex-wide technical strategy is being developed for determining the location and type of new T/S/D capability and for allocating DOE LLW to existing T/S/D capabilities. As part of this strategy, decision making criteria incorporating stakeholder input will be developed and used to evaluate alternatives for acquiring new capability and allocating DOE LLW. The complex-wide configuration of these T/S/D capabilities will evolve in parallel with the Department's ongoing LLW system integration efforts.

Management

The restructured management of the DOE LLW program at Headquarters is responsible for developing the technical strategy, implementing the systems engineering approach and integrating the numerous 94-2 Implementation Plan tasks into a structured program. The 94-2 Implementation Plan tasks related to improved regulatory structure, LLW forecasting, and LLW research and development are integral to a successful technical strategy.

For the DOE LLW technical strategy to be effective, the system functions must be based on an accepted set of requirements that are understood and applied consistently across the DOE complex. To accomplish this, the requirements, standards, and guidance needed to improve the regulatory structure and process for DOE LLW management are being evaluated. Results of these evaluations will form the technical basis for developing DOE LLW management requirements for incorporation into a revision to DOE's Waste Management Order. As an adjunct to the studies, implementing guidance will be prepared. The results of the DOE LLW systems engineering activities support the regulatory structure and process activities and, in turn, the results of the regulatory structure and process activities will be input into a revision of the system description.

An effective technical strategy is dependent upon accurate forecasts of LLW generation. Efforts to improve the Department's projections of future LLW generation and disposal capacity needs are ongoing and reflected in the system functions. These functions include LLW activities of waste generators as a part of the DOE LLW system and focus on improving the Department's forecasting of future volumes of LLW needing to be disposed, and integrating planning for use of LLW T/S/D capacity. Guidance will also be issued for minimizing the generation of LLW.

Development of the technical strategy will also be enhanced by ongoing activities to redefine the DOE LLW system research and development needs. These activities, which are being coordinated with ongoing technology development programs and initiatives, provide a re-focused research program that takes into account the results of the systems engineering approach, the radiological assessments, waste projections, and the studies to determine improved standards, requirements, and guidance to improve the technical basis for LLW management.

Headquarters management will combine the results of the system engineering activities and the

94-2 Implementation tasks in a Program Management Plan that will:

- describe the programmatic strategies, policy initiatives, and assumptions for achieving the DOE complex-wide integrated LLW management system;
- describe the near-term and longer term actions, milestones and responsibilities necessary to achieve the desired future state of the DOE LLW system;
- identify the key management interfaces, organizational structure, and the appropriate divisions of roles and responsibilities among Headquarters and Field Elements; and
- describe the process for assessing effectiveness of the DOE LLW management system.

The Program Management Plan and this System Description Document will be updated, as necessary, to incorporate future changes in DOE LLW management policy and requirements.

Implementation

In addition to strong management, a firm technical basis, and guidance provided as part of the regulatory and forecasting activities, effective implementation of the DOE LLW technical strategy requires integration of resource allocation and work activity planning. As a part of the DOE LLW system evaluation functions, performance measures will be established and system operations across the complex will be evaluated on a periodic bases to assess performance and implement corrective action where necessary. Similarly, work activities will be controlled by the Field Elements to assure that resources are applied as planned and that the results of the LLW work activities meet established performance measures.

CHAPTER 2. DOE LLW SYSTEM BOUNDARIES AND INTERFACES

LLW generation, treatment, storage, and disposal activities occur throughout the federal government and in the private sector. The Department performs these activities in varying degrees throughout the DOE complex. Within the Department numerous programs manage LLW activities. It is therefore necessary that DOE clearly understand and define its LLW management system and interfaces with LLW generators to effectively manage the treatment, storage, and disposal of LLW. Boundaries of the DOE LLW system, identified below, describe the scope of LLW management activities.

2.1 System Boundary Description

The DOE LLW management system includes solid and liquid waste that is the management responsibility of the Department and meets the definition of LLW in the Nuclear Waste Policy Act of 1982, as amended:

“radioactive material that - (A) is not high-level radioactive waste, spent nuclear fuel, transuranic waste, or by-product material as defined in section 11e(2) of the Atomic Energy Act of 1954 [42 U.S.C. 2014(e)(2)]; and (B) the Commission, consistent with existing law, classifies as low-level radioactive waste.”

Examples of waste streams generated in the DOE LLW system are: legacy LLW; routine plant operations LLW (i.e., anti-C's, HEPA filters, etc.); LLW generated by Defense Programs (DP), Nuclear Energy (NE), and other Programs; and Department of Defense classified LLW. Programmatic activities of waste generators (DP, NE, and other programs) are outside the DOE LLW system until LLW is generated. However, generator responsibilities for LLW forecasting and pre-certification are considered within the DOE LLW system. The transportation of LLW within the DOE complex is also within the System. DOE LLW sent to commercial facilities for treatment, storage, or disposal is considered to have exited the DOE LLW system. If the waste is returned to DOE after treatment or storage, it again enters the system.

The following paragraphs delineate the DOE LLW system boundary with regard to mixed waste and other waste types:

Mixed Low-Level Waste contains both a hazardous and radiological waste component. The management of mixed waste is defined as outside the DOE LLW system to the extent that its management is driven by Resource Conservation and Recovery Act (RCRA) and the Federal Facility Compliance Act (FFCAct) requirements which are not applicable to LLW. There is, however, an important interface because mixed waste management must comply with all LLW waste requirements. If a treatment process renders the “hazardous” component of a mixed RCRA or TSCA waste “non-regulated,” the waste would then be managed solely within the

DOE LLW system after treatment (e.g., the treatment of characteristic mixed waste destroys its "hazardous component" rendering it LLW). Additionally, mixed waste may be stored or treated by the same facilities as LLW at a particular site, and this interface needs to be considered when managing the capability and capacity of these facilities.

Environmental Restoration LLW, including LLW from decommissioning activities, is within the DOE LLW system. Contaminated media in an in-situ remediation is outside the System because the waste has not yet been generated. However, the radionuclide source term contained in contaminated media will be factored into LLW disposal facility Composite Analyses for those facilities for which there is source-term interaction. For remediation sites that plan to excavate LLW for shipment to DOE disposal sites, the estimate of buried LLW serves as an inventory bounding assumption for planning future disposal.

DOE "special-case" waste is LLW that cannot currently be treated or disposed as LLW at the site at which it is currently generated or stored. This waste does not meet the definition of HLW or TRU but exhibits special characteristics (e.g., high radionuclide concentrations which preclude management as LLW at the site where it currently resides). These wastes however fit the definition of LLW and are within the DOE LLW system. This includes those low-level wastes considered PA limited (which would need to be handled specially at a particular site) and those wastes referred to as high specific activity LLW.

Accelerator produced wastes and DOE technologically enhanced naturally occurring wastes are within the DOE LLW system. Material defined as 11e(2) is to be managed as uranium mill tailings and is outside the DOE LLW system. However, the small quantities provisions in the DOE Waste Management Order (5820.2A) are such that small quantities of 11e(2) material may be inputs to the DOE LLW system and managed as LLW.

Commercially generated GTCC for which the Department has taken title, the management, and storage responsibility (prior to disposal) is within the DOE LLW system. The disposal of such wastes is currently expected to occur in facilities licensed by the Nuclear Regulatory Commission (presumably the High-Level Repository) and is outside of the DOE LLW system.

Incidental waste resulting from processing plant operations and incidental wastes generated in the further treatment of HLW, as defined by the Nuclear Regulatory Commission, that is managed as LLW and is considered within the DOE LLW system (if it is not mixed waste or TRU). Conversely, if after treatment LLW is concentrated such that it meets the definition of TRU, it is no longer part of the DOE LLW system and is managed as part of the TRU waste system.

Radionuclides contained in contaminated media, previously disposed mixed waste, TRU or other materials that remain in the ground are outside the DOE LLW system. However, such radionuclide material will be factored into the LLW disposal facility Composite Analyses for

those facilities for which there is source-term interaction.

2.2 Use of System Boundaries

The above described boundaries identify the envelope of operation for the DOE complex-wide LLW system. Thus, the system boundary (in conjunction with the system requirements) guides the determination of what functions (activities/actions) constitute the DOE LLW system. The system boundary will be utilized in the redraft of the Department's Radioactive Waste Management Order by specifying the scope of activities covered by the Order's LLW chapter. The Program Management Plan, specified by the 94-2 Implementation Plan, will be prepared for the DOE LLW system as defined by the above system boundary description.

2.3 System Interfaces

As discussed at the beginning of this chapter, to effectively manage the treatment, storage and disposal of DOE LLW, it is necessary that DOE clearly understand and define its LLW system interfaces with LLW generators. Interfaces may entail the physical transfer of DOE LLW or transfer of information such as waste acceptance requirements, manifests, or waste generation forecasts. Figure 2.1 graphically represents the interfaces between the DOE LLW management system and other DOE systems. The following paragraphs describe each of these interfaces:

The DOE LLW system interfaces with other Departmental Offices, such as DP, NE, and Energy Research which generate LLW as a byproduct of their operations. The DOE LLW system interacts with these Offices by providing them the acceptance criteria that waste must meet for the waste to be accepted for storage, treatment, or disposal by the DOE LLW system. The criteria include both complex-wide specifications and specifications specific to the receiving site. These criteria are referred to as "Waste Acceptance Criteria" (WAC). WACs include specifications such as the amount of free liquids allowable in a barrel of waste and limits on the concentration of specific radionuclides. These Departmental Offices in turn provide the DOE LLW system both the waste and waste stream data. Therefore, although most generator activities are outside the scope of the DOE LLW system, the generator activities of waste forecasting, pre-certification of waste generation, and waste characterization are within the DOE LLW system.

Through an Interagency Agreement, a similar interface exists with the Department of Defense with regard to classified LLW.

When EM activities generate LLW, the same interface exists with EM generation activities as

Figure 2.1: DOE LLW System Interfaces

with other Departmental Offices generating LLW. EM activities input routine plant operation LLW streams, ER LLW streams, D&D LLW streams as well as waste data to the DOE LLW system. The DOE LLW system provides (outputs) treatment, storage, and disposal WACs to the EM programs conducting activities that generate LLW.

The DOE LLW system also interfaces with the other waste type systems: the mixed waste system, the TRU system, and high-level waste system.

The mixed waste system will produce LLW as input to the DOE LLW system (i.e., if the mixed waste treatment process renders the “hazardous” component of a mixed RCRA or TSCA waste “non-regulated,” the waste then is “transferred” to the DOE LLW system). In conjunction with the waste, waste stream data is “transferred.” Disposed mixed waste radioactive source term data is an input from the mixed waste system to the DOE LLW system, allowing the DOE LLW system to prepare required composite analyses for LLW disposal facilities. The DOE LLW system provides LLW waste acceptance criteria to the mixed waste system. Due to the potential of programmatic planning interactions with mixed waste, it is beneficial to clearly describe the interface between the DOE LLW system and the Mixed Waste system. A summary description of the interfaces specific to the Mixed Waste system is in Appendix A, with a detailed listing of these interfaces given in an appendix to Volume 2.

The TRU system will produce routine plant operation LLW streams that along with its waste stream data is input to the DOE LLW system. The DOE LLW system may produce TRU waste streams (if after treatment, the alpha concentration of the LLW is concentrated above 100 nci/gm) which are then input to the TRU system. The TRU system will provide TRU WACs to the DOE LLW system. The TRU system also needs to provide the DOE LLW system radioactive source term data of any TRU waste to be left in the ground at the site.

The high-level waste system will also produce routine plant operation LLW streams and radioactive source term data. In addition, the high-level waste system will generate incidental LLW which is an input to the DOE LLW system. The DOE LLW system will develop a WAC for the incidental waste.

Commercially generated GTCC is an input to the DOE LLW system for its storage and treatment and is an output for its disposal.

The utilization of commercial T/S/D facilities is outside the DOE LLW system. Therefore, service contracts for and waste sent to these commercial facilities are an output from the DOE LLW system. The commercial facilities provide the Department with their WAC for the waste to be sent them. Wastes returned to the Department for storage or disposal are inputs to the system.

2.4 Use of System Interfaces

The system interfaces described above will be utilized in the redraft of the Department's Radioactive Waste Management Order and in the development of definitions of the different waste types. The description of organization interfaces will guide the development of organizational roles and responsibilities. A more detailed description of the organizational interfaces resulting from the system's strategic planning and implementation planning functions will be provided in the Program Management Plan.

CHAPTER 3. DOE LLW SYSTEM-SPECIFIC REQUIREMENTS

Requirements are statements or specified characteristics that identify what the system must accomplish to produce the required result or objective. A requirement must be measurable or verifiable. Requirements identify tasks, actions, or activities (functions) that must be accomplished. Requirements establish “what” the product must contain, “when” the product must be complete, or “how well it must be done” (performance measure).

Requirements that define the DOE LLW system have been derived from Federal statutes and Departmental orders, policy statements, and plans. Source documents for the requirements are listed in Table 3-1, below. Only requirements specific to the DOE LLW system have been included. Other Department general requirements that apply to all work and specify "how well" the activities (functions) must be performed (e.g., requirements for life-cycle asset management, budget formulation, and configuration management) are not part of the DOE LLW system requirements. These requirements will be specified at the work planning level.

Table 3-1: Source Documents for LLW-Specific Requirements

- The Nuclear Waste Policy Act of 1982, as amended
 - Low Level Radioactive Waste Policy Act of 1985, as amended
 - DOE Order 5820.2A, Radioactive Waste Management
 - Memorandum, July 21, 1995, T. P. Grumbly, Interim Policy on Regulatory Structure [Establishes requirements on Performance Assessment review and approval.]
 - Memorandum, October 12, 1993, T. P. Grumbly, "Exemption from Department of Energy Order 5820.2A for Mixed Waste from Environmental Restoration and Waste Management Activities." [Authorizes use of commercial facilities for disposal of small quantities of mixed waste on a case-by-case basis.]
 - DOE Implementation Plan for Recommendation 94-2, Rev. 1, April 1996
-

The DOE LLW system requirements were initially issued in April 1996, as a stand-alone document entitled, “DOE Complex-Wide Low-Level Waste Program Requirements.” Subsequently, the DOE LLW system requirements have been revised to incorporate changes resulting from revision of the Implementation Plan for DNFSB Recommendation 94-2.

3.1 Description of System Requirements

The current DOE LLW system requirements are included in Chapter 1 of Volume 2 of this Systems Description Document. It contains approximately three hundred requirements which specify: work scope, Department policies, quantitative measures, and product descriptions. When

major revisions are made to the source documents that the DOE LLW system requirements are derived from, this System Description Document will be updated.

3.2 Summary of System Requirements

Each DOE LLW system requirement has been given a unique identifier. The unique identifier is an alpha-numeric designator that provides traceability back to the source document. The designators are:

DOE.R.x where x is a unique number, identifies requirements originating in statutes, policy statements, orders, notices, manuals, and letters containing policy statements.

IP.R.x where x is a unique number, identifies requirements that originate in the DOE Implementation Plan for DNFSB Recommendation 94-2.

A majority of the DOE LLW system requirements establish system scope, set system boundary conditions, or specify the execution of work. For example, the Nuclear Waste Policy Act, as amended, requirement, DOE.R.1, establishes the statutory definition of LLW. DOE.R.10, from DOE's Radioactive Waste Management Order, specifies boundary conditions by requiring the radioactive components of mixed low-level waste to adhere with the LLW requirements. Other requirements that assign responsibility also set boundary conditions. These include requirements from the Nuclear Waste Policy Act and the Low Level Radioactive Waste Policy Act, as amended, (DOE.R.1.1, DOE.R.2 and DOE.R.3) which give the Secretary of Energy the authority and responsibility to assume ownership of closed commercial disposal sites, responsibility for LLW generated by other federal government agencies, and responsibility for commercial GTCC waste.

A key work scope requirement from the DOE Implementation Plan for DNFSB Recommendation 94-2 (IP-R-9) specifies an integrated LLW program to be implemented with the objective of disposing of DOE-owned LLW. DOE.R.32, from the DOE Radioactive Waste Management Order, specifies that such disposal shall be by methods appropriate to achieve stated performance objectives. A number of other scope requirements specify treatment, storage, and disposal related activities.

Work scope requirements from the DOE Implementation Plan for DNFSB Recommendation 94-2 (IP.R.63, IP.R.187.1, etc.) specify the need for continuing activities to assess the requirements and develop additional requirements and guidance where necessary. These scope requirements direct the system to consider existing commercial requirements as input to the development of requirements. A number of requirements (DOE.R.30, IP.R.2.2, IP.R.221.3, and IP.R.239) specify the need for a projections process that includes improved LLW forecast data and for a process to assure waste minimization and pollution prevention criteria have been incorporated

into LLW generation planning processes. One of these requirements (DOE.R.30) assigns to the LLW generator the responsibility for providing LLW projections. A number of work scope requirements (DOE.R.16, IP.R.42, etc.) address the preparation and approval of performance assessments and composite analyses to establish the performance objectives for disposal facilities. Other key work scope requirements specify the need for developing Waste Acceptance Criteria (WAC), characterizing LLW, and certifying LLW meets the receiving facility's WAC.

3.3 Use of System Requirements

The DOE LLW system requirements provide a baseline for development and operation of DOE's LLW management system. Decisions made regarding DOE's LLW management system must be consistent with the requirements. Requirements that specify scope establish the bases for LLW management system activities (functions) which will be performed. Other requirements establish boundary conditions on the system. Requirements that assign responsibility require appropriate actions to be taken. Requirements that specify level of performance, product descriptions, and completion dates establish performance measures for the system. Adherence with these measures will be verified as a part of the DOE LLW system evaluation functions. Application of the requirements is further discussed in Chapter 4, DOE LLW System Functions, and Chapter 5, LLW Performance Measures.

CHAPTER 4. DOE LLW SYSTEM FUNCTIONS

Functions identify tasks, actions, or activities performed by DOE's LLW system to satisfy the DOE LLW system requirements, execute the DOE LLW system processes, and develop the required products to achieve the LLW mission. A function produces one or more products (outputs) and requires one or more enabling conditions (inputs). It is generally described using a verb/noun combination e.g., "store waste," and has an interface with at least one other function. A function describes what must be done, not how.

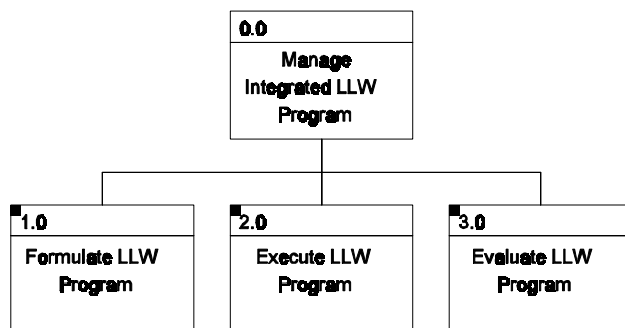
The DOE LLW system functions are the activities that are performed to operate DOE's complex-wide LLW management system. These functions were compiled by Headquarters and Field personnel familiar with the day-to-day functioning of DOE's LLW management system and the associated management activities.

4.1 Description of System Functions

One hundred and forty-two functions have been demarcated to describe DOE's LLW management system. A summary description of the DOE LLW system functions is provided in the following paragraphs. Detailed descriptions are provided in Chapter 3 of Volume 2 to this document. Diagrams depicting the complete set of LLW functions are provided in Appendix B of this volume.

Figure 4.1 presents the top-level LLW functions. The top-level function, "Manage the Integrated LLW Program," is derived from DOE's mission statement for the LLW program, "... to develop and implement a nationally integrated system for low-level waste management ...". The three subfunctions: *Formulate*, *Execute*, and *Evaluate the LLW Program*⁷ are the management

Figure 4.1: Top-Level LLW Functions



7. Throughout this chapter, the names of functions will be shown in italics with the initial letter of each word capitalized.

functions which establish a framework for further functional breakdown. The *Formulate*, *Execute*, and *Evaluate* functions are not sufficiently detailed to manage the DOE LLW system, and therefore have been broken down into more detailed functions to a level where sufficient detail for management purposes is provided. Functions necessary to integrate the DOE LLW system and to perform program planning across the DOE complex are included under the *Formulate* function. The *Execute* function addresses activities necessary to assure safe, environmentally sound, and efficient treatment, storage, and disposal of LLW. Activities related to measuring and evaluating performance are included as part of the *Evaluate* function. The following sections describe these three functions in greater detail.

4.1.1 Formulate Functions

The *Formulate* function is broken down into six more detailed functions as shown in Figure 4.2 and discussed in the following paragraphs.

Set LLW Policy includes the review of existing standards and requirements, evaluation of alternative DOE LLW policies, and achieving consensus among various stakeholders on the

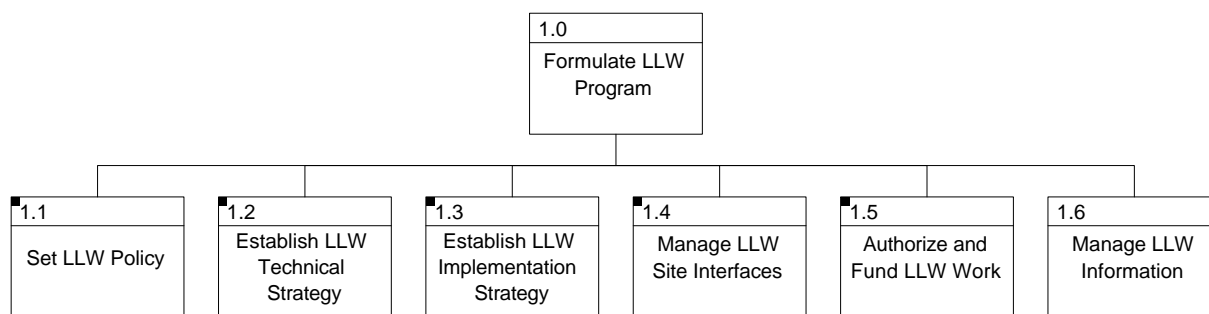


Figure 4.2: Formulate Functions

Department's LLW policies. Development of new or revised policy positions for revision of DOE Order 5480.2A, Radioactive Waste Management, are included in this function.

Establish LLW Technical Strategy encompasses the strategic planning activities to integrate DOE's LLW program activities. This function includes defining the technical baseline for the DOE LLW system, pre-certifying waste generation, forecasting the LLW generation rates (both volume and radionuclide content), developing LLW configuration strategies (location and type of T/S/D facilities and distribution of LLW across the complex), and performing systems engineering analyses.

Establish LLW Implementation Strategy includes planning activities to combine technical baseline information with cost and schedule baseline information in an implementation strategy to meet the

LLW mission. This function includes defining divisions of responsibility between Department organizational elements and between the DOE and other Federal organizations, establishing the LLW Program organization, establishing complex-wide LLW program milestones, and defining the cost and schedule goals for the LLW program. The implementation strategy is documented in the LLW Program Management Plan.

Manage LLW Site Interfaces includes Field Element activities defining and documenting DOE LLW T/S/D site interfaces in Memoranda of Understanding (MOU) and other cooperative agreements and actively managing interfaces between DOE sites.

Authorize and Fund LLW Work includes Field Element activities to develop DOE site budget requests for LLW activities, Headquarters activities ensuring site budget submissions for LLW activities are consistent with the LLW program goals and objectives, Headquarters activities for preparing program execution guidance and adjusting DOE site budgets for LLW activities based on Congressional appropriations, and Field Element funding of LLW activities.

Manage LLW Information includes record management and configuration control activities necessary to maintain the System Description Document, Program Management Plan, and documents specifying the DOE complex-wide LLW T/S/D configuration.

4.1.2 Execute Functions

As shown in Figure 4.3, there are four subfunctions to the *Execute* function. They represent the four steps in the radioactive waste life-cycle management process: generation, treatment, storage, and disposal. These four subfunctions include the activities associated with the generation of LLW and the activities needed to treat, store, and dispose of LLW in a safe, environmentally sound, and efficient manner. The *Execute* subfunctions are further discussed in the following paragraphs.

Perform Generator WM Activities includes activities which the generator of LLW is expected to perform. These activities include providing information on the generator's LLW process to pre-certify waste before generation, implementing waste minimization and pollution prevention practices, providing LLW forecast data, characterizing LLW, and certifying and packaging LLW for shipment.

Treat LLW includes activities to acquire LLW treatment capability, to operate and maintain existing treatment facilities and to close treatment facilities. The function to acquire LLW treatment capability includes three options: (1) procurement of treatment capability from a commercial supplier, (2) use of existing capacity, and (3) construction of new DOE facilities. Operate and maintain existing treatment facilities includes receiving LLW for treatment, interim storage of the waste both before and after treatment, treatment of the waste, and certifying and

packaging LLW for shipment. Activities to close treatment facilities include the actions necessary to decontaminate and decommission the treatment facilities.

Store LLW includes activities to acquire LLW storage capability, to operate and maintain existing storage facilities and to close storage facilities. The function to acquire LLW storage capability includes three options: (1) procurement of storage capability from a commercial supplier, (2) use of existing capacity, and (3) construction of new DOE facilities. Operate and maintain existing storage facilities includes receiving LLW for storage, monitoring the waste in storage, and certifying and packaging LLW for shipment. Activities to close storage facilities include the

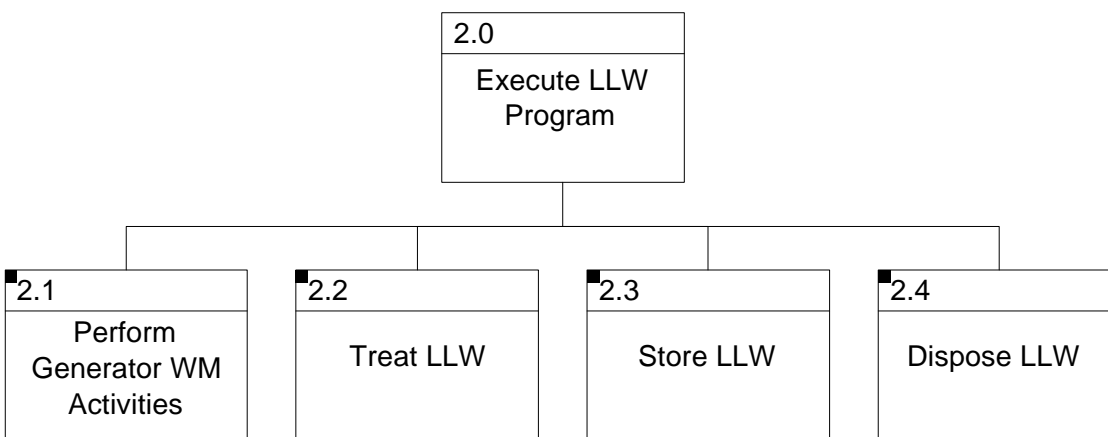


Figure 4.3: Execute Functions

actions necessary to decontaminate and decommission the storage facilities.

Dispose LLW includes activities to acquire LLW disposal capability, to operate and maintain existing disposal facilities and to close disposal facilities. The function to acquire LLW disposal capability includes three options: (1) procurement of disposal capability from a commercial supplier, (2) use of existing capacity, and (3) construction of new DOE facilities. The acquire function also includes activities to prepare and maintain radiological performance assessments (PA) and composite analyses (CA). Operate and maintain existing disposal facilities includes receiving LLW for disposal and monitoring the disposed waste. Activities to close disposal facilities include the actions necessary to monitor and maintain the disposal facility after closure.

4.1.3 Evaluate Functions

The *Evaluate* function, depicted in Figure 4.4, is broken down into subfunctions for measuring and evaluating performance of the DOE LLW system. It includes activities for establishing performance measures (technical, regulatory, cost and schedule); evaluating reported performance data relative to established performance measures, and identifying and recommending potential

changes. These subfunctions are further discussed in the following paragraphs.

Assemble Performance Measures includes activities of selecting and approving appropriate complex-wide and site technical, regulatory, cost and schedule performance measures for DOE LLW system functions.

Collect Performance Data includes activities of collecting performance data from across the complex to support the evaluation of the system's status in meeting the approved performance

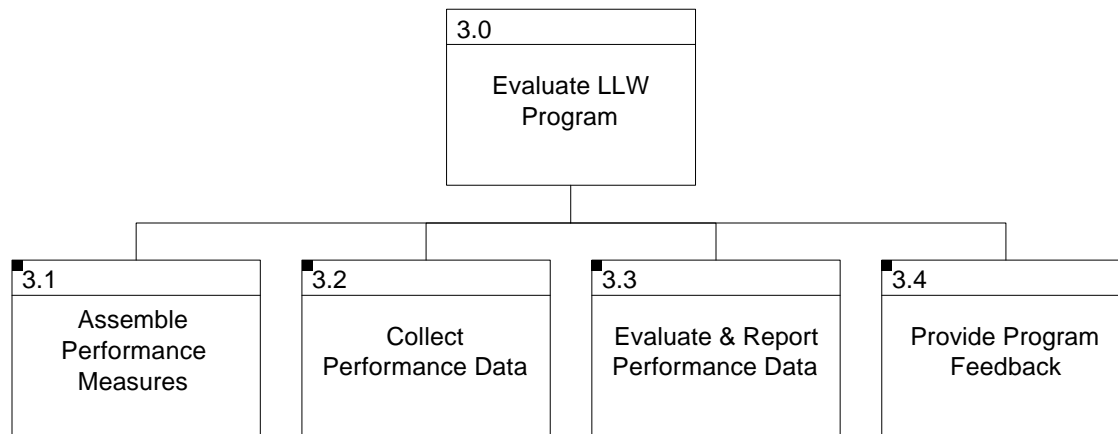


Figure 4.4: Evaluate Functions

measures.

Evaluate & Report Performance Data subfunctions include activities of evaluating performance data relative to approved performance measures and reporting on variances.

Provide Program Feedback includes activities to identify and recommend potential changes to LLW policy, contractor award fees, LLW strategies and interfaces, changes to T/S/D capacity configuration, and any necessary enforcement actions.

4.2 Allocation of Requirements to Functions

The DOE LLW management system functions, documented in the functional hierarchy map, support the accomplishment of the DOE LLW system requirements. As a part of the functional analysis, each LLW requirement was allocated (assigned) to one or multiple functions. A description of all functions and their allocated requirements is documented in Chapter 3 of Volume 2.

Of the 142 system functions, there are 101 functions at the level at which work is performed. Forty-five of these functions have no DOE LLW system-specific requirements that cause these functions to be performed. Of these 45, 31 functions are caused by Department requirements that are not LLW-specific. Some of the key source documents for the non-LLW-specific requirements are shown in Table 4-1.

Table 4-1: Source Documents for Non-DOE LLW-Specific Requirements

The documents listed below are key sources of requirements that are not specific to the DOE LLW system.

- 10 CFR 830, Nuclear Safety Management
- 10 CFR 835, Occupational Radiation Protection
- 40 CFR 61, National Emission Standards for Hazardous Air Pollutants
- National Environmental Policy Act (NEPA)
- DOE Order 130.1, Budget Formulation Process
- DOE Order 232.1, Occurrence Reporting and Processing of Operations Information
- DOE Order 430.1, Life-Cycle Asset Management, for project management
- DOE Order 440.1, Worker Protection Management for DOE Federal and Contractor Employees
- DOE Order 460.2, Packaging and Transportation Safety
- DOE Order 5400.5, Radiation Protection of the Public and the Environment
- DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities
- DOE Order 5480.22, Technical Safety Requirements
- DOE Order 5484.1, Environmental, Safety, and Health Protection Information Reporting Requirements, for environmental monitoring programs
- DOE Order 5700.6C, Quality Assurance

Fourteen functions do not have any requirements (LLW-specific or non-LLW-specific) that cause them to be performed. The most prominent of these functions are: *Confirm T/S/D Need/Compatibility*, *Monitor Waste in Treatment*, *Place Waste in Storage*, *Update PA/CA for Closed Conditions*, and *Monitor Waste Containment*. The results of this functional analysis are being utilized in the revision of DOE's Radioactive Waste Management Order to support the development of additional requirements where functions exist with no driving requirement. When this Order is redrafted, any changed or new requirements will be incorporated into the DOE LLW system description.

4.3 Description of System Interfaces

System interfaces identify the interactions among functions within the DOE LLW system and interactions between functions of the DOE LLW system and other systems. Interfaces between functions of the DOE LLW system and other systems have previously been discussed in Chapter 2. The focus of this section is on the interactions among functions within the DOE LLW system.

The interfaces among functions within the DOE LLW system are described by the inputs and outputs that flow between the functions. The inputs and outputs that flow between the functions can be information such as the characteristics of a LLW stream, or a physical transfer, such as the waste stream or a container of LLW. The flow of inputs and outputs for the DOE LLW system functions are depicted in N-square diagrams. An example and definition of an N-square diagram are provided in Figure 4.5 on the following page. An N-square diagram has been developed for each function in the LLW functional hierarchy that has more detailed subfunctions. A summary discussion of the top-level N-square diagrams is provided in the following paragraphs. Additional N-square diagrams and detailed discussion are included in Chapter 3 of Volume 2 of this document. A detailed description of each item that flows between the functions is provided in Chapter 4 of Volume 2.

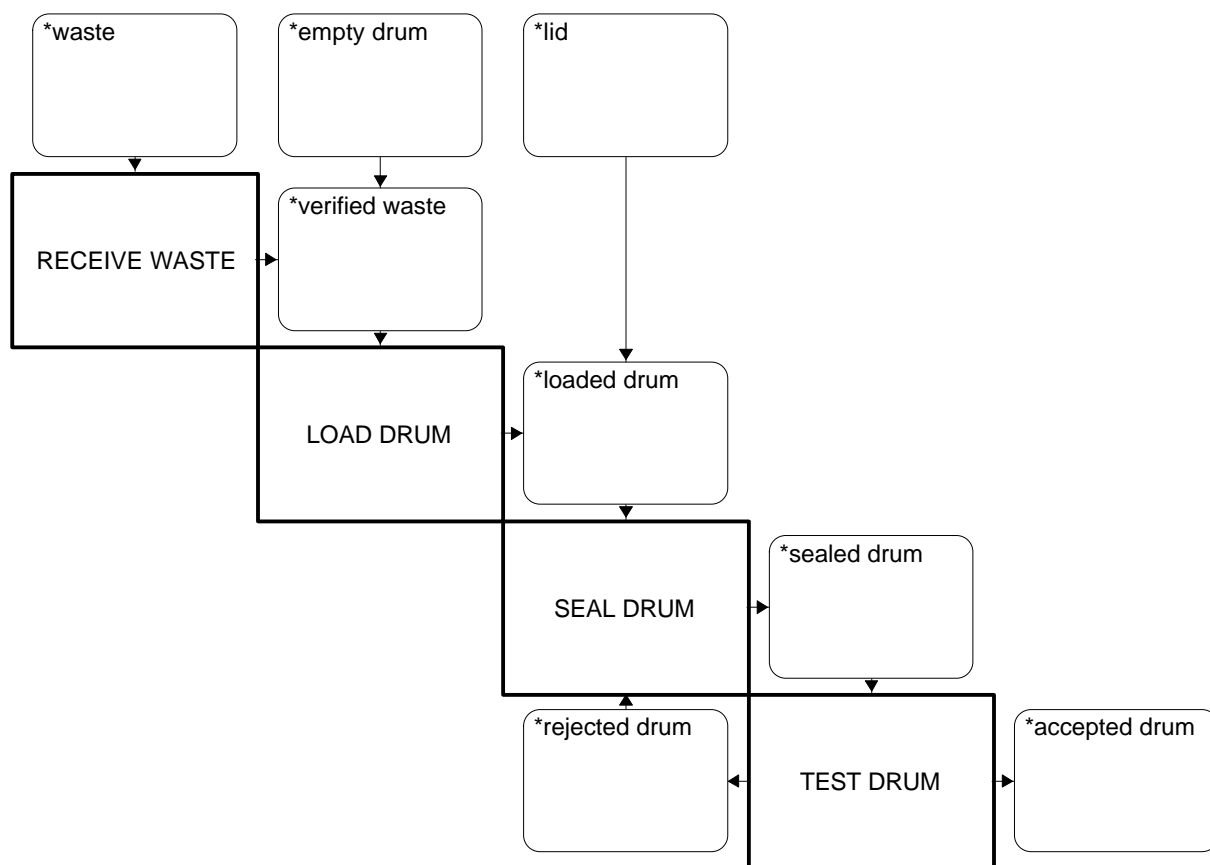
Figure 4.6 is referred to as an IDEF⁸ diagram and was developed as a roll-up of the N-square diagrams for the DOE LLW system. The IDEF diagram shows the top-level inputs and outputs of the DOE LLW system. The left side of the diagram depicts input into the DOE LLW system such as *Newly Generated LLW*⁹. Outputs exit the system such as *Closed T/S facilities* and *DOE LLW to commercial T/S/D Service* are shown exiting the system on the right side. Inputs entering from the top of the diagram are external requirements placed on the system (controls) including *Existing DOE LLW policies and Orders*. Resources, such as *Congressional appropriations*, are shown entering the system at the bottom.

8. IDEF (Integration Definition Function Modeling) is a modeling methodology for developing structured graphical representations of a system. Use of this modeling technique permits the construction of models comprising system functions (activities, actions, processes, operations), functional relationships, and data (information or objects) that support systems integration.

9. Throughout this chapter, the names of inputs and outputs will be shown in italics.

Figure 4.5: N-Square Diagram Example

The flow of inputs and outputs for the DOE LLW system functions are depicted in N-square diagrams. N-square diagrams consist of a square matrix comprised of “n” columns by “n” rows, hence the name N-square or N^2 . “N” equals the number of functions to be shown in the diagram. If four functions are to be shown, “n” equals four and the matrix is four columns by four rows. External inputs and outputs are shown coming into or coming out of the four functions included in the matrix.



A typical set of activities that might be used to package waste are used in this example. The functions are shown along the shaded diagonal. Inputs from external sources (waste, empty drum, and lid) are on the top row and the output (accepted drum) to a function not shown is shown in the right hand column. Items that are inputs to a function are shown in the same column as the function (e.g., “empty drum” and “verified waste” are inputs to LOAD DRUM). Outputs from a function are shown in the same row as the function (e.g., “accepted drum” and “rejected drum” are outputs of TEST DRUM). “Rejected drum” is an input back to “SEAL DRUM.”

Figure 4.6: LLW Level 0 IDEF Diagram

4.3.1 Formulate Interfaces

The interfaces among the *Formulate* functions are depicted in Figure 4.7 and described in the following paragraphs.

Set LLW Policy receives inputs from outside its parent function, *Formulate LLW Program*, which include the *94-2 Implementation Plan*, *domestic standards/requirements*, *existing DOE LLW policies & orders*, and others as shown. These external inputs are used by the *Set LLW Policy* function to provide the output entitled *LLW input to DOE orders and policies*. This output is not an input to any other function within the DOE LLW system. It only goes to functions and activities outside the DOE LLW system, such as revising DOE Order 5480.2A and issuing Department policy.

Establish LLW Technical Strategy also receives inputs, as shown in the figure, from functions outside of the parent function. Inputs from the *Execute* functions such as *generator request & process data* and *generator forecast data* are evaluated as part of this function prior to providing the outputs: *LLW technical strategy* and *complex-wide LLW forecast data*. Similarly, recommendations from the *Evaluate* function for improving configuration and forecasting are evaluated as part of developing the LLW technical strategy. In addition to those already mentioned, major outputs from this function include: criteria that will be used to determine the optimum complex-wide facility configuration and allocation of waste to facilities; LLW input to the WM PEIS ROD; an evaluation of the safety merits of LLW privatization; the Systems Description Document; justification of mission need for any new T/S/D facilities; and a strategy to obtain needed LLW R&D.

Establish LLW Implementation Strategy receives many of the same external inputs as the two previous functions. However, it combines these inputs with inputs from the *Establish LLW Technical Strategy* function to produce the LLW Program Management Plan and any corrective action plans required as a result of oversight findings/recommendations. These two outputs are inputs to other *Formulate* functions and many of the *Execute* and *Evaluate* functions.

Manage LLW Site Interfaces utilizes the external inputs *existing DOE LLW policies and strategies* and inputs from *Establish LLW Technical Strategy* and *Establish LLW Implementation Strategy* in defining and documenting DOE LLW T/S/D site interfaces in Memoranda of Understanding (MOU).

Authorize and Fund LLW Work uses *Activity Data Sheets* generated by the Field Elements as inputs to the DOE budget process. Upon receiving *Congressional Appropriations*, Headquarters provides execution guidance to the Field Elements.



Figure 4.7: Formulate Interfaces

Manage LLW Information receives DOE LLW management system records and documents which need to be maintained and controlled as inputs and provides *permanent records* as outputs.

4.3.2 Execute Interfaces

Interfaces for the *Execute* functions are shown in Figure 4.8. The *Execute* function includes the activities related to the actual flow of waste from one subfunction to another: *new LLW* shipped from the generator to either *Treat*, *Store*, or *Dispose*; *treated LLW* as an input to *Store* or *Dispose*; and *stored LLW* as an input to *Treat* or *Dispose*. [Note: Any LLW shipment includes the shipping facility or organization's request for approval to ship and certification to the receiving facility's WAC.]

For each of the possible flow paths, the diagram also depicts the flow of the receiving facility's WAC and approval to ship as well as the shipping facility/organization's certification program documentation and documentation of the receiving facility's audits of the certification program. The flow paths also provide inputs and outputs for procurement of storage, treatment or disposal services from commercial contractors. In addition to the inputs and outputs related to the actual flow of waste, significant external inputs and outputs from the *Execute* subfunctions are described below.

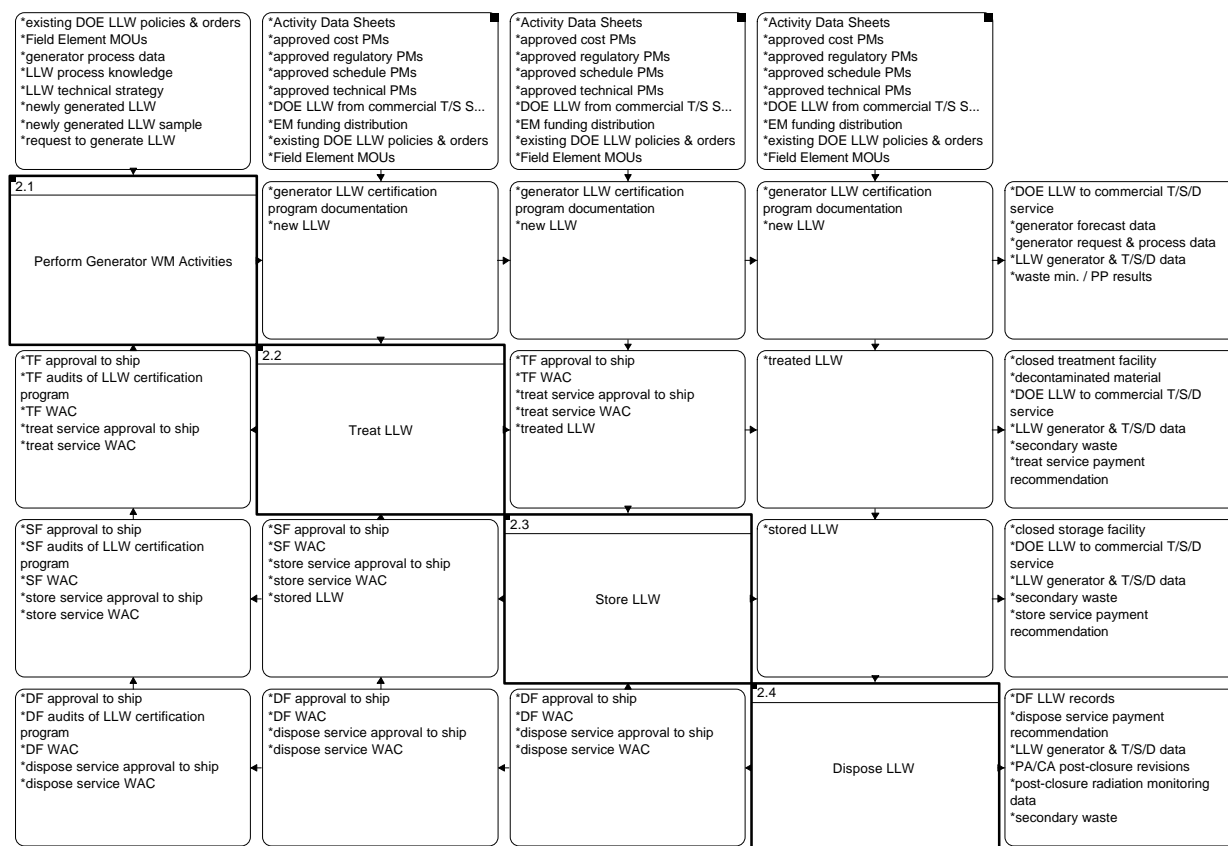


Figure 4.8: Execute Interfaces

Perform Generator WM Activities includes external inputs and outputs related to: pre-certifying waste prior to generation, planned and actual implementation of waste minimization and pollution prevention practices, developing and reporting LLW forecast data, and reporting data on actual waste generated.

Treat LLW and Store LLW include external inputs defining work scope and performance measures and external outputs such as reporting actual LLW treatment and storage data, documentation related to management of commercial treatment or storage service contractors, and activities to close the facilities.

Dispose LLW includes many of the same external inputs and outputs as *Treat* and *Store*. However, it has unique inputs and outputs related to preparation and maintenance of PAs/CAs.

4.3.3 Evaluate Interfaces

As shown in Figure 4.9, *Evaluate* subfunctions combine approved cost, regulatory, schedule and technical performance measures with reported performance and T/S/D data as inputs to the *Evaluation & Report Performance Data* function. Assessment and evaluation data resulting from this function is the basis for developing program feedback in the form of recommendations which are inputs to the *Formulate* and *Execute* functions.

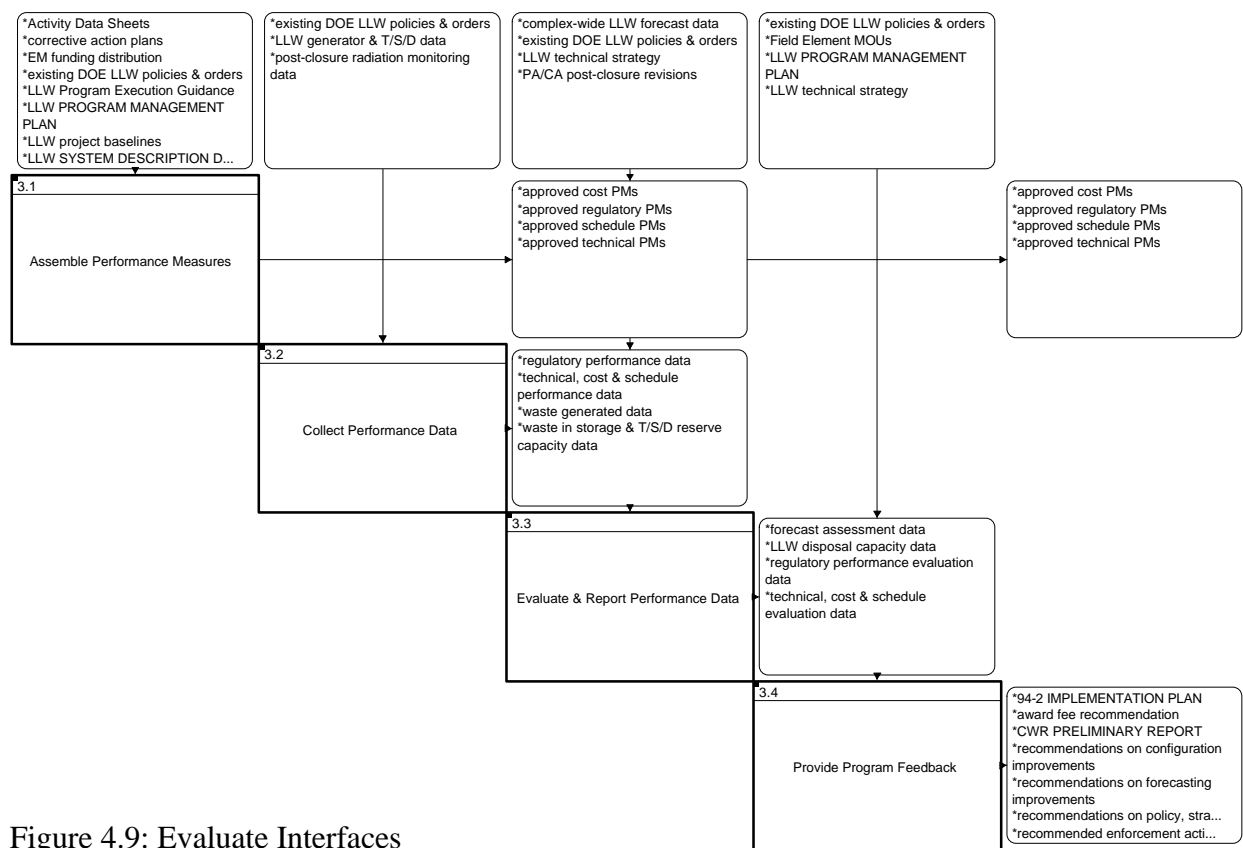


Figure 4.9: Evaluate Interfaces

4.4 Use of System Functions

The DOE LLW management system functions will be used as a bases for further system planning and for managing the execution of work. In the planning area, the functions can be used as the work breakdown structure for estimating the cost for all DOE LLW system work, formulating annual budget input, and allocating annual funding across the DOE complex-wide LLW system. As a part of the planning efforts (see functions 1.2, *Establish LLW Technical Strategy*, and 1.3, *Establish LLW Implementation Strategy*), the Office of Environmental Management determines what functions apply to which organizational element and the scope of the application of the functions within that organization. All functions will not necessarily apply to each organizational element nor is the scope of application expected to be the same in each organization. However, it is expected the functions will apply to both Headquarters and Field Elements. In addition, the Field Elements may have further detailed subfunctions to better understand the work activities necessary to accomplish a given function and to assure that specific requirements are met.

CHAPTER 5. DOE LLW SYSTEM PERFORMANCE MEASURES

Performance measures are quantitative or qualitative characterizations of physical or functional attributes relating to performance of a function or product. Performance attributes include quantity (how many or how much), quality (how well), coverage (how much area, how far), timeliness (how responsive, how frequent), and readiness (availability, mission operational readiness).

Performance measures are used to indicate progress, achievement, or effectiveness in accomplishing the LLW mission. Performance measures are grouped into three areas that indicate: (1) top-level measures of system performance, (2) compliance with system requirements, and (3) effectiveness of system functions. Performance measures are used to identify how well the DOE LLW system is being managed, if the system requirements are being met, and if processes are effective.

This System Description Document describes the DOE LLW management system's top-level performance measures and the performance measures for measuring compliance with system requirements. Performance measures of the effectiveness of the system functions, including metrics and limits, will be developed by DOE Headquarters and Field Elements as a part of work activity planning and the activities associated with the system's evaluation functions.

The top-level performance measures reflect DOE's expectations for the DOE LLW system performance and form the bases for establishing the DOE LLW system requirements. The performance expectations are expressed in the metrics established for these measures. The DOE LLW system requirements flow from the top level performance measures and support the accomplishment of these measures.

5.1 Top-Level System Performance Measures

DOE has identified 10 top-level performance measures with associated metrics that measure the desired performance of DOE's LLW system, see Table 5-1. These measures focus on safety, environment, stakeholders, compliance, cost, and capacity. As a part of the systems engineering evaluation, the existing DOE LLW system requirements were reviewed and assigned to each appropriate top-level performance measure. Requirements that do not align with and support the accomplishment of these measures have been identified and will be further assessed to determine if they are necessary. The grouping of requirements under each top-level performance measure will be further reviewed to determine if they will produce the desired system performance. Changes resulting in the requirements will be incorporated into this system description.

Table 5-1: Top-Level LLW Performance Measures

Performance Measure	Metric	Value
Public Exposure	mrem per person over time	set by the requirements statements associated with this specific performance measure
Worker Exposure	mrem per person over time	set by the requirements statements associated with this specific performance measure
Life-Cycle Cost	cost of the alternative over the DOE LLW system life-cycle beginning when waste is generated and ending when administrative controls are dropped at the disposal site	selected alternative represents an effective life-cycle cost for the DOE LLW system
Public Acceptance	approved record of decision (ROD)	selected DOE LLW system T/S/D physical configuration is acceptable to stakeholders
Regulatory Compliance	permit issued, fines paid, or convictions	complex-wide DOE LLW system is in compliance with governing Federal and state laws and regulations for the area of concern
Congressional Acceptance	funds appropriated	funding supports selected alternatives
Departmental Compliance	number of audit findings	system work is performed to DOE policy , commitments, and orders
Contaminant Level	radionuclide contaminants per unit volume	contaminant levels are below the limits set by Federal or state law or regulation for the area of concern
Environmental Compliance	- acres of sensitive land disturbed - number of species at risk	acres disturbed and species at risk are supported and accepted through the NEPA process
Available Capacity for Disposal	volumetric and radionuclide capacity per time period	disposal capability is available to dispose of LLW per the generators production plans as agreed to by the generator and WM

5.2 Bases for Performance Measures for System Requirements

Performance measures are needed for each DOE LLW system requirement that specifies work scope or activities to be performed. These performance measures specify the metric that will be used to determine compliance with the DOE LLW system requirement. The metrics can include both quantity measures and other verifiable events such as: completion of an assignment;

implementation of a task; release of a report; or inclusion of specified elements in an analysis.

As noted in Chapter 3.0, some of the DOE LLW system requirements specify Department policy, work scope or activities to be performed. Performance measures, expressed as a measurable or verifiable parameter of compliance, have been established for each of these system requirements in Volume 2 of the System Description Document.

Other DOE LLW system requirements have been identified as definitions, product descriptions, or performance requirements. These requirements do not require performance measures. In many cases, the performance requirements specify a quantitative or deterministic measure for a specific work scope requirement. In these cases, the performance requirement has been identified as the performance measure for the work scope requirement.

The method used to review the DOE LLW system requirements and determine the performance measures involved the following activities: identifying the requirement type, assigning the requirement to a top-level performance measure, defining a metric, and specifying the verification method. Table 5-2 identifies the candidate selections used for each of the attributes. Chapter 2, Volume 2, of this systems description presents results of this effort.

Table 5-2: LLW Performance Measure Attributes

Requirement:

work scope	performance requirement
work scope with measure	definition
policy	

Top-Level Performance Measure:

public exposure	congressional acceptance
worker exposure	departmental compliance
life-cycle cost	contaminant level
public acceptance	environmental compliance
regulatory compliance	available capacity for disposal

Metric (Unit): quantitative or deterministic, based on specific requirement

Verification Method: analysis, test, or demonstration

5.3 Use of Performance Measures for System Requirements

The performance measures identified above establish the expectations for performance of DOE's LLW management system. These performance measures will be used in the planning activities to determine the work-completion level and in evaluation activities to determine if the system solutions or products comply with the system requirements. The work-completion level will be factored into the system work plans. As a part of the evaluation effort, a plan to verify compliance with system requirements will be developed and incorporated into the LLW Program Management Plan. The verification plan will specify: methods that will be used to determine compliance with the system requirements, the timing of the verification activities, the process for documenting the interpretation of the verification results, and the approach for handling any identified non-compliance.

Appendix A: Summary of DOE LLW System Interface with MLLW

The management of Mixed Low-Level Waste (MLLW) has been defined as an interface with the DOE LLW system because MLLW must comply with all LLW requirements, as well as the requirements of RCRA and the Federal Facility Compliance Act (FFCAct).

As with the DOE LLW system, the DOE MLLW system has been divided into three programmatic elements: Formulate MLLW Program; Execute MLLW Program; and Evaluate MLLW Program. Formulation of the MLLW program and methods for evaluating the MLLW program are presented at one level below the program definition only. Functional elements of the MLLW program and interfaces between the DOE MLLW system and the DOE LLW system are focused on the Execution level because that is where the primary operational interfaces occur. Execution of the MLLW program is defined to a depth of five levels. This level of detail is consistent with the level of detail provided in defining the DOE LLW system.

The MLLW functional decomposition, functional descriptions, and identification of interfaces with the DOE LLW system are presented in Appendix A to Volume 2 of this document. In the appendix, the DOE MLLW system is first represented as a functional breakdown diagram. Each element in the diagram identifies a function that must be executed. The diagram represents the DOE MLLW system on a complex-wide basis and does not define responsibility for the individual functions. Each element in the DOE MLLW system is listed in the functional description which accompanies the functional breakdown diagram. The functional description defines the scope of each element and the functional interfaces between the individual MLLW functional element and the DOE LLW system.

Appendix B: DOE LLW System Functional Hierarchy Diagrams

Appendix C: DOE LLW System Goals

Goals describe future expectations for the DOE LLW system and are combined with other stakeholder inputs in a set of criteria for decision making. The DOE LLW system goals were taken from DOE Order 5820.2A and the DOE Implementation Plan in response to DNFSB Recommendation 94-2. These goals are applicable to all activities conducted as part of the DOE complex-wide LLW management system.

The DOE LLW system goals have been segregated into five groupings to facilitate understanding. Under each of these groupings, the requirements may be further sorted into topical subgroups.

- Organization and Management
- DOE Regulatory Structure and Process
- Performance Assessments
- Research and Development
- Operations

The vision of the DOE LLW management system as seen by the LLW Steering Committee establishes a complex-wide goal that is applicable to all groupings:

IP.G.6: The vision of the future DOE LLW management program is of a nationally integrated, cost-effective program, based on acceptable risk and sound planning which results in public confidence and support. This management and operations system will isolate and dispose all legacy and D&D waste while also managing and disposing of newly generated wastes at the same rate it is being generated. [II.B]

ORGANIZATION AND MANAGEMENT

LLW Program Management

DOE.G.4: DOE LLW shall be managed on a systematic basis using the most appropriate combination of waste generation reduction, segregation, treatment, and disposal practices so that the radioactive components are contained and the overall system cost effectiveness is maximized. [5820.2A: Chapter III 2b]

DOE.G.5: DOE LLW shall be disposed of on the site at which it is generated, if practical, or if on-site disposal capability is not available, at another DOE disposal facility. [5820.2A: Chapter III 2c]

IP.G.10: (Short-Term Goals) Establish adequate storage capacity for special-case waste. [II.B]

- IP.G.18: (Short-Term Goals) Establish modular data/information system. [II.B]
- IP.G.23: The Department is committed to improving the low-level waste management system consistent with its acceptance of Recommendation 94-2. [III.A]
- IP.G.24: The Department is committed to achieving the future state of the program projected by the Low-Level Waste Management Steering Committee. [III.A]

Interfaces

- IP.G.12: (Short-Term Goals) The Program should implement the DOE LLW system consistent with PEIS and FFCAct equity decisions. [II.B]

Assessment

- IP.G.13 (Short-Term Goals) Establish effective DOE internal oversight process. [II.B]

DOE REGULATORY STRUCTURE AND PROCESS

- IP.G.16 (Short-Term Goals) Establish limit of radioactivity for LLW, below which it need not be managed as LLW. [II.B]
- IP.G.18.1 (Long-Term Goals) Establish consistent regulatory framework for all LLW. [II.B]

PERFORMANCE ASSESSMENTS

- IP.G.7: (Short-Term Goals) DOE Headquarters should make approval decisions on all existing LLW disposal facility PAs. [II.B]

RESEARCH AND DEVELOPMENT

- IP.G.11: (Short-Term Goals) Program elements should identify their LLW management technology needs. [II.B]

OPERATIONS

- DOE.G.1: Radioactive and mixed wastes shall be managed in a manner that assures protection of the health and safety of the public, DOE, and contractor employees, and the environment. [5820.2A: 5.]
- DOE.G.2: The generation, treatment, storage, transportation, and/or disposal of radioactive wastes, and the other pollutants or hazardous substances they contain, shall be

accomplished in a manner that minimizes the generation of such wastes across program office functions and complies with all applicable Federal, State, and local environmental, safety, and health laws and regulations and DOE requirements. [5820.2A: 5.]

DOE.G.3: DOE LLW operations shall be managed to protect the health and safety of the public, preserve the environment of the waste management facilities, and ensure that no legacy requiring remedial action remains after operations have been terminated. [5820.2A: Chapter III 2a]

IP.G.8 (Short-Term Goals) Maintain adequate disposal capacity. [II.B]

IP.G.9 (Short-Term Goals) Eliminate legacy LLW storage (except special-case waste). [II.B]

IP.G.14 (Short-Term Goals) Establish LLW minimization implementation plan. [II.B]

IP.G.15: (Short-Term Goals) The Program should Implement consistent WAC and certification methodology. [II.B]

IP.G.17 (Short-Term Goals) Develop integrated Quality Assurance/Quality Control (QA/QC) Program for LLW management functions. [II.B]

IP.G.19 (Long-Term Goals) Integrate LLW management facilities with other waste-type management facilities. [II.B]

IP.G.20 (Long-Term Goals) Require sites to evaluate LLW minimization and/or volume reduction, and implement where feasible. [II.B]

Appendix D: DOE LLW System Assumptions

Assumptions are conditions or characteristics impacting the DOE LLW system that have not been proven or demonstrated. Because use of assumptions causes risk to system performance, they must be tracked until they are proven or demonstrated.

- IP.A.1.1: The program will rely on a system of self-assessments and independent evaluations to maintain the level of operating practice and compliance that will be achieved by the Implementation Plan initiatives. [II.D, last sentence]
- IP.A.1.3: DOE will continue to be self-regulating for LLW, at least for the near-term for onsite activities not involving mixed LLW. [II.C]
- IP.A.2: DOE will continue the policy that LLW generated at Department-owned and operated facilities should be disposed at that facility to the extent practicable. [II.C]
- IP.A.3: The implementation of proposed changes in the management of LLW described in the documentation prepared under the 94-2 Implementation Plan may result in operational changes or in facilities being built or modified. [III.B.3]
- IP.A.4: Pursuant to CERCLA and/or RCRA, Environmental Restoration generates LLW in performing cleanup work. Office of Waste Management (EM-30) operations provide waste management services for some of this LLW. In other instances, Environmental Restoration may dispose the waste onsite as part of the CERCLA/RCRA remedial action. [III.B.4.b]
- IP.A.7: Current waste type classifications will remain in effect. [SE Team]