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Department of Energy

Washington, DC 20585

December 26, 1996

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DNF SAFETY BOARD

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

Dear Mr. Chairman:

Enclosed is the "Low Level Waste Projection Program Guide." This document is a deliverable pursuant to the commitment in Task Initiative VIII.B.2 identified in the Department of Energy's Implementation Plan, Revision I, for the Defense Nuclear Facilities Safety Board Recommendation 94-2.

This document describes the overall approach, major elements, and key implementation steps of the Department's Low Level Waste (LLW) Projections Program. The document also provides a standardized approach and methodology for developing LLW projections including the provisions to establish Data Quality Objectives, conduct periodic review and assessment of the quality and accuracy of the projections data, and integration of projections information into life-cycle planning activities.

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

Sincerely,

[signature] for

Alvin L. Alm
Assistant Secretary for
Environmental Management

Enclosure

cc: Mark Whitaker, S-3.1

LOW-LEVEL WASTE
PROJECTION PROGRAM GUIDE

December 18, 1996

PREPARED BY:

OFFICE OF ENVIRONMENTAL MANAGEMENT
DEPARTMENT OF ENERGY

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EXECUTIVE SUMMARY

This document has been prepared in accordance with the Department of Energy's response to Defense Nuclear Facilities Safety Board Recommendation 94-2, *Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites*, as documented in the Implementation Plan issued by the Secretary of Energy in April 1996. This document describes the overall approach, major elements, and key implementation steps of the Department of Energy's Low-Level Waste Projection Program. The *Low-Level Waste Projection Program Guide* (referred to as the Guide) provides a standardized approach and methodology for developing low-level waste projections and a mechanism for continuous improvement of projection data through the use of data quality objectives and periodic quality assessments. Improved forecast quality will help the Department of Energy manage its low-level waste inventory safely and efficiently.

Department of Energy field elements (waste management units or other field element responsible for management of low-level waste) should use this Guide to develop site-specific low-level waste projection guidance to address all low-level waste forecasts including data requests in support of national level planning documents (e.g., the Integrated Database Report and the Ten Year Plan), and for the development of design basis documents (e.g., environmental impact statements and safety analysis reports). It is expected that waste management units will use this Guide to review existing site-specific low-level waste data collection systems and make revisions where appropriate to achieve consistency with this document. If there is no existing data collection system, then waste management units should develop one. An example of this development process is provided in Attachment D. This Guide should be used for all low-level waste related forecasts that occur after its issue. Waste management units should fully implement the guidance of this document in 1997.

The *Low-Level Waste Projection Program Guide* is not a request for data. The Guide provides projection techniques and sources for additional information that should be used to improve site-specific low-level waste data collection systems. It is intended to improve the quality of data through the selection of assumptions and other parameters in a consistent and systematic manner.

Implementation of the Department of Energy Low-Level Waste Projection Program will continue through the incorporation of key elements of this Guide into the provisions and requirements of other documents under preparation. These include the *Low-Level Waste Program Management Plan*, the revised Department of Energy *Radioactive Waste Management Order 435.1*, and the Technical Directives Manual associated with the Order.

The *Low-Level Waste Program Management Plan* will identify elements of the Guide for direct implementation by field elements, with particular focus on waste management units. In addition, the *Low-Level Waste Program Management Plan* will identify the Department of Energy's strategy and mechanism for collecting and maintaining low-level waste projection information and how projections will be integrated into national level life-cycle planning and analysis activities. A key requirement of the *Low-Level Waste Program Management Plan* will be to ensure the development and maintenance of a systematic low-level waste projections data set that is used for all reporting, planning, and analysis activities.

Department of Energy Order 435.1 will contain a requirement for appropriate Department of Energy field elements to develop and maintain low-level waste projections.

The Technical Directives Manual associated with Order 435.1 will include requirements based upon key elements in this Guide. Specifically, the following elements are expected to be included in the Technical Directives Manual:

- Each waste management unit (or other appropriate Department of Energy field elements responsible for management of low-level waste) shall implement a Low-Level Waste Projection Program. Projections will provide annual totals for years 1 through 10 and a total sum for years 11 through 30. The Low-Level Waste Projection Program shall, at a minimum, address the following elements:

    - generator information;
    - projected volume;
    - waste form;
    - radionuclide data including key isotopic and curie content;
    - container types; and
    - treatment, storage, and disposal facility capacity.

- Each waste management unit shall implement data quality objectives to improve the quality of low-level waste forecasts. A period of three projection cycles may be allowed to fully meet data quality objectives.

- Low-level waste projections shall be updated annually.

- Low-level waste projections shall be integrated into program life-cycle planning efforts.

Also, in accordance with its Implementation Plan developed in response to Defense Nuclear Facilities Safety Board Recommendation 94-2, the Department of Energy is revising the *Current and Planned Low-Level Waste Disposal Capacity Report.* The revised report will be prepared in accordance with this guidance and will incorporate radiological information. It is due to be completed by September, 1997. A data request to collect the national low-level waste projection and capacity information needed for this report will be issued in the second quarter of fiscal year 1997. A summary of the projections information will also be published in the 1997 Integrated Database Report.

In subsequent years, the Department's Office of Environmental Management will continue to collect and maintain a national low-level waste projections data set. The national low-level waste data set will be published annually in the Integrated Database Report and will be used to periodically update the *Current and Planned Low-Level Waste Disposal Capacity Report*. The Office of Environmental Management will also periodically assess the quality of low-level waste projections as compared to actual generation. Further, the national low-level waste data set will be integrated into national level planning and analysis activities.

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1.0 INTRODUCTION

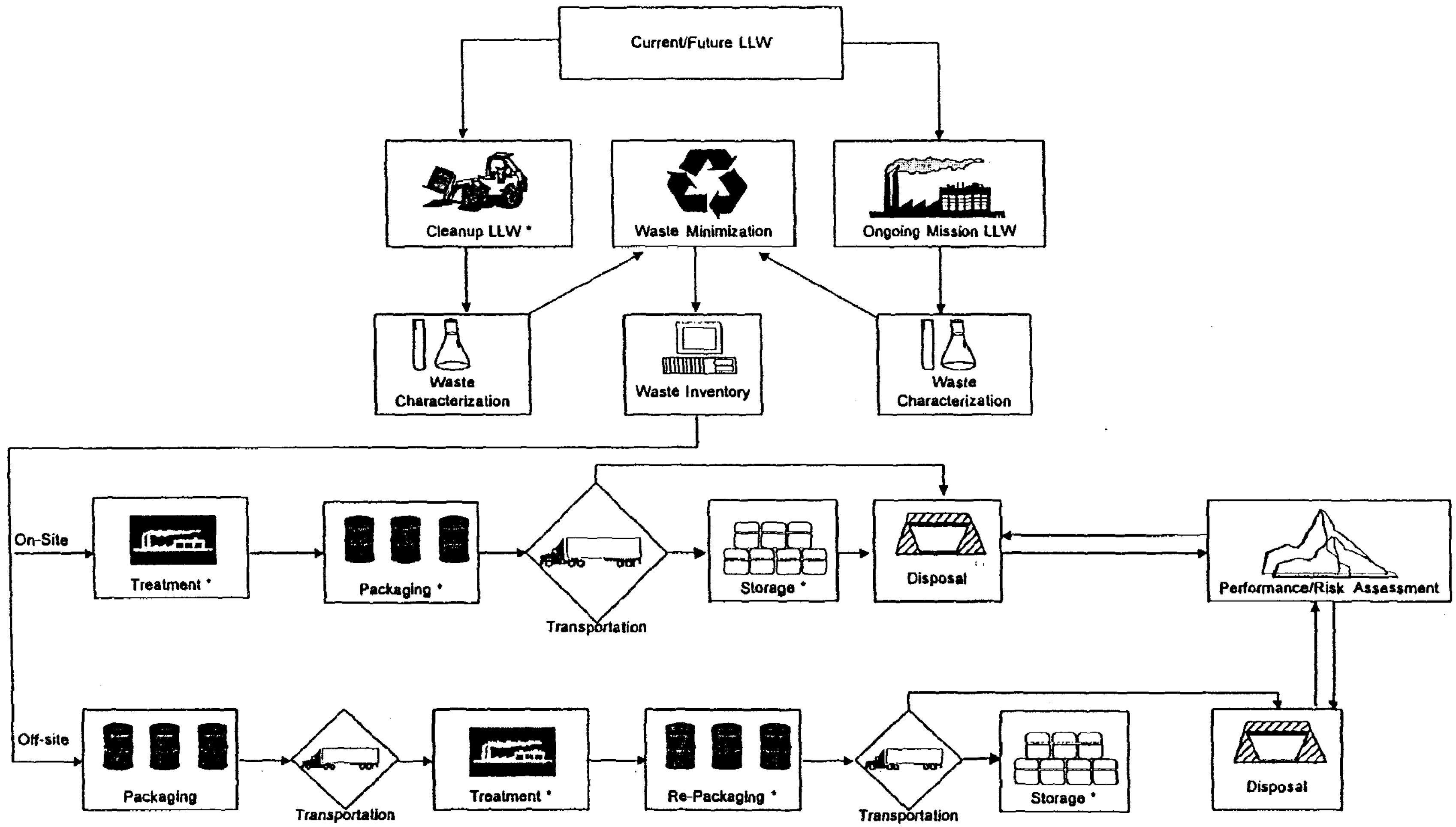
The U. S. Department of Energy (DOE or the Department) is taking a structured approach for the determination of its low-level waste (LLW) disposal needs through the development of this *Low-Level Waste Projection Program Guide* (referred to as the Guide). The Department has developed this Guide as part of a process to improve the management of DOE LLW (Figure 1). This Guide has been prepared by the Office of Environmental Management (EM) and establishes a consistent methodology for forecasting the volume and characteristics of LLW across the DOE complex.

1.1 Background

This Guide was prepared as part of the Department's response to the Defense Nuclear Facilities Safety Board's (DNFSB) Recommendation 94-2, "Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites," (Attachment A lists additional requirements and oversight body concerns important to LLW management). As part of responding to Recommendation 94-2, the Department identified a number of deficiencies related to the projection of LLW generation within the DOE complex:

- disposal facilities do not receive the same quality of projections from on- and off-site generators;
- only current generators submit projections, therefore, future generation of LLW (especially environmental restoration waste) is not captured;
- the projections of LLW received by disposal facilities are not uniformly developed by the generators;
- the quality and detail (e.g., radiological characteristics and physical/chemical forms) of data received by disposal facilities are insufficient;
- projections are dramatically impacted by unstable budgets, out-year projections are rapidly outdated as budgets, and thus priorities, change; and
- projections, particularly from decontamination and decommissioning, and environmental restoration activities, will be dramatically impacted by cleanup level and land-use decisions.

Figure 1 - Low-Level Waste Management



* Legacy, Remedial Action, Decommissioning, and Deactivation LLW

* *Treatment, Packaging, and Storage as Needed*

Subsequent to the issuance of the DNFSB Recommendation 94-2, the DOE has implemented or is in the process of implementing several initiatives that have begun to address these concerns and the core issue of the adequacy of DOE LLW disposal capacity. These initiatives include a LLW minimization strategy and recent forecasts which contain improved estimates of future waste volumes including: the *Baseline Environmental Management Report* (BEMR)(reference 1), the Office of Environmental Restoration (EM-40) Core Database, the *Current and Planned Low-Level Waste Disposal Capacity Report* (reference 2), the EM Ten Year Plan (TYP), and the National Low-Level Waste Program Center for Excellence. These initiatives are summarized below.

Baseline Environmental Management Report

The BEMR was prepared in response to a mandate from Congress and provided a life-cycle cost estimate for all environmental management activities including waste management, environmental restoration, and decommissioning. As part of the BEMR effort, life-cycle estimates for management of contaminated media and LLW were developed. These estimates included projected LLW generation from environmental restoration and decommissioning activities, as well as waste generated from on-going operations.

For environmental restoration and decommissioning activities, data was collected on proposed remediation strategies, contaminated media and waste type (including LLW), projected annual waste volumes requiring treatment, storage, and disposal; and the planned site of disposal.

The BEMR also contains an estimate of contaminated surplus facilities that may be transferred to EM in the future and the amount of LLW that would be generated from decommissioning those facilities. In addition, the BEMR collected data on the amount of LLW expected to be generated from on-going "routine" mission support activities and secondary waste streams arising from waste management activities.

EM-40 Core Database

The Office of Environmental Restoration developed the EM-40 Core Database to provide a consolidated data set to support its planning and integration activities. The Core Database combines data elements from the 1993 Environmental Restoration contaminated media/waste data call, site project baselines, and the requirements of the 1996 BEMR. It may be noted that the Office of Waste Management (EM-30) is developing a similar database using data elements and requirements from the BEMR, site baselines, the Integrated Database Report (IDB Report), the Mixed Waste Inventory Report, and previous LLW data calls.

Current and Planned Low-Level Waste Disposal Capacity Report

In accordance with the DOE Implementation Plan developed in response to DNFSB Recommendation 94-2, the *Current and Planned Low-Level Waste Disposal Capacity Report*, Revision 0, was prepared using existing data from the BEMR, EM-40 Core Database, and the IDB Report. The report provides volumetric projections of LLW generation through the year 2070 and compares those projections to the disposal capacity of DOE's current and planned LLW disposal facilities. Another revision of the report incorporating radiological information (e.g., radiological capacity based on specific nuclides) is scheduled for completion in September 1997.

Office of Environmental Management Ten Year Plan (TYP)

Environmental Management is currently developing the TYP. The purpose of the TYP is to provide a vision and framework for accelerating EM's environmental cleanup efforts with the goal of completion, to the extent possible, by FY 2006. LLW generation and disposal estimates are included in the TYP. EM is working toward integrating the project work structure of the TYP into the budget and planning process.

National LLW Center for Excellence

A National Low-level Waste Center for Excellence is being established at the Idaho Operations Office in concert with the Albuquerque and Nevada Operations Offices. The Center for Excellence will become operational in 1997. The Center for Excellence responsibilities related to LLW projections will be described in the Low-Level Waste Program Management Plan to be issued in March 1997.

1.2 Low-Level Waste Projection Program

As described above, DOE has been active in improving LLW forecasting capabilities since DNFSB issued Recommendation 94-2. However, DOE has not issued formal guidance nor established a program to ensure the consistency of LLW projection data and the integration of LLW forecasts into Departmental life-cycle planning. Although the BEMR and the LLW Capacity Report provide life-cycle estimates of LLW, including LLW generated from environmental restoration and decommissioning activities, national life-cycle projections are essentially summations of projections prepared independently by individual sites rather than data developed and collected in a standardized manner.

In response to this need, EM is implementing a LLW Projection Program as recommended by DNFSB. The LLW Projection Program will facilitate consistency and uniformity in the development of LLW projections, improve the quality of LLW projections, and ensure that accurate LLW projections are integrated info life-cycle planning activities.

The LLW Projection Program addresses LLW generated from all sources including stabilization, deactivation, and decommissioning activities, environmental restoration activities, LLW generated by the treatment of other wastes (such as mixed LLW and TRU waste), nuclear materials disposition, as well as LLW generated by operational facilities. The objectives of the LLW Projection Program, the major elements of the program, and the key implementation steps are described below.

1.2.1 Objectives of the Low-Level Waste Projection Program

The objectives of the DOE LLW Projection Program are as follows:

- Provide the Department with accurate and consistent projections of LLW, including: current and future LLW volume; LLW characteristics; treatment; storage; and disposal facility capacity information; and where applicable, identify LLW that has no management plan.
- Ensure that LLW projections are developed in a standardized, systematic manner using a consistent methodology and common assumptions. and,
- Provide LLW projection data that can be integrated into Departmental life-cycle program planning and execution activities to ensure that adequate, cost effective treatment, storage, and disposal facility capacity will be available.

1.2.2 Major Elements of the LLW Projection Program

Efforts by the Department to establish and implement a LLW Projection Program will proceed in 1997 and beyond. The major elements of the Program are the Low-Level Waste Projection Program Guide, the Low-Level Waste Program Management Plan, the revised DOE Radioactive Waste Management Order 435.1, and technical directive manual associated with DOE Order 435.1. These are described in more detail below.

Low-Level Waste Projection Program Guide

This Guide describes the overall approach, major elements, and key implementation steps of the LLW Projection Program. The Guide provides a standardized approach and methodology for developing LLW projections including the establishment of data quality objectives and periodic assessment of the quality and accuracy of the projections. To the extent practical, this Guide has been developed in a manner to be consistent with LLW forecasting and data collection practices already in place at DOE sites.

Low-level Waste Program Management Plan

As part of the DOE Implementation Plan developed in response to DNFSB Recommendation 94-2, DOE is preparing a Low-Level Waste Program Management Plan which will accomplish the following objectives:

- establish the programmatic strategies, policy initiatives, and assumptions for achieving a complex-wide integrated LLW program;

- describe the near-term and long-term actions, milestones, and responsibilities necessary to achieve the desired future status of the LLW program;

- identify the key management interfaces, organizational structure, and the appropriate division of roles and responsibilities between DOE/HQ and field elements; and

- define the process for assessing LLW program effectiveness.

The Program Management Plan will identify elements of the LLW Projection Program for direct implementation by field elements, with particular focus on waste management units. In addition, the Program Management Plan will identify DOE's strategy and mechanism for collecting and maintaining LLW projection information and how LLW projections will be integrated into national level life-cycle planning and analysis activities. A key requirement of the Program Management Plan will be to ensure that DOE develops and maintains a consistent LLW projections data set that is used for all reporting, planning, and analysis activities.

Department of Energy Order 435.1, Radioactive Waste Management

DOE Order 435.1 (the revised Radioactive Waste Management Order) will contain a requirement for Field Offices to development and maintain LLW projections.

Department of Energy Order 435.1 Technical Directives Manual

The Technical Directives Manual to be developed in concert with DOE Order 435.1 implementation will include LLW Projection Program requirements based upon key elements in this Guide. Specifically, the elements listed below are expected to be included in the Technical Directives Manual:

- Each waste management unit (or other appropriate Department of Energy field element responsible for low-level waste) shall implement a Low-Level Waste Projection Program. Projections will provide annual totals for years 1 through 10 and a total sum for years 11 through 30. The Low-Level Waste Projection Program shall, at a minimum, address the following elements:

- generator information;
- projected volume;
- waste form;
- radionuclide data including key isotopic and curie content;
- container types; and
- treatment, storage, and disposal facility capacity.

- Each waste management unit shall implement data quality objectives to improve the quality of low-level waste forecasts. A period of three projection cycles may be allowed to fully meet data quality objectives.
- Low-level waste projections shall be updated annually.
- Low-level waste projections shall be integrated into program life-cycle planning efforts.

1.2.3 Low Level Waste Projection Program Implementation

During 1997 waste management units (or other appropriate DOE field elements responsible for low-level waste) should implement the provisions contained in this Guide. Key elements of the Guide include data requirements, a consistent projection methodology, establishment of data quality objectives, and periodic review and assessment of data quality (Figure 2). In addition, the development and collection of LLW projection data should be integrated into overall information management, data collection, and life-cycle planning activities. It is expected that in 1997, LLW projections developed by waste management units will be consistent with the data requirements and approach contained in this Guide.

In accordance with the DOE Implementation Plan developed in response to DNFSB Recommendation 94-2, the Department is revising the *Current and Planned Low-Level Waste Disposal Capacity Report*. The revised report will be prepared in accordance with this guidance and will incorporate radiological information. It is due to be completed by September, 1997. A data request to collect the national low-level waste projection and capacity information needed for this report will be issued in the second quarter of fiscal year 1997. A summary of the projections information will also be published in the 1997 DOE Integrated Database Report.

In subsequent years, the Department's Office of Environmental Management will continue to collect and maintain a national low-level waste projections data set. The national low-level waste data set will be published annually in the IDB Report and will be used to periodically update the *Current and Planned Low-Level Waste Disposal Capacity Report*. The Office of Environmental Management will also periodically assess the quality of low-level waste projections as compared to actual generation. Further, the national low-level waste data set will be integrated into national level planning and analysis activities.

1.2.4 Integration with Life-Cycle Planning

LLW projections should be integrated into site program planning, execution activities, and information collection activities (Figure 3). It is essential that this information be available and used in program planning and execution activities to support the following objectives:

- safe, efficient, and timely disposal of LLW generated by DOE activities;
- timely planning for additional treatment, storage, and disposal facilities;
- determination of the DOE complex-wide configuration for future LLW disposal facilities based on specific waste characteristics; and
- achievement of DOE complex-wide strategic planning to determine the most efficient use of LLW disposal capacity.

The use of LLW projection information should be expanded at the site level to ensure adequate budget and planning for waste management. Data regarding disposal volumes, shipping schedules, treatment plans, and waste management plans (or lack there of) should be collected during the LLW projection process and is important to budget and life-cycle planning efforts. The site-specific LLW Projection Program should be designed to ensure that these data are in a form that can be easily transferred to budget and life-cycle planning processes. In any case, the data collected should be consistent with budget requests and long range life-cycle planning.

At the national level, implementation of the LLW Projection Program will result in collection of data from each site in a consistent manner, facilitating its use in complex-wide planning. Data collected under this program will be integrated with Departmental life-cycle planning, where appropriate, and will support assessment of disposal capacity against the results of Radiological Performance Assessments and Composite Analyses to ensure that DOE has adequate disposal capacity.

Figure 2 - Development of LLW Projections

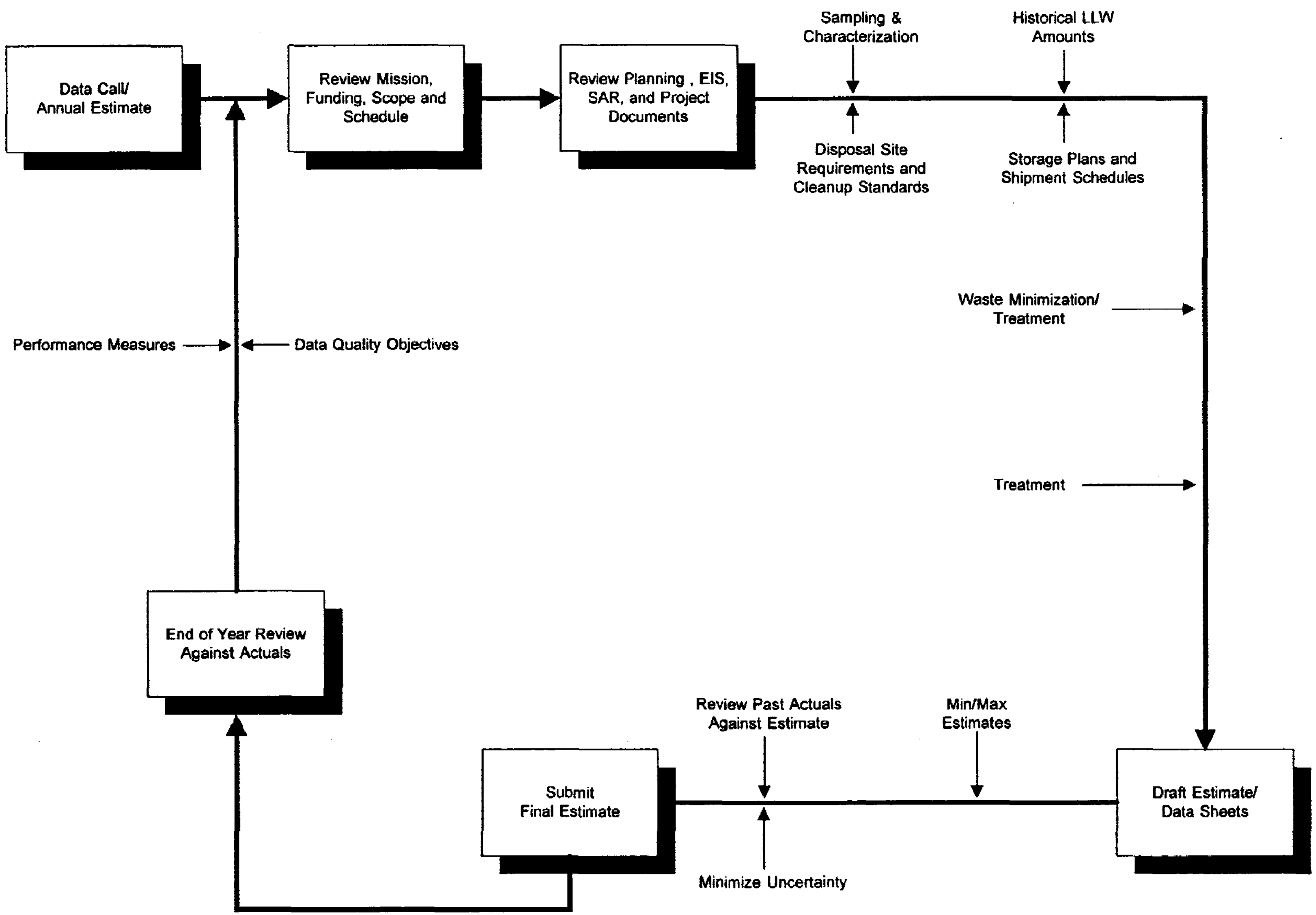
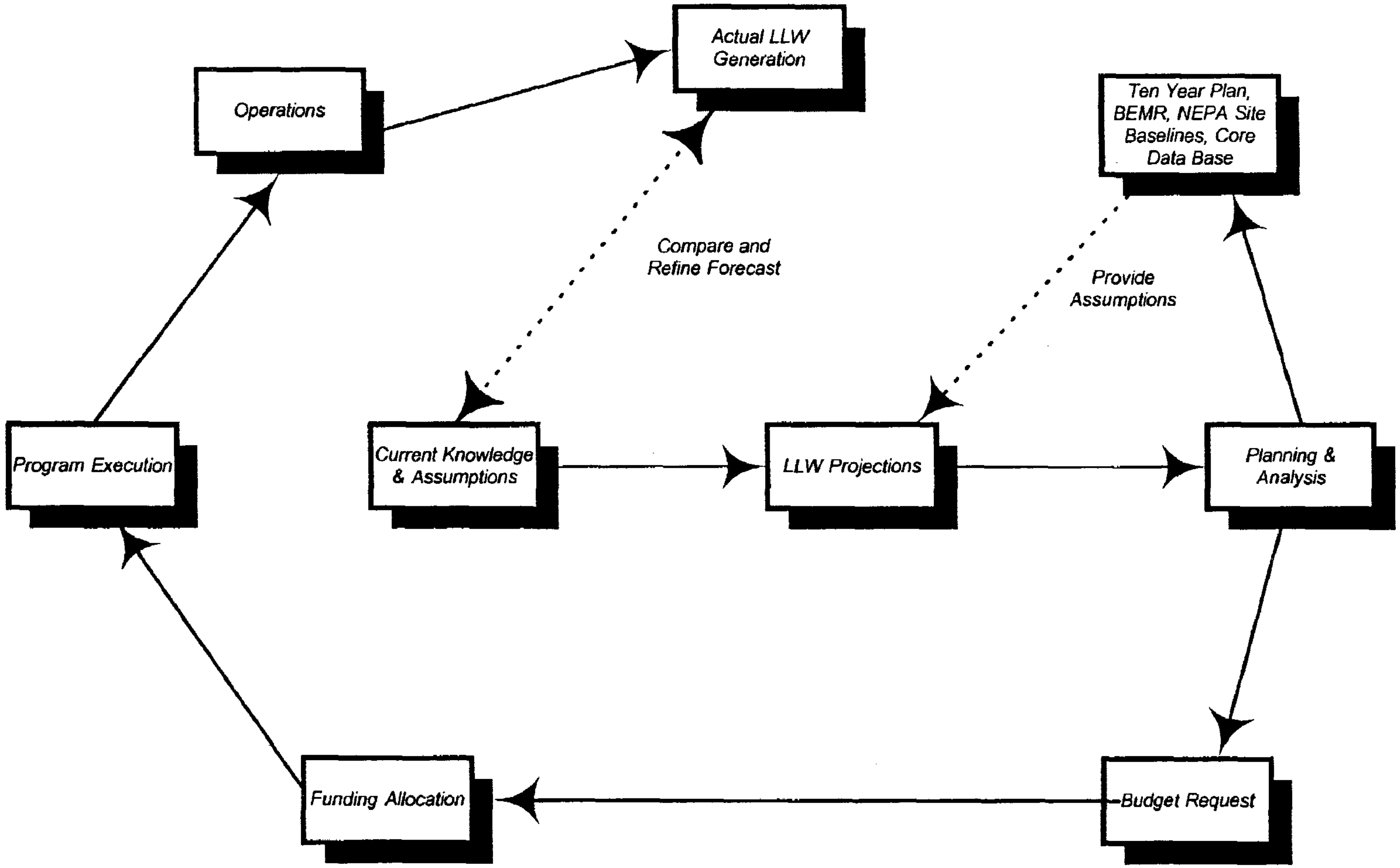


Figure 3 - Integration of LLW Projections into Life Cycle Planning and Analysis



2.0 ROLES & RESPONSIBILITIES

The roles and responsibilities identified in this section illustrate the typical activities to be conducted by primary organizations in order to implement the LLW Projection Program.

2.1 LLW Generators and Waste Management Units

Waste generators and waste management units (i.e., organizations that are responsible for managing waste for a specific site or DOE Office) are responsible to:

- provide LLW forecasting data and treatment, storage, and disposal capacity data;
- provide oversight to ensure generators provide accurate forecasts;
- ensure data quality;
- determine waste management options or destination for LLW;
- interface with generating site planning and management functions to determine new activities and long-term program plans that may affect waste generation and waste management facility needs;
- establish data quality objectives and other effective accountability features to ensure reliable waste forecasts; and
- develop an appropriate LLW projections guide for compiling forecast data.

In order to avoid confusion and inefficiency, coordination of the above roles and responsibilities between waste management units and generators must occur. Oversight and integration activities are within the purview of waste management units that may inherently interface with multiple generators. To the extent practical, clear delineation of activities should be specified in site-specific LLW Projection Programs.

2.2 Treatment, Storage, and Disposal Facilities

Treatment, Storage, and Disposal facilities are responsible to:

- provide cost effective and competitive rates for treatment, storage, and disposal of DOE waste;

- provide historical and projected waste management capacity data;
- ensure data quality;
- assist in the determination of waste management options and terminal destinations;
- interface with generators to determine future needs for waste management capacity;
- establish effective accountability features to verify forecast data and identify and correct the root cause for unreliable waste forecasts; and
- assist DOE/HQ in other forecast related activities.

2.3 Headquarters, Office of Environmental Management

The DOE/HQ Office of Environmental Management is responsible to:

- establish requirements and guidance for LLW generation forecasting, reporting, and capacity planning;
- provide guidance to improve consistency and accuracy of forecast information developed;
- coordinate, plan, and integrate data requests;
- coordinate, plan, and integrate facility needs identification and planning;
- improve DOE's complex-wide waste forecasting capability;
- promote timely development of adequate LLW management capabilities and capacities across the DOE complex; and
- interface with other Program Offices (Defense Programs, Energy Research, Nuclear Energy, etc.) in forecast related activities.

2.4 Interfacing With LLW Generators

Department projects planned for the future can invalidate LLW projections by generating LLW that was not anticipated and for which adequate treatment, storage, and disposal facilities have not been planned or developed. Programmatic planning efforts like the TYP minimize the number of such disruptions by making available the Department's long range planning and budget information. However, other DOE Offices may not have similar planning documents and a resulting lack of foreknowledge of future projects may impact LLW planning. The most effective method for addressing this potential is for waste management unit and treatment, storage, and disposal facility personnel to interface regularly with LLW generators. It is not appropriate to specify the extent and content of this interface in a DOE-wide programmatic document, but the value of regular interface should be recognized by management. The type of information that may be exchanged includes current LLW shipment schedules, project plans for generation of LLW, and significant changes in current plans and future plans for projects that may generate LLW.

It is the LLW generator's responsibility to answer data calls with LLW projections, but in the case of future projects, there may be no operational organization to address the data call. However, if waste management unit personnel are aware of a future project that is not addressed in a data call, the situation can be corrected directly. Other checks and balances may correct this type of problem, but the most effective solution is knowledgeable interface at the staff level, to ensure a full understanding by the parties involved, of the waste management unit's needs and the LLW generator's plans.

3.0 PROJECTION METHODOLOGY

The *Low-level Waste Projection Program Guide* is not meant to dictate a prescriptive methodology. The development of LLW projections should be integrated into other site-specific planning, execution, and information collection activities. It would be inappropriate to direct implementation of a prescriptive approach for LLW projection development that may conflict with similar site functions. This document provides general principles, concepts, insights, and "factors to consider" that should be considered in developing LLW projections. The Guide provides common definitions and data requirements that will enable projections to be compiled in a consistent fashion at the national level. To the extent possible, the intention is to build upon existing data collection systems rather than begin anew. However, as discussed in the Executive Summary, elements of this document are also expected to be incorporated in the DOE Low-Level Waste Program Management Plan and the Technical Manual developed in support of the revised DOE Radioactive Waste Management Order.

This Guide should be used by each appropriate field element (waste management units or other field elements responsible for management of LLW) to develop a site-specific projection program for forecasting LLW. Attachment D provides guidance on this development process. The elements of this Guide may be modified to address site-specific situations, but the process should be consistent with this Guide to ensure that complex-wide LLW projections accurately depict the expected LLW burden. This Guide should be used by Field Offices and DOE Headquarters to assess the adequacy of LLW forecast data provided.

This section discusses major considerations in the development of LLW projections, provides the Department's preferred methods and assumptions for projections, and provides guidance for improvement of projection completeness and quality. Accurate LLW projection data is important for the development of budgets, the planning of treatment, storage, and disposal facilities, and the assessment of progress in meeting Departmental goals. These terminal uses and the objectives discussed in Section 1.0, should be considered when developing LLW projections.

3.1 Forecast Periods

Forecast information should be grouped by two time frames:

- annual totals for years 1 through 10; and
- cumulative total for years 11 through 30.

If the project extends beyond this time frame, a total from the end of the projection period until the end of facility life may also be included.

These forecast periods are consistent with those used in national level planning documents. Moreover, this data is important to DOE planning irrespective of the requirements of any particular planning document.

The forecast assumptions associated with projection data should be grouped by the time frames described, so that the assumptions used can be directly related to the data associated with those assumptions. It is expected that the uncertainty of data will increase for more distant time frames. However, the quality of projection data for the first three years of the forecast period should be reasonably high. The use of data quality objectives is discussed in Section 4.0 of this document. The data quality objectives developed in the LLW Projection Program are designed to improve the quality of all volume projection data, but they concentrate on attaining high quality data for the first three years of the projection.

3.2 Major Assumptions

Analysts who prepare LLW projections must have in-depth, site-specific knowledge and access to reliable information sources in order to develop a high quality LLW forecast. Site-specific information is superior to assumptions made on a complex-wide basis and should be used whenever available. However, assumptions are inherent to all LLW projections and the major assumption areas are discussed below.

Mission

Assumptions regarding the site mission impact LLW projections. Unclear, changing, or new missions create uncertainty as do the budgeting changes that accompany changing missions. The organization assigned the responsibility for developing the forecast must be cognizant of site missions and future plans for those missions. This may be accomplished through review of planning documents for the major programs that generate LLW. The objective of the review is to gain insight into evolving missions, identify inconsistencies between program and facility plans, and incorporate associated mission changes into LLW projection data. The mission assumptions contained in national level planning documents, such as the TYP, IDB Report, and BEMR may be used to model the mission unless better site-specific information is available. A relevant assumption regarding the site mission and its impact on LLW projections should be developed by each waste management unit (or other assigned field element) responsible for preparing LLW projections.

Land Use Scenarios

Land use scenarios must be specified for environmental restoration projects to identify the necessary end point. Land use scenarios will dictate the cleanup levels which will affect the volume of LLW. Generally, the land use scenario is known for a project that is fully planned and scheduled, but projects that are only conceptual may have less detail available. If the land use scenario has not yet been determined, it may be necessary to assume a scenario based on land use decisions made for nearby sites or similar projects elsewhere. The basis and assumptions used to develop the land use scenario should be clearly described, documented, and maintained for later review.

Funding Levels

Funding levels can dramatically affect the volume and schedule of LLW generated by a project. Generally, site-specific budget forecasts will be available and should be used in forecast efforts. However, if budgets are uncertain, national level documents such as the TYP may be used to develop estimates. The basis of assumptions should be noted in the projection documentation and discussion.

Changing Requirements

Regulatory and contractual requirements are inherent to LLW projections. In the case of on-going projects, the requirements generally are well known, but this may not be the case for future and conceptual projects. Unless the content of new requirements is known with some certainty, existing requirements and the assumptions used in national level planning documents should be used. For projects where requirements may be negotiated on a site-specific basis, requirements from similar projects should be assumed.

3.3 Data Requirements

A request for LLW projection data will normally contain specific guidance, but a discussion of normal requirements and considerations that will improve quality is provided below. A LLW data request will typically address the following:

- generator information;
- projected volume;
- waste form;
- radionuclide data including key isotopic and curie content;
- container types; and
- treatment, storage, and disposal facility capacity.

Generator Information

The name and location of each generator that created or will create the waste stream being analyzed should be included. Future generators should also be identified. Operations that are expected to terminate during the projection period should be identified accordingly.

Projected Volume

The basis for LLW volume estimates varies substantially with the nature of the LLW source: Process and Facility LLW (including LLW generated by the treatment of other wastes); Stored and Legacy LLW; Nuclear Material and Facility Stabilization LLW; and LLW from Environmental Restoration Projects. The analyst must become familiar with the operation involved to effectively forecast LLW.

The LLW volume should include LLW packaged for the next management activity, i.e., treatment, storage, and disposal facilities. For storage and disposal activities, the final waste form, package, container, and shielding material (unless it is removed prior to storage or disposal) should be considered in the volume estimate. The LLW data from treatment activities should include the volume, weight, and radiological data.

The LLW volume may be assigned relative certainty levels by including maximum and minimum expectation volume with baseline volume. The assumptions used for the development of the baseline, and maximum and minimum forecasts should be provided.

Radionuclide Information

Radionuclide information is important for evaluation of treatment, storage, and disposal needs, disposal site limitations, special handling needs, and shielding requirements. Radionuclide information is used to determine whether waste classifications will change during treatment. Radionuclide information may be limited to the controlling key radionuclides that present the greatest potential for radiation exposure during handling or present long-term risks to the public health and safety or the environment. A list of typical key radionuclides is provided in Attachment B, but it should be noted that key radionuclides vary with disposal site, due to site-specific performance analysis parameters and site-specific waste acceptance criteria.

Waste Form

The physical/chemical form (matrix) of LLW should be included in the forecast to aid in determining site treatment and management alternatives. Waste with matrices that require special treatment or that are specifically regulated may influence management options. The *DOE Waste Treatability Group Guidance* (DOE/LLW-217, Revision 0) presents a logical, hierarchal array of categories that describe waste matrices. To ensure consistency with data activities for other waste types, the matrices for LLW should be based on the Treatability Group Guidance

(TGG). Attachment C provides a recommended subset of the TGG matrix categories for use in development of projections and other LLW data activities.

Container Types

Container information for packaged LLW should be included to facilitate planning for storage requirements, volumetric needs, and facility waste handling capabilities. Storage capacity for LLW is dictated by the external volume of containers. If the waste volume is provided without consideration of the container, storage capacity could potentially be underestimated. If a facility is in the planning stage, container information may be very useful to ensure that handling equipment is adequately designed. Additionally, accommodations may be necessary for shielding associated with waste containers or for the handling of special use containers.

3.4 LLW Scenarios

Low-level waste is generated by several unique DOE activities and the scenario that LLW goes through may involve several phases. Any phase may change the state of LLW and forecast data is dependant on the timing of the data call. Additionally, capacity information for treatment, storage, and disposal facilities is impacted by the LLW scenario and the timing of the data call. The scenarios that LLW may pass through are discussed below.

Facility/Process Generated LLW

This source of LLW should be well understood for facilities and processes that have been in operation long enough for historical data to be accumulated. These operations generate LLW as a byproduct of their mission. Wastes could include output streams that are ancillary to the mission, such as sludge or resins due to clean up of circulating systems as well as solid LLW due to operations and maintenance. This scenario represents the fundamental generation of LLW in operating facilities. Although the scenario is common, the facilities are diverse and spread across the DOE complex. There are facilities with similar missions that may share information regrading LLW generation. Analysts with site-specific knowledge should be aware of similarities in facilities.

Environmental Restoration Generated Waste and Material and Facility Stabilization Project Generated Waste

These scenarios probably represent the greatest volume of LLW generated in the DOE complex. Volume and content of LLW generated by environmental restoration projects and material and facility stabilization projects are estimated by project scoping documents. However, these estimates are dependant on the validity of the site sampling program. The total LLW volume may vary from the estimate as project work proceeds and actual field conditions become known. However, the schedule of LLW generation is more prone to variation due to budget changes, project schedule changes, and actual project progress. These variations may not affect the eventual total volume of LLW, but can cause significant variations in yearly estimates.

There is an important consideration for environmental restoration sites that should be discussed. It is not the intention of the LLW Projection Program to include contaminated media, for which there is an in situ remediation plan, in LLW projections. These projects will generate LLW as a byproduct of remediation activities and this LLW should be included in forecasts, but it will be small compared to the volumes of contaminated media that would become LLW if it were remediated by removal. However, contaminated media without an in situ remediation plan should be included in LLW forecasts, even if an in situ remediation plan is a possibility in the future. This conservative approach will alert treatment, storage, and disposal planners to a potential large volume of LLW. Assumptions should be included with data to ensure proper understanding of the likelihood that these materials may become LLW.

Storage

The useable volume of DOE approved storage facilities should be determined from design or certification documents. Space that is already occupied should not be included in data given for available capacity. Storage facilities may have specifications for floor loading, allowable heights for stacked waste containers, types of containers accepted for storage, concentrations of radioactivity accepted, and levels of radiation accepted, that will effectively reduce the available capacity. Complicating factors such as these should be considered when identifying the available capacity.

Planned facilities that are currently approved in higher tier management planning documents should be included in forecasts of available capacity. This capacity should be noted as planned, however. Although individuals sometimes have site-specific knowledge of impending revisions to planned facility scope and schedule, for consistency reasons it may be appropriate to assume that the capacity will be built until management plans are formally revised or superseded.

Plans for storage of waste should include reason(s) for storage and future plans for final disposition. If final disposition plans are not yet complete, the schedule for completion and discussion of technological or resource challenges hindering completion should be included. A DOE site-specific or complex-wide solution may be required to determine the final disposition.

Treatment

The treatment facility type and its capacity should be identified. Capacity estimates should be tempered with considerations of downtime, process design capacity, operational cycle, and availability of feed material. Analysts should be cognizant of planned outages, status of feed material availability, and forced outage rates to ensure a valid forecast. Estimates should be compared with actual volumes treated (throughput) to improve estimates. Estimates of throughput in out years should be based on approved management planning documents which address the facility's mission. Additional detail on minimization of uncertainty is provided in Section 4.0 "Data Quality & Uncertainty".

Planned facilities that are currently approved in higher tier management planning documents should be included in forecasts of available capacity. This capacity should be noted as planned, however. Although individuals sometimes have site-specific knowledge of impending revisions to planned facility scope and schedule, for consistency reasons, it may be appropriate to assume that the facility will be built as planned until management plans are formally revised or superseded.

Disposal

Estimation of disposal capacity is based on land available for the disposal site, design of disposal trenches or vaults, and site physical limitations such as buffer zones. Disposal site operators are cognizant of available space and can provide adequate estimates. However, capacity may be limited by radiological assessments or agreements with state authorities. All limitations that affect the site, should be discussed in forecast information.

Planned facilities that are currently approved in higher tier management planning documents should be included in forecasts of available capacity. This capacity should be noted as planned, however. Although individuals sometimes have site-specific knowledge of impending revisions to planned facility scope and schedule, for consistency reasons, it may be appropriate to assume that the facility will be built as planned until management plans are formally revised or superseded.

Use of Commercial Facilities

The Department uses commercial facilities for the disposal of some LLW. There is some potential for this use to increase in the future and for additional facilities to be established. Planning documents associated with the environmental restoration efforts that use commercial sites will provide estimates of the volume and content expected to be shipped. However, it is difficult to estimate the capacity of a commercial facility due to the potential for changes in facility status and/or customer access. Regardless of this potential, the best estimates based on current agreements should be provided in LLW projections. It may be inappropriate to estimate the availability of this capacity for time periods beyond those currently negotiated or approved by DOE. Although this could result in LLW projections showing a potential shortfall of capacity, it should be known for planning purposes that this capacity is not controlled by DOE and/or that further waste acceptance commitments do not extend through the projection period.

3.5 Tools for LLW Projection

The use of analytical tools, models, and techniques can facilitate the development of LLW projections. The tools identified in this subsection are most applicable for projecting LLW resulting from facility decommissioning activities. They are examples of the type and range of tools available.

Technical Resources

Several technical documents provide information that may be of use in forecasting LLW for DOE projects. Although the facilities described in these documents are commercial facilities, LLW volume information is given for components and systems that are similar to those found in DOE facilities. A listing is provided below.

- NUREG/CR-1754, "Technology, Safety and Costs of Decommissioning Reference Non-Fuel Cycle Nuclear Facilities." (reference 3)
- NUREG/CR-1266, "Technology, Safety and Costs of Decommissioning a Reference Uranium Fuel Fabrication Plant." (reference 4)
- NUREG/CR-0672' "Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station." (reference 5)
- NUREG/CR-0130, "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station." (reference 6)

Other documents may also be useful in the development of LLW generation estimates and should be applied as appropriate.

Models

Most sites are able to provide their own estimates of decommissioning waste volumes through a characterization study of structures and soil volume. In some instances, sites are not able to provide these estimates and contractor specialists may assist in estimating the potential volume of contaminated materials generated by deactivation activities. Some environmental restoration sites have also used the "Automated Remedial Assessment Methodology," computer model, which facilitates estimation of the volume of LLW generated by decommissioning activities. If site-specific computer models or estimation models are available they should be used.

Technique for Facility Decommissioning Estimate

Low-level waste volume estimates are performed by the organizations responsible for preparing project scoping and site characterization documents. Estimates will form the basis for project schedules, budgets, and LLW volume estimates. The project documentation may contain estimates suitable for use in LLW projections, but for projects that have not yet been planned in detail, the volume estimates may not be complete. In this case an estimate may have to be developed for the facility to support LLW projection. There may be site-specific guidance on estimation assumptions and techniques or an approved computer program designed to ensure consistent and accurate estimates. Detailed site-specific tools, where available, should be used. Alternately, estimating tools from other sites with similar projects/facilities may be available. However, if estimating guidance or computerized tools are not available, an estimate may have to be developed with general techniques. A technique for developing estimates is provided below:

The factors suggested in this technique are not absolute and may be modified based on the actual situation. These factors will, however, identify considerations important in developing an estimate. The technique may be modified with site-specific information, but care should be taken because some simplifying assumptions build on previous conservative assumptions.

- Release levels - Radiological release levels for contaminated materials may be determined from project documentation, DOE requirements, or negotiated agreements. If no project specific guidance is available, assume that release levels used on other similar projects will be applicable.

- Concrete rubble - The volume of concrete generated will be dependant on the techniques used for decontamination. If surfaces can be sandblasted or otherwise cleaned by use of an abrasive, the volume will be much less than if scrabbling is required. Judgement will have to be used in determining appropriate techniques. However, if concrete removal or scrabbling is necessary, the volume of rubble may be estimated by using plan drawings and walk downs with estimated measurements. Terminal radiological survey data is critical to this effort.

  Estimate the surface area of cubicles, spaces, pits, and rooms that are contaminated using plan drawings and terminal surveys. If an area has been contaminated by radioactive processes, assume that contamination exists on surfaces unless surveys show otherwise. If the material can not be removed from the surface, assume scrabbling will be necessary.

  For each area, assess the depth of contamination. Characterization of the facility is the best way to determine this, but characterization data may not be available. Assessment of the processes that contaminated the area can also help determine the likely penetration of contaminants. For example, if there has been no penetrating contaminant, it might be assumed that a minimum depth of surface can be scrabbled to achieve release levels. For estimate purposes, perhaps one half inch might be appropriate. In an alternate example, areas that have been exposed to contaminants that penetrate the surface to greater depths, require deeper scrabbling. Core boring survey information would identify the depth of contamination. If the chemical components are known, there may be diffusion coefficients appropriate for concrete. If there is no site-specific information available, an estimate will have to be developed based on engineering judgement. In the case of prolonged exposure to penetrating contaminants, this estimate could be the total volume of wall material with, perhaps, a maximum depth of three feet considered.

Using the depth of contamination determined, and the surface area, a volume may be estimated.

- Pipe and Valves - Construction files may provide the amount of pipe and valves purchased. Design documents may identify the total amount of pipe and valves designed into the facility. Eliminate items that are obviously for non-radiological purposes, such as sanitary systems, and use the remaining sum as an estimate of the material that must be disposed of as LLW. Calculate the volume of LLW based on the solid volume pipe and ignore the volume of valves (unless the facility has an extremely high number of valves for the pipe used). Major piping additions to the facility should be assessed in the same manner. If construction documentation is not available, it would be necessary to use mechanical drawings to estimate pipe run volume. Although this technique takes more time, it would likely yield a much more accurate estimate as the installed pipe would be identified and non-contaminated systems could be eliminated from the estimate.

  Small bore pipe is sometimes not identified on mechanical drawings. Unless there is a large amount of small bore pipe, it could be ignored in view of the conservative assumptions in this estimation technique.

  Certain pipes may have insulation. There are special considerations if asbestos is involved that will be addressed by mixed waste handling plans. In general, the additional volume of insulation may be ignored due to the conservative nature of this estimate. However, if a significant amount of contaminated, attached insulation exists, it could be treated as part of the pipe volume for simplification of calculations, i.e., the diameter of the pipe could include the insulation.

  Hangers, component stiffeners, pipe whip shields, and snubbers can be ignored given these conservative assumptions.

- Mechanical Components - Major and minor components in contaminated systems should be identifiable from mechanical drawings. This could be checked against construction purchase lists and lists of components identified in design documents. Items like heat exchangers with significant internal components, should be treated as solid waste and the volume directly calculated. Hollow items such as tanks and vessels, may be treated as having one quarter their solid volume for small or thick walled vessels and one tenth their solid volume for standard tanks and liners. Any LLW within vessels should be assessed separately.

Pumps and the associated motors in contaminated systems should be considered as contaminated, unless survey information shows otherwise. These components may be identified from mechanical drawings and the LLW volume assumed to be the volume of the component. Normally a cylinder of appropriate size can be used to calculate the estimated LLW volume.

Large components, such as condensers, should be addressed on an individual basis. Conservatively, their total volume may be considered as LLW, but it is likely that the component will be disassembled for disposal. In this case, a more realistic estimate of one quarter of the total volume may be appropriate. If a large tube sheet is involved, it may be appropriate to estimate the region of the tube sheet at its actual geometric volume.

- Heating, Ventilation and Air Conditioning Components - Contaminated heating, ventilation, and air conditioning (HVAC) components should be included in estimates. These components should be identified on HVAC drawings. If the size of ducts are not drawn to scale, a walk down will be necessary to determine the size of various types of duct. Generally, HVAC ducts will not have insulation. However, if insulation is attached (e.g., insulating plaster applied to the duct) and likely to be contaminated, it may be considered as expanding the size of the duct. Volume would be estimated from the geometrical shape of the ducting. Most ducting is sheet metal and would be crushed before being packaged. A reduction factor of one quarter may be appropriate for estimate purposes unless the duct is particularly rigid. Fans that are contaminated may be ignored given the conservative nature of this estimate.

  Motors, furnaces, chillers, and other components may not be contaminated if facility design avoided the spread of contamination. However, if these components are contaminated, they should be included in the estimate at their full volume.

- Electrical Components - Facility design should have minimized the amount of contaminated electrical equipment. Some cable and instrumentation within radiological areas may be contaminated, but given the conservative techniques suggested, this could be ignored. However, if a significant number of large components, such as switch gear and electrical motors, are contaminated, they may need to be included as solid waste, assuming their full volume. It should be acceptable to ignore cable and instruments associated with this equipment in all but the most extreme situations.

  While cable can be ignored, contaminated cable trays should be included in the estimate. The volume of the tray should be determined and reduced by one half to approximate packing efficiencies. Electrical drawings should show cable tray runs and a walkdown can determine physical dimensions. Straight and curved trays can be treated as having the same volume, allowing a volume factor to be applied against the linear feet of tray. These assumptions will allow hangers to be ignored.

- Glove Boxes, Hot Cells, and Material Handling Equipment - Glove boxes and hot cells can be identified from mechanical drawings and LLW volume estimates based on one half their volume. Material handling equipment, such as master-slave manipulators, should be considered as LLW based on their full volume. A geometric shape that approximates the equipment may be used for developing estimates. Alternately, an estimate of LLW volume for these types of components can be found in the literature cited in Section 3.5 above.

- Miscellaneous Components and Materials - Doors, windows, stairway handrails, drain covers, and similar components of buildings may be ignored due to the conservative assumptions suggested.

  Grating should be estimated at its full volume. Assume a thickness of two inches and the surface area that it covers to calculate a volume.

  Component pedestals and labyrinth walls can be ignored if the room in question is treated as contaminated and an estimate for concrete walls performed as suggested above.

- Salvage Considerations - Terminal survey information will identify items and areas that are contaminated. It may be assumed that certain valuable equipment will be further decontaminated for salvage, if possible. If project planning is not complete, the criteria for decontamination and salvage will not be known. In some cases the decision will be left to project management when the effort is actually begun. Unless project documentation identifies salvage plans, items that are contaminated should be estimated as LLW. This may overestimate the eventual volume of LLW, but without project detail refinement may not be possible.

- Packaging - A packaging efficiency of fifty percent should be assumed for debris materials from building demolition, i.e., the volume of waste determined by these techniques should be multiplied by two, if it has to be packaged for shipment. This assumes no waste volume minimization techniques are employed.

- Waste Minimization - Waste treatment techniques can greatly reduce volume for metals, compactable items, and combustibles (if incineration is allowed), but unless project plans are fully developed, waste minimization techniques may not be identified for the project. In this case, assume a treatment level consistent with other projects on the site, and if there are no such projects, assume a treatment level consistent with similar projects elsewhere. If no comparisons are appropriate, do not consider waste minimization for reduction of LLW volume.

3.6 Data Sources

Data sources may vary for each facility, however, site-specific sources are the most effective. The identification of all current and future generators is critical to treatment, storage, and disposal capacity planning efforts and the quality of LLW projections. Cognizant waste management units are best suited to identify generators (existing and future) that plan to ship LLW to them. Potential future waste generators may include onsite and offsite operational facilities, facilities undergoing terminal cleanout and stabilization, treatment, storage, and disposal facilities, and/or planned new facilities. There are several sources discussed below that may be of use in the identification of generators and that provide information useful in the development of LLW projections.

Source Documents

Several types of DOE documents are important sources of information for LLW projections. These include:

- Remedial Investigation and Feasibility Studies (e.g., *Fernald Environmental Management Project, Feasibility Report Operable Unit 2*);
- Safety Analysis Reports;
- Hazards Analysis Reports;
- Site Characterization Studies;
- Environmental Impact Statements (EIS); and
- Environmental Assessments.

For comparison of historical information the following documents may be useful:

- Individual site Ten Year Plans;
- BEMR;
- IDB Report; and
- EM-40 Core Database.

The applicability of an individual report is best determined by the analyst assigned to develop the forecast. However, the type of information contained in these documents is generally supportive. For example, the TYP will provide an overview of projects under the Office of Environmental Management, including information on scope and schedule. The BEMR and the IDB Report provide information of a historical nature that can be used to reduce uncertainty in LLW projections. The LLW forecast should be reviewed against these documents and any differences reconciled or justified. However, it should be noted that in some cases, such as with EISs, the LLW volumes estimated may be upper bounds. In this case, caution should be exercised when using this information in LLW projections.

Process Knowledge

Process knowledge may assist in the development of LLW projections for generation activities. Knowledge of historical generation rates from facility operation and maintenance activities can form a basis for estimating future generation, providing the mission and scope have remained similar. Process knowledge can also shed light on the radiological characteristics to be expected of waste generated from the facility.

Alternately, information on the process design of facilities is useful in estimating the quantities and physical forms of waste generated by stabilization, deactivation, and decommissioning activities or for future planned facilities.

Low-level waste forecasts for future planned facilities present difficulties because there is no historical record with which to estimate LLW. Fortunately, the volume of LLW generated by facilities and processes is generally small compared to the volume generated by environmental restoration, stabilization, deactivation, and decommissioning activities. Inaccuracies are not likely to cause DOE to build an over-capacity of treatment, storage, and disposal facilities, but the best estimate practical should be developed and data quality objectives should still be applied. The Safety Analysis Report and the EIS for a particular facility may be sources of information for development of the LLW forecast. However, care should be taken because these sources may conservatively estimate the volume of LLW. Alternately, comparison to similar facilities may provide an appropriate and realistic estimate.

Sampling & Analysis

Sampling and analysis data can be useful in the development of waste projections, particularly for activities involving remediation, stabilization, deactivation, and decommissioning. Sampling and analysis of an environmental restoration site would provide information on the radiological characteristics of the contaminated media. If there is no plan for in situ remediation, the sampling and analysis data could facilitate estimates on the quantities and characteristics of LLW from restoration activities.

Environmental Restoration and Nuclear Material and Facility Stabilization projects can generate significant quantities of LLW through cleanup efforts. Treatment (e.g., volume reduction) of a portion of these wastes is possible, further complicating the estimation process. Site characterization studies, EISs and environmental assessments may be useful sources of information to estimate the volume of LLW. For any processing facilities involved, the techniques used for estimating facility output may be used. Clearly differences in funding, schedule, strategy, and standards have the potential to impact the LLW forecast significantly. The assumptions provided in the TYP development guidance and the applicable site TYPs themselves may be useful sources of information.

DOE Order 5820.2A "Radioactive Waste Management" (reference 7) requires that the major radionuclides and their concentrations in LLW must be characterized. Screening techniques have been used to reduce the number of analyses required to ensure that radionuclide concentration and inventory do not exceed performance assessment criteria. This being the case, the major radionuclides are determined on a site-specific basis in accordance with the waste acceptance criteria of the disposal site being used. A method that is often used for estimating the inventory of some radionuclides in a LLW waste stream is to perform a detailed analysis periodically to identify all necessary nuclides and thereafter, use the easily detectable components to "scale" the values of the less easily detectable components. Scaling estimates may be performed by using gamma measurements obtained with hand held instruments. The quality of such estimates has been adequate for commercial sites, but overall quality is dependent on the initial (and periodic) full analyses. In particular the use of higher than necessary "lower limits of detection" may cause overestimation of the disposal site inventory of some long lived isotopes. Therefore, radioanalytical methods of high quality should be used to develop LLW scaling factors. NUREG/CR-6230, PNL-9444 *Radioanalytical Technology for 10 CFR Part 61 and Other Selected Radionulcides* (reference 8), provides a literature review of current radioanalytical techniques. It should be referred to and the methods identified considered, as may be applicable, to LLW characterization efforts and the development of scaling factors for LLW manifesting purposes.

Waste Shipment Manifesting

Waste manifests are a valuable source of information for LLW projections. Manifests can provide detailed information on LLW volume, radiological components, container types, and chemical characterization. DOE Order 5820.2A requires that a manifest accompany each LLW package through final disposal. The Order requires that the manifest contain the following information: waste physical and chemical characteristics; quantity of each major radionuclide present; weight of waste; volume of waste; and other data necessary to demonstrate compliance with waste acceptance criteria. While all DOE disposal sites comply with this requirement, there are minor variations in manifest information between sites.

- Radionuclide Data - Radionuclide information on manifests provides, at the least, curie amounts of the key radionuclides addressed in the site-specific radiological performance assessment. However, in many cases it will provide a more extensive listing of radionuclide quantities.

- Waste Form - All manifests require that physical form be specified. This will be provided for each waste container at most sites, but may also be provided by shipment or waste stream.

- Chemical Form - Waste stream chemical characterization information is required by most DOE disposal sites, although older manifests and some sites may not require chemical form information.

Low-level waste that is disposed in a commercial facility will be manifested in accordance with U. S. Nuclear Regulatory Commission (NRC) requirements. There are minor differences in DOE and NRC manifesting requirements. In particular, the waste form categories and containers used by NRC differ from those used by DOE. However, these differences should not be a significant impediment to using commercial LLW manifests in projection efforts

In general, manifests are a useful source of information in the development of LLW projections and should be used as appropriate.

3.7 Prioritization of Effort

The quality of LLW forecast data decreases the further into the future that the projection extends. The forecast time periods suggested by the LLW Projection Program are one year totals for years 1 through 10 and a lump sum total for years 11 through 30. It is likely that the quality of data will vary considerably between these time periods.

LLW projections are dependant on many factors discussed throughout this document, but uncertainty can be minimized. However, the quality of estimates should be the highest for the first three years of the one year totals. Data quality objectives should reflect this and projection efforts should be concentrated on attaining the most accurate projections available for this period. It should be understood that if mission or budget revisions affect the projects in question, the LLW projections will require revision, but in the case where these factors are constant, accurate projections should be expected.

3.8 Developing the Estimate

Where waste management units have established site-specific LLW projection guides, forecasts should be developed in accordance with that direction. However, where there is a lack of such guidance, a method for the development of LLW projections is discussed below:

- Generator - Identify the generator and/or associated waste stream. As discussed previously, all generators and potential future generators should be identified. This process should be applied to each generator individually.

- Projected Volume and Container Types - Identify the number of waste containers used for each generator and the volume of each type of container.

- Waste Form - List the physical form expected to be in the containers.

- Radionuclide data - Provide the curies of each key isotope expected to be in each container type.

- Treatment, Storage, and Disposal Facility Capacity - Provide the capacity or throughput volume of facilities for the treatment, storage, and disposal of LLW.

This process should be repeated until an estimate that addresses all applicable generators, waste streams, and facilities has been developed.

4.0 DATA QUALITY & UNCERTAINTY

The data quality objective (DQO) process should be applied in developing LLW projections. The DQO process is a flexible, iterative, and interactive planning tool for improving the quality of LLW projections and arriving at better decisions. The DQO process, institutionalized for EM activities per a September 7, 1994 memorandum from Mr. Thomas Grumbly, then Assistant Secretary for Environmental Management (reference 9), has been/is being applied to various LLW-related activities, including radiological performance assessments and composite analyses associated with LLW disposal facilities. Where possible, DQO initiatives that are underway should be leveraged for application to LLW projections.

Data quality objectives are qualitative and quantitative statements derived from the DQO process that clarify study objectives, define appropriate types of data and often specify the tolerable levels of potential errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. Application of the DQO process to LLW projections should implement a flexible, simplified (not prescriptive), approach which reflects the important features of the DQO process. Information on the DQO process, including a copy of Mr. Grumbly's memorandum, can be found at http://terrassa.pnl.gov:2080/. Discussed below in sections 4.1 and 4.2 are general considerations affecting the application of the DQO process to LLW projections.

4.1 Data Quality

Review of some past LLW projections has shown a data quality of ±100% uncertainty for the next projection year (e.g., the LLW projection for the following year was twice what the actual receipts were). Clearly, the accuracy and quality of such data requires improvement to avoid potential unnecessary expenditures by DOE. Toward that end, waste management units (or other appropriate field elements responsible for LLW management) should establish appropriate DQOs.

Low-level waste projection accuracy decreases with extrapolation into the future. However, it should be possible to provide volume estimates for the first year of the projection that closely reflect actual values. Waste management units should consider establishing a DQO of ± 20% uncertainty for total LLW volume for the first year of the projection. This DQO may be relaxed in years that are further out, for example to ± 35% uncertainty for the second and third years, etc., until a DQO of ± 100% uncertainty for LLW volume is recognized for the lump sum total for years 11 through 30.

Comparison of actual values of LLW volume and the projected values should be performed annually and during development of new LLW projections. This feedback should be used to identify what factors are the major influences (see section 4.2) on LLW volume estimates, to improve the quality of data, and move the process toward the established DQOs. Three cycles of LLW projections and feedback may be allowed to meet DQOs.

A data quality improvement measure implemented by some disposal facilities is worthy of note. These disposal facilities require that waste management units provide an estimate of LLW expected for the following year and pay for the disposal volume in advance. Extenuating circumstances are considered for return of fees, but generally the fees are not refundable. This measure has greatly improved the quality of LLW forecasts and has enhanced the disposal facility's advanced planning efforts.

4.2 Uncertainty

Uncertainties associated with forecasting data gathered during the projection life-cycle should be considered. These uncertainties typically fall into seven categories:

- budget uncertainty;
- programmatic direction and mission uncertainty;
- waste generation uncertainty;
- shipment schedule uncertainty;
- waste characterization uncertainty;
- waste generator facility maturity; and
- comprehensive profile uncertainty.

The level of uncertainty may generally increase for later years of the projection period, but where possible, improvements should be made to reduce these uncertainties. The following discussion addresses each area of uncertainty and provides guidance to minimize the impact on projections.

Budget Uncertainty

The level of funding dictates the production level of a project or facility and is a necessary assumption for all LLW projections. However, future funding levels are uncertain and fluctuations can significantly affect the amount of LLW generated. Unless better information is available, (e.g., the TYP provides a date for facility shutdown.) a flat funding level should be applied for the duration of facility mission.

Programmatic Direction and Mission Uncertainty

The changing DOE mission can create LLW projection uncertainty because facility and project missions may be redirected in the future. A facility may base LLW forecasts on a single mission (e.g., facility design operation,) but may be redirected to undertake additional missions (e.g., stabilization, deactivation, and decommissioning of areas within the facility). Planning documents for additional missions may estimate the volume of LLW, if they are available. An estimated budget for LLW disposal may have been developed and could be analyzed to estimate the amount of LLW associated with the project. The actual progress of the project should be compared against the schedule to estimate the timing of LLW creation and its impact on treatment, storage, and disposal facilities. Often facility management plans cite an expected change in mission in future years. In this case, environmental impact statements and other project documentation may contain estimates on LLW generation. However, care should be taken in estimating the LLW created during the transition period between mission changes. This will require specific knowledge of the project scope and schedule. Expected radionuclide inventories may also be available from project documentation.

Occasionally a LLW forecast is based on an assumed mission that is not consistent with national level plans (e.g., the TYP states that the facility will be closed). Analysts who develop LLW forecasts should remain cognizant of long-range plans that reflect site mission changes. In some cases high mission uncertainty exists due to technical challenges (e.g., Hanford tank farm waste treatment options and timing). This situation complicates projection of LLW volume, characteristics, and scheduling. In this case it may be appropriate to assume the project will be completed in accordance with the current TYP or other site-specific planning document. However, the assumptions should be documented in LLW projections.

Projection of LLW generation from recently built facilities or planned facilities is difficult because there is no operation and LLW generation history to draw upon. Project documentation, (e.g., the EIS or design specifications) may contain estimated LLW generation, but these estimates may be conservative. Comparison to similar operational facilities may be useful for tempering estimates based on design documents. Additionally, operational capacity should be estimated at less than 100%, especially during facility startup and early operation. However, unexpected maintenance outages, modifications and repairs may tend to increase the LLW estimate.

The organization assigned the responsibility for developing LLW forecasts must remain cognizant of site wide mission changes and future plans through the review of national level planning documents and site-specific plans for facilities and projects under their cognizance.

LLW Generation Uncertainty

The volume of LLW produced by projects and facilities may be uncertain even when the mission is clearly defined. Process equipment downtime is difficult to predict and may impact LLW generation significantly. Further, if the process is dependant on other processes/facilities to feed material to it, downtime in those processes will impact the generation of LLW. Additionally, unexpected waste generation, such as spills or equipment failure requiring replacement may occur. A strategy that addresses this uncertainty is to estimate maximum, minimum, and baseline (best estimate) values. The maximum should be based on the maximum throughput the facility is capable of and that is possible given the status of processes that feed material to it. The minimum could be based on a historical low capacity factor and a conservative forced outage rate. The best estimate should be based on the best information available from site plans, tempered by a realistic assessment of throughput, forced outage rate, and expected volume of feed materials. A brief explanation of the assumptions used should be provided to facilitate analysis of alternate scenarios.

Shipment Schedule Uncertainty

Uncertainties in funding can create uncertainties in the shipment schedule. LLW may be ready for shipment, but the necessary funding may not be available in the expected time period. In addition, LLW shipping schedule is often driven by work scope accomplishments. If work milestones are not met, the expected LLW will not be available for shipment. However, in the absence of better information, analysts should use approved budget plans and schedules to estimate the volume of LLW to be shipped. Uncertainties may be addressed as maximum and minimum shipment levels, with a reasoned estimate as the baseline estimate (with assumptions provided). Uncertainty due to shipping schedule delay should be distinguished from waste generation uncertainty because schedule uncertainty only affect the timing of LLW arrival at treatment, storage, and disposal facilities, whereas waste volume uncertainty may affect capacity planning.

Waste Characterization Uncertainty

Low-level waste characterization requires detailed analysis of waste streams, contaminated media or other materials and, in some instances, this data is not available. In particular, legacy LLW and LLW from environmental restoration activities may not be well characterized, (e.g., the Hanford Tank Farms). In this case, the best estimate may be derived from the most recent planning, assessment, and project documentation. This forecast may be supplemented with minimum and maximum estimates based on other potential scenarios of waste generation. However, the assumptions used in conservative estimates should be noted because it would be inappropriate to base treatment, storage, and disposal planning efforts on overly conservative forecasts.

New or planned facilities lack a LLW generation history making characterization of the resulting LLW difficult. Process knowledge and review of conceptual design documents will allow projection of LLW volume and characteristics but these estimates should be tempered by LLW generation history from similar facilities.

Waste Generator Facility Maturity

The availability of production history for a LLW generator can reduce uncertainty. Established facilities have many years of historical data that can be used to forecast LLW data with certainty, assuming the mission and funding do not change. However, new or planned facilities lack such generation history. In this case uncertainty can be minimized by comparing forecast data to that from similar facilities and supplementing the forecast with maximum and minimum values (with documentation of assumptions).

Comprehensive Profile Uncertainty

Occasionally, potential LLW generators are not included for the entire projection period (e.g., a facility planned to pretreat LLW prior to disposal will generate LLW itself, but this LLW volume may not be included in forecasts). Analysts assigned to develop LLW projections should remain cognizant of site planning documents to ensure that all future LLW generators are accounted for. Site-wide mission plans, national level planning documents, and facility plans may identify future LLW generators.

5.0 MAINTAINING HISTORICAL PROJECTIONS

Data analysis and reporting is necessary to ensure that LLW information supports focused planning efforts. Reporting concludes the projection cycle by communicating the projection data and supporting analyses in a manner that supports life-cycle planning.

5.1 Data Verification

Waste management units should compare actual receipts with previous years projections to assign certainty levels to the projection data. If poor data quality is noted an assessment should be made as to the potential reasons. The generator should be included in this assessment and the results should feedback into DQO values. If data errors are detected, such as LLW projections beyond the life of a project, or the LLW volume projection exceeds the volume estimated in characterization documents, the generator should be asked to review the basis for these parts of the forecast. Finally, if projections consistently overestimate the actual waste received, the trend should be discussed with the generator to improve data quality.

5.2 Data Analysis

Data analysis may be performed by disposal sites, waste management units, the newly established National LLW Program Center for Excellence, or DOE/HQ. Analyses will consist of identifying major LLW generators, trends, and significant impacts to treatment, storage, and disposal facility planning. The process requires from two to eight months, depending on staff knowledge of the process, waste generator missions and uncertainties, the amount of data to be reviewed, the completeness of data, and the quality of the data. If the analyst staff lacks experience in the process, the analysis will require more time. Additionally, data that are extensive, incomplete, or of poor quality may also extend the time required for analysis.

The major waste generators should be identified and analysis efforts prioritized. In some cases, a few facilities will contribute most of the total waste; whereas other cases may show 20 or more facilities as major waste generators. A greater number of major generators may extend the time required for data analysis. Once the major waste generators have been identified, three key points should be addressed for each facility:

- Projection Assumptions

  Each data request will identify objectives and complex-wide assumptions that are to be used in the response. However, responders should indicate where they deviated form the major assumptions or how these assumptions may have decreased the quality of data. Other assumptions that were important to data development should be included. These assumptions should be reviewed to ensure consistency with the objectives of the data request and for validity.

- Projection Uncertainties

  Each data request responder should identify and discuss data uncertainties in accordance with the guidance of Section 4.0. The data analyst should review the uncertainties and their potential to impact forecasts.

- Projection Completeness

  Each data request responder should submit a complete projection packet including references where appropriate. This will allow data analysts to identify alternative sources of data to supplement the projection.

These three elements should be addressed in data requests. If the requested information is not provided in sufficient detail, data analysts should contact the appropriate waste management unit for clarification and follow-up information. This effort may provide additional data that can reduce uncertainty.

Trends should be identified to compare data results and identify any unusual scenarios. Trends may also be identified by comparing projection data with actual receipts. These trends are useful in evaluating the quality and accuracy of the projection data.

5.3 Data Reporting

Data reporting is the last step in the projection cycle and is the means of communicating analysis results and conclusions reached during the data collection cycle. Reports should be developed in support of site and national level needs and should be tailored to meet the data user's needs. There are generally two types of reports: standard reports and ad hoc reports. Standard reports are those requested on a periodic basis and are typically used for budgeting purposes or to aid in treatment, storage, and disposal facility planning. Ad hoc reports are those that are requested for unplanned activities, often in support of management inquiries.

5.4 National Level Planning and Analysis

Site level LLW projections will be compiled by DOE/HQ to support national level planning and analysis activities such as BEMR and TYP. It is essential that this information is available and used to support program planning and execution activities to support the following objectives:

- safe, efficient, and timely disposal of LLW generated by DOE activities;
- timely planning for additional treatment, storage, and disposal facilities;
- determination of the DOE complex-wide configuration for future LLW disposal facilities based on specific waste characteristics; and
- achievement of DOE complex-wide strategic planning to determine the most efficient use of LLW disposal capacity.

6.0 TRAINING

It is expected that in 1997 DOE waste management units (or other field elements responsible for management of LLW) will incorporate elements from this Guide into site-specific LLW data collection systems. When this process has been finalized it may be appropriate for the waste management unit to conduct training sessions to ensure understanding of the projection process. This may also provide an opportunity for the users to identify additional improvements for the program. Training is estimated to take less than one week, but development of the training course and preparation to conduct it may require several person-weeks. A point of contact from each facility that will ship LLW should attend the training

Training should communicate LLW data requirements and collection methods in a clear, consistent way and create support of the projection strategy. Additionally, development of a training program increases site knowledge of the program and its goals and reinforces ownership of the process. These efforts will improve data quality.

The training should be structured to address all facets of a simulated data call. An example data packet should be completed during the training session for hands-on experience. The training session should also address the purpose of each data element being collected to help ensure the waste generator understands the terminal uses of the data. Finally, feedback on the training session and data packet usability should be solicited from the students and incorporated into the next revision of the training. Feedback on the data packet may be shared with DOE elements that develop data request guidance.

7.0 SPECIAL INFORMATION NEEDS

7.1 Classified LLW

Development of projection data for classified LLW requires particular attention to ensure proper handling of safeguards information. Although the need for security of information is the overriding priority, it should be possible to adequately forecast LLW volume. However, the schedule for release of classified materials as LLW, container type information, waste form information, and radionuclide data may be uncertain. It may be necessary to coordinate the gathering of this forecast information with the appropriate representatives of the Office of Environmental Management, the Office of Defense Programs, and The Naval Nuclear Propulsion Program.

7.2 Special Case Waste

Special case waste (SCW) includes a variety of forms and isotopic mixtures. It is particularly important to include SCW in LLW projections because it is often waste that has no management plan for disposal. EM is in the process of evaluating the current known inventory of SCW to determine appropriate management plans. It is expected that much of this waste will eventually be identified as transuranic or high-level waste and that only a fraction will remain as SCW. However, this remainder will still be considered SCW until an appropriate waste management plan is finalized. The Low-Level Waste Program Management Plan, as well as the ongoing revision to the DOE Order for radioactive waste management will address this issue.

SCW includes various types of waste as described below:

- <u>Specific Performance Assessment Required (SPAR) Waste</u>

  This is DOE-titled waste that contains radionuclides in concentrations that exceed the limits of 10 CFR 61.55, Class C (DOE equivalent) waste. These waste are a special case because they are not generally acceptable for near surface disposal. DOE Order 5820.2A requires that these wastes receive a specific performance assessment through the National Environmental Policy Act process and concurrence of DOE/HQ.

- <u>DOE-titled Fuel and Fuel Debris Waste</u>

  This waste is fuel and fuel debris that has been used for research and development purposes. This waste is similar to waste destined for the High-Level Waste (HLW) Repository but, the packaging of these wastes may not conform with current planned HLW Repository waste acceptance criteria. The processing and repackaging of this waste will generate LLW.

- Excess Nuclear Material

  These wastes are nuclear materials that do not have enough economic value to warrant processing for useable nuclear material. Some materials contain RCRA-regulated constituents, which preclude processing and limit waste management options.

- Sealed Sources

  Encapsulated radioactive material whose main purpose is to generate gamma radiation, heat or neutrons. The concentration of radioactive material in sealed sources may require that they be treated as SPAR waste.

- DOE-Titled, held by NRC Licensees

  DOE-titled wastes that are held by NRC licensees under contract, loan or grant from DOE for use in research related fields. This waste can be expected to return to DOE at some time in the future and a management option may not be immediately available.

Consistent with site-specific plans and funding, every effort should be made to develop disposal plans for SCW. However, if this can not be done, SCW should be reported with LLW projections and the current status of plans to characterize, treat, or store this waste should be summarized. LLW that would result from such evolutions should be included in LLW projections if it represents significant volumes in excess of normal operations at the facility handling the waste. The uncertainty minimization techniques described in this Guide should also be applied. However, where plans or technologies are not finalized for disposition of SCW, the estimates of LLW from treatment or handling will have greater uncertainty. These limitations should be noted with the data.

A significant portion of SCW will not be considered as LLW when it is characterized and disposal plans developed. For example, DOE-titled fuel may simply be appropriately packaged and disposed of in the same manner as other fuel, but will not be treated as LLW in any case. However, SCW without a management plan should be reported as requested. The known characteristics of the SCW should be described to support LLW treatment, storage, and disposal planning.

Sealed radioactive sources are included as SCW and have been routinely reported in previous data collection efforts. The radiological characteristics of this waste should be known and reported with a high degree of accuracy. However, the integrity of encapsulation is important in the assessment of management options. To the extent that such information is known it should be reported as either "effective encapsulation" or "questionable encapsulation." Source encapsulation known to have failed should be reported as "ineffective encapsulation."

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ATTACHMENT A

REQUIREMENTS AND CONCERNS IMPORTANT TO LLW MANAGEMENT

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ATTACHMENT A

Requirements and Concerns Important to LLW Management

The following requirements and concerns establish the basic framework for the Department's management of LLW. Many of these requirements and concerns have been taken from the referenced documents.

DOE Order 5820.2A

The development of large scale waste treatment facilities shall be supported by appropriate National Environmental Policy Act documentation in addition to the following: a) a document shall be prepared that analyzes waste streams needing treatment, treatment options considered and a rationale for selection of proposed treatment process; (Chap. III, Sec. 3, f(3)[a])

Design criteria (for a disposal facility) shall be established prior to selection of new disposal facilities, new disposal sites, or both. The criteria shall be also based on assessment of projected waste volume, waste characteristics, and facility and disposal site performance. (Chap. III, Sec. 3, i[8]a)

Generators shall provide an annual forecast in the third quarter of the fiscal year to the field organizations managing the offsite disposal facility to which the waste is to be shipped. (Chap. III, Sec. 3, g[2])

Each field organization shall develop and maintain a record keeping system that records the following: a historical record of waste generated, treated, stored, shipped, disposed of, or both, at the facilities under its cognizance. The data maintained shall include all data necessary to show that the waste was properly classified, treated, stored, shipped, and/or disposed of. The data maintained in the system shall be based on the data recorded on waste manifests. (Chap. III, Sec. 3, m[1])

Waste manifests will be kept as permanent records. At a minimum, the following data will be included a) waste physical and chemical characteristics; b) quantity of each major radionuclide present; c). weight of the waste; d) volume of the waste; e) other data for compliance with waste acceptance criteria. (Chap. III, Sec. 3, m[2])

The following concerns have resulted from oversight activities or studies:

DNFSB Recommendation 94-2 (reference 10)

A regularized program for forecasting future burial needs relative to existing capacity, taking into account the projected programs for decontamination and decommissioning of defense nuclear facilities and environmental restoration activities as well as current operational units. (Sec. 1, D.2, para. 1)

DOE Implementation Plan Commitment in Response to 94-2 (reference 11)

The Department will conduct an evaluation of current waste generation and volume projections of LLW received by LLW disposal facilities, current methodologies used to project volumes, and planned disposal capacity for LLW. (Please note: This part of the commitment was completed in "The Current and Planned Low-Level Waste Disposal Capacity Report" Rev. 0.) Following this effort, LLW projection implementation guidance will be developed, by the end of 1996, to describe the recommended methodologies for LLW volume projections and their recommended frequencies. The guidance document will also contain a system for evaluation of the projected volumes of waste requiring disposal to determine the accuracy and validity of waste volume projections. The guidance will be directed specifically at improving projections of LLW from decontamination and decommissioning and remedial action projects, but it will also be coordinated with generators creating LLW routinely. (Sec. 1, D.2, para. 2)

Complex-Wide Review of DOE's Low-Level Waste Management ES&H Vulnerabilities (reference 12)

Complex-Wide Vulnerability 1: Inadequate LLW generation forecasting and capacity planning on a complex-wide basis.

In addition to being identified as a site-specific vulnerability, inadequate forecasting was found to contribute significantly to other vulnerabilities (e.g., storage of waste with a path forward; storage of waste under inadequate conditions). As a contributing cause to other vulnerabilities, inadequate forecasting and capacity planning is characterized as an inherent vulnerability. (Chap. 2, Sec. 2.3, para. 2)

DOE Order 435.1 (Revision of DOE Order 5820.2A) Radioactive Waste Management

DOE Order 5820.2A "Radioactive Waste Management" is being revised with the input from field elements throughout the complex. The intention of this revision is to improve the management of DOE waste and provide clarification of the requirements associated with waste handling. It is expected that the effort will be completed in 1997 and that it will implement the DOE Low-Level Waste Program Management Plan.

ATTACHMENT B

LIST OF TYPICAL KEY RADIONUCLIDES

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ATTACHMENT B

List of Typical Key Radionuclides*

Symbol	Name	Half-Life
H-3	Hydrogen-3	12.35 yr
C-14	Carbon-14	5730 yr
Cl-36	Chlorine-36	3.01×10^5 yr
Co-60	Cobalt-60	5.27 yr
Ni-59	Nickel-59	7.5×10^4 yr
Ni-63	Nickel-63	96 yr
Se-79	Selenium-79	6.5×10^4 yr
Sr-90	Strontium-90	29.1 yr
Nb-94	Niobium-94	20,000 yr
Tc-99	Technetium-99	213,000 yr
I-129	Iodine-129	1.57×10^7 yr
Cs-137	Cesium-137	30 yr
Eu-152	Europium-152	13.33 yr
Eu-154	Europium-154	8.8 yr
Ra-226	Radium-226	1600 yr
Ac-227	Actinium-227	21.7 yr
Ra-228	Radium-228	5.76 yr
Pa-231	Protactinium-231	3.28×10^4 yr
Th-230	Thorium-230	7.5×10^4 yr
Th-232	Thorium-232	1.41×10^{10} yr
U-233	Uranium-233	1.59×10^5 yr
U-234	Uranium-234	2.45×10^5 yr
U-235	Uranium-235	7.04×10^8 yr
U-238	Uranium-238	4.47×10^9 yr
U-NAT	Natural Uranium	**
U-DEP	Depleted Uranium	**
Np-237	Neptunium-237	2.14×10^6 yr
Pu-238	Plutonium-238	87.74 yr
Pu-239	Plutonium-239	2.41×10^4 yr
Pu-240	Plutonium-240	6,537 yr
Pu-241	Plutonium-241	14.4 yr
Pu-242	Plutonium-242	3.76×10^5 yr
Am-241	Americium-241	432.2 yr
Cm-244	Curium-244	18.11 yr

* Please note: This list of isotopes is compiled from a review of performance assessments and the EM-40 Core Database. It does not reflect the key isotopes from any single performance assessment.

** Natural and Depleted Uranium contains U-238 (4.47×10^{9} yr), U-235 (7.04×10^{8} yr), and trace amounts of U-234 (2.46×10^{5} yr).

ATTACHMENT C

DEFINITION OF WASTE FORMS

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ATTACHMENT C

Waste Form Categories

The *DOE Waste Treatability Group Guidance* (TGG) (reference 13) defines a logical, hierarchal array of categories that are intended to describe the overall, composite physical/chemical form (matrix) of waste. Beginning with a very general, or broad, level of categories (e.g., Liquids, Solids), the array proceeds to successively more definitive, or waste form specific, levels (e.g., Solids → Homogeneous Solids → Inorganic Homogeneous Solids → Inorganic Particulates → Ash).

Table C-1 presents a subset of the TGG matrix categories which are recommended for use in development of LLW projections. Note that Table C-1 reflects certain modifications, as footnoted, that are pending incorporation into the TGG. In addition to these modifications, some of the category definitions are paraphrased to reflect the criteria of their associated, less definitive categories.

Relative to the entire array of matrix categories in the TGG, the categories in Table C-1 represent recommended minimum levels. However, wastes for which insufficient characterization information is known to enable categorization at these minimum levels should be assigned to the appropriate, less definitive TGG categories. Likewise, the recommendation of these minimum levels is not meant to preclude sites from assigning wastes to more definitive categories, if applicable. Refer to the TGG document for additional clarification.

Table C-1. Recommended Matrix Categories

Code	Name	Definition
L1100	Wastewaters	Liquids that are treated in wastewater treatment facilities and discharged under the Clean Water Act to the environment. Typically, these are relatively large volume, aqueous effluents which, following generation, are sent directly to wastewater treatment.[1,2]
L1200	Aqueous Slurries	Liquids/slurries that contain <1% total organic carbon (TOC) and do not meet the criteria for classification as Wastewaters (L1100). Slurries are defined as liquids with a total suspended/settled solids (TSS) content of ≤30%. Only wastes packaged in bulk, free form (e.g., drum, tank) are included in this category. Liquids/slurries packaged as lab packs are categorized as such.[2]

Code	Name	Definition
L2000	Organic Liquids	Liquids/slurries that contain ≥1% TOC and do not meet the criteria for classification as Wastewaters (L1100). Only wastes packaged in bulk, free form (e.g., drum, tank) are included in this category. Organic liquids packaged as lab packs are categorized as such. [2]
S3110	Inorganic Particulates	Waste that is at least 50% by volume inorganic particulates, including any residual or absorbed liquids. Particulates are defined as solid material, excluding soil/gravel, that do not meet the criteria for classification as debris (see below). Typical examples of inorganic particulates are incinerator ash, dust, sandblasting residue, vermiculite, and ion-exchange media.[2, 3]
S3111	Ash	Waste that is primarily (i.e., ≥50% by volume) bottom or fly ash resulting from incineration.
S3115	Ion-Exchange Media	Waste that is primarily (i.e., ≥50% by volume) unused or spent inorganic ion-exchange media.
S3118	Activated Carbon	Waste that is primarily (i.e., ≥50% by volume) unused or spent activated carbon, including any residual liquids.
S3120	Inorganic Sludges	Waste that is at least 50% by volume inorganic sludges, including water content. As opposed to slurries (see above), sludges are defined as having a TSS >30%. The sludge may be mixed with stabilization agents, such as cement, provided the mixture has not properly cured to form a solidified monolith (see category S3150). The sludge may also be mixed with inorganic particulate absorbent materials.[2]
S3130	Paint Waste	Waste that is at least 50% by volume new, used, or removed paint. The paint may be in the form of chips or other solids (e.g., containers filled with dried paint), or sludge (e.g., opened or unopened cans of heavy, viscous paint). This category does not include waste that is 50% by volume, or more, paint-related solids, such as empty paint cans, depressurized spray paint cans, or other painting equipment (brushes, rollers, etc.) that meet the criteria for classification as debris (see below). Pressurized spray paint cans are categorized as Compressed Gases/Aerosols (X7700).[2]
S3140	Salt Waste	Waste that is at least 50% by volume salts, including interstitial liquids, if present.[2]

Code	Name	Definition
S3150	Solidified Homo-geneous Solids	Waste that is at least 50% by volume solidified forms that require further treatment before disposal. The original, unsolidified waste may be either inorganic or organic, while the solidification agent must be inorganic. An example might be a particulate or sludge waste that has been immobilized with cement and cured into a solidified form, but that does not meet LDR treatment standards, if applicable, or other relevant disposal criteria.
S3200	Organic Homo-geneous Solids	Waste that is at least 50% by volume organic homogeneous solids. These are homogeneous solids with a base structure that is primarily organic such that a maximum of approximately 20% by weight would remain as residue (i.e., ash or solids) following incineration.[2]
S4000	Soil/Gravel	Waste that is at least 50 vol% soil, including sand and silt, or rock and gravel that does not meet the criteria for classification as debris.[2]
S5111	Nonactivated Metal Debris	Waste that is estimated to be 80% by volume, or more, metal debris materials for which the metal debris material is not activated (i.e., radioactivity is due to surface contamination).[4, 5]
S5112	Activated Metal Debris	Waste that is estimated to be 80% by volume, or more, metal debris materials that for which the metal debris material is activated.[4, 6]
S5120	Inorganic Nonmetal Debris	Waste that is estimated to be 80% by volume, or more, inorganic, nonmetal debris materials. Examples of these materials are concrete, glass and brick.[2, 4, 7]
S5122	Glass Debris	Waste that is estimated to be 80% by volume, or more, glass debris materials. Examples of waste that might be included in this category are leaded glass windows, bottles, or light bulbs. [4]
S5125	Asbestos Debris	Waste that is estimated to be 80% by volume, or more, asbestos or asbestos-based debris materials. Examples of waste that might be included in this category are asbestos-containing gloves, fire hoses, aprons, flooring tiles, pipe insulation, boiler jackets, and laboratory tabletops. [4]
S5300	Organic Debris	Waste that is estimated to be 80% by volume, or more, organic debris materials. Examples of organic debris materials are plastic, rubber, wood, paper, cloth, and biological materials.[2, 4, 8]

Code	Name	Definition
S5340	Biological Debris	Waste that is estimated to be 80% by volume, or more, biological debris materials, including any chemical agents such as lime or formaldehyde. Examples of waste that might be included in this category are biological samples and animal carcasses. [4]
S5400	Hetero-geneous Debris	Waste that is at least 50% by volume debris materials that do not meet the criteria for assignment as either Inorganic (S5100) or Organic (S5300) debris. An example is waste that is essentially entirely debris, but is not dominant (i.e., estimated to be 80% by volume or more) in either inorganic or organic debris materials. Another example is waste that is at least 50% by volume debris materials, with the balance being soil (S4000) or homogeneous solids (S3000's).[2, 4, 9]
S5410	Composite Filter Debris	Waste that is estimated to be 50% by volume, or more, high-efficiency particulate air filters (HEPA) or other filters constructed of more than one material type (e.g., metal, inorganic nonmetal, and organic materials). Filters constructed of a single material type are assigned into the appropriate inorganic, organic, or heterogeneous debris category depending on the composition of the entire waste matrix. [4]
X6000	Lab Packs	Waste packaged in lab pack configurations. A lab pack configuration is defined as two or more waste containers packaged within a larger outer container. Typically, the inner containers are surrounded by absorbent materials. If present, the absorbents can be homogeneous solids or debris materials.[2]
X7210	Elemental Lead	Waste that contains at least 50% by volume bulk elemental lead. Examples include lead bricks, sheets, and pipes.[2]
X7700	Compressed Gases & Aerosols	Waste consisting of pressurized gas cylinders, including aerosols. Waste consisting of depressurized gas cylinders or aerosol cans would not be assigned to this category. This waste would be assigned to the appropriate debris category (see above).

Code	Name	Definition
X7800	Sealed Sources	Waste consisting of encapsulated radioactive material whose main purpose is to generate known amounts of radiation. Sealed sources are defined as a category of special-form radioactive material in 10 CFR Part 71.4. Special-form radioactive material is radioactive material which satisfies the following conditions: [10] (1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule; (2) The piece or capsule has at least one dimension not less than 5 mm; and (3) It satisfies the test requirements of 10 CFR 71.75.
Z1100	Micro-encapsulated Forms	Wastes that have been immobilized and meet applicable disposal criteria. More specifically, this category includes immobilized final waste forms resulting from the treatment of liquids and slurries, or solids (e.g., sludges, particulates, soils) with relatively small particle sizes (i.e., not meeting the criteria for classification as debris).[2, 11]
Z1110	Cement Forms	Waste meeting the criteria specified for category Z1100 which have been immobilized with grout or other cement-type binders.
Z1120	Vitrified Forms	Waste meeting the criteria specified for category Z1100 which have been immobilized via vitrification.
Z1130	Polymer Forms	Waste meeting the criteria specified for category Z1100 which have been immobilized with organic binders.
Z1140	Amalgamated Forms	Waste meeting the criteria specified for category Z1100 which have been immobilized via amalgamation.
Z1150	Crystalline Forms	Waste meeting the criteria specified for category Z1100 which have been immobilized via methods that produce a crystalline final waste form. Example methods are microwave solidification and the Synrock process.
Z1200	Macro-encapsulated Forms	Wastes that have been immobilized and meet applicable disposal criteria. More specifically, this category includes immobilized final waste forms resulting from the treatment of solids with relatively large particle sizes (e.g., debris).
U9999	Unknown or Other Matrix	Waste for which insufficient characterization is known to enable evaluation per the criteria of the Liquids (L0000), Solids (S0000), or Specific Waste Form (X0000) categories.

Table C-1 Footnotes

1 This definition reflects a modification from Revision 0 of the TGG.

2 Revision 0 of the TGG includes matrix categories titled "Unknown/Other" within each summary level category. Except for category U9999, plans are to eliminate these unknown/other categories because they are essentially equivalent to their associated summary category. For example, assigning a waste to category S3119 - Unknown/Other Inorganic Particulates is equivalent to assignment as S3110 - Inorganic Particulates.

3 Within the concept of implementing these minimum category levels, this category would include inorganic particulate wastes that do not meet the criteria for more definitive classification as either S3111-Ash, S3115-Ion-Exchange Media, or S3118-Activated Carbon.

4 Debris is defined as solid material exceeding a 60 mm particle size that is: 1) a manufactured object, or 2) plant or animal matter, or 3) natural geologic material.

5 Plans are to replace the category S5111-Metal Debris Without Pb or Cd in Revision 0 of the TGG with this category.

6 Plans are to replace the category S5112-Metal Debris With Pb in Revision 0 of the TGG with this category.

7 Within the concept of implementing these minimum category levels, this category would include inorganic nonmetal debris that do not meet the criteria for more definitive classification as either S5122-Glass Debris or S5125-Asbestos Debris.

8 Within the concept of implementing these minimum category levels, this category would include organic debris that do not meet the criteria for more definitive classification as S5340-Biological Debris.

9 Within the concept of implementing these minimum category levels, this category would include heterogeneous debris do not meet the criteria for more definitive classification as S5410-Composite Filter Debris.

10 Plans are to add this category in the next revision of the TGG.

11 Within the concept of implementing these minimum category levels, this category would include microencapsulated final waste forms do not meet the criteria for more definitive classification as either Z1110-Cement Forms, Z1120-Vitrified Forms, Z1130-Polymer Forms, Z1140-Amalgamated Forms, or Z1150-Crystalline Forms.

ATTACHMENT D

DEVELOPMENT OF A SITE-SPECIFIC LOW-LEVEL WASTE PROJECTION PROGRAM

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ATTACHMENT D

Development of a Site-Specific Low-Level Waste Projection Program

This example is intended to assist waste management units (or other field elements responsible for management of LLW) in the development of a site-specific LLW Projection Program. The areas discussed are recommendations, but it is expected that certain elements will be included in a manner appropriate for the site-specific technical situation. These elements are discussed in the Executive Summary and are noted here for completeness. Waste management units that already have a LLW Projection Program need not develop a new one, but should review this Guide for elements that should be included in the existing program.

Issuing Authority

A high level of management authority should issue the LLW Projection Program. Perhaps this has more meaning for sites where most LLW generators and the waste management unit report to the same chain of management. However, field elements responsible for complying with the LLW Projection Program that report to management chains other that the waste management unit's will likely comply with the requests of the LLW Projection Program even if it is approved through another management chain. Alternately, concurrence of the appropriate management chain may increase compliance if necessary.

Introduction

The elements, purpose, objectives, and organizational relationships of the LLW Projection Program should be described to educate the user. This should assist in increasing the quality of the projection by providing the user with a sense and purpose for LLW projections. Sections 1.0 and 2.0 of this Guide provide information that may be adapted for this purpose. It may be appropriate to provide points of contact to improve informational relationships between the waste management unit and the users of the LLW Projection Program.

Forecast Cycle

This may be specified by the waste management unit to the extent that it does not exceed the minimum frequency given in the LLW Program Management Plan (expected to be annually.) Site-specific aspects to the forecast cycle should be provided and may include forecast format preparation, data request forms transmittal, training sessions, electronic media, Internet and E-mail submission, solicitation of feed back for improvements, and the availability of assistance during the process.

Background Information

Sections 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 7.0, and Attachment A provide information that may be applicable to LLW projections for which the waste management unit is responsible. The information should be culled to only include those items of value to the target users and may be expanded to include site-specific aspects such as applicable source documents, available computer programs, approved methodologies, and points of contact that can assist in explaining site-specific information.

Development of the Estimate

This section should provide information for completing data forms. Example forms should be provided, but it may be advisable to provide and describe a "basic" form to simplify description of deviations that may be required by a specific data call. The elements of a minimal data call are expected to include:

- generator information;
- projected volume;
- waste form;
- radionuclide data including key isotopic and curie content;
- container types; and
- treatment, storage, and disposal facility capacity.

If an electronic system is used to collect data, it should also be described.

The forecast periods are specified in the Low-Level Waste Program Management Plan and should be reflected in data collection forms (expected to be annual totals for years 1 through 10 and a lump sum for years 11 through 30.) Additional information may be collected if it is useful to the waste management unit.

Data Quality Objectives

The use of DQOs is expected. Section 4.0 describes the application of DQOs and allows the adaptation of the concept to site-specific situations. It is expected that the waste management unit will hold responsible individuals/organizations accountable for the quality of LLW projections. DQO and accountability expectations should be described in this section.

Additional Information

Attachments B, C, and E provide general lists of applicable information. These attachments could be revised with site-specific information and included as attachments or in the Background Information Section.

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ATTACHMENT E

REFERENCES

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ATTACHMENT E

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12. *Complex-Wide Review of DOE's Low-Level Waste Management ES&H Vulnerabilities*, US Department of Energy, Final Report, May, 1996.

13. *DOE Waste Treatability Group Guidance*, US Department of Energy, DOE/LLW-217, January, 1995.