



Department of Energy

Washington, DC 20585

August 30, 1996

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

Dear Mr. Chairman:

Enclosed is the "Low-Level Radioactive Waste Minimization and Evaluation Strategy." This report is a deliverable pursuant to the commitment in Task Initiative VIII.B.3 identified in the Department of Energy's Implementation Plan, Revision 1, for the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2.

This strategy outlines activities that Department of Energy sites can implement to reduce generation of low-level waste. The examples of waste minimization activities that are contained in the strategy document can be effective in reducing waste from routine operations, as well as environmental restoration and decommissioning operations. This strategy is intended to support the Department's overall strategy to reduce generation of low-level waste at its sites as outlined in the 1996 Pollution Prevention Program Plan (Enclosure 2). This Plan contains specific waste reduction goals that have been agreed to by the Offices of Energy Research, Defense Programs, Nuclear Energy, and Environmental Management (Enclosure 3).

The strategy document is also intended to be used by the Office of Environmental Management in achieving its Ten Year Plan to complete cleanup at its nuclear sites within the decade. One of the implementing principles of this plan is reduction of waste generation. Accordingly, the report is being transmitted to the Operations Offices.

Although not requested by the DNFSB, we are developing a similar strategy document for mixed low-level waste, a copy of which will be forwarded to you by the end of calendar year 1996.

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

A handwritten signature in cursive script, appearing to read "Alvin L. Alm".

Alvin L. Alm
Assistant Secretary for
Environmental Management

3 Enclosures



DOE/ORO-2043

U. S. Department of Energy

Low-Level Radioactive Waste Minimization Evaluation and Strategy

August 1996



EXECUTIVE SUMMARY

On September 1, 1994, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 94-2, "Conformance with Safety Standards at DOE Low-Level Nuclear Waste Disposal Sites," which concluded that the U.S. Department of Energy's (DOE's) low-level radioactive waste (LLW) program required improvement. Part of this recommendation calls for "studies of enhanced methods that can be used to reduce the volume of waste to be disposed of..." (Conway 1994). In response to Recommendation 94-2, DOE developed and submitted to DNFSB an Implementation Plan that included plans to "...undertake an evaluation of its current LLW minimization efforts [which will] identify efforts that are successful in reducing the amounts of LLW requiring disposal with the purpose of developing a strategy for extending successful practices to other applications" (DOE 1995). A Revised Implementation Plan, dated April 1996, has been ^{provided} sent to the DNFSB and was accepted in August 1996.

The Low-Level Radioactive Waste Minimization Evaluation and Strategy document is intended to support the overall strategy for reducing low-level waste at Department of Energy (DOE) sites as outlined in the 1996 Pollution Prevention Program Plan, issued on May 3, 1996. It is designed to be a reference tool to help DOE sites implement successful waste reduction approaches to achieve the waste reduction goals. While this document is not a stand-alone strategy document, it provides tactical methods for sites to use to meet the overall low-level waste reduction goal, which is the strategic objective. It is the responsibility of DOE sites to implement pollution prevention and to contribute to achieving the Department-wide goal. Specific guidance on meeting this goal is provided in the 1996 Pollution Prevention Program Plan.

Clearly, there are many steps that sites must take to reach the pollution prevention goals. They include:

1. Critically evaluating all new processes/activities to determine waste generation before the process/activity is approved for start-up. The cost of waste management must be clearly understood before waste generation starts.
2. Evaluating all existing operations for potential waste reduction or replacement by new processes. The use of the Pollution Prevention Opportunity Assessment (PPOA) methodology is recommended to find and evaluate waste reduction concepts.
3. Changing contracting and subcontracting mechanisms to fully address waste management responsibilities and assign waste reduction goals.
4. Conducting total life cycle cost analysis of projects, including environmental restoration and

decommissioning projects.

5. Assessing the cost/benefit of waste reduction activities to clearly demonstrate that pollution prevention pays.

In addition, changes to facilities, processes and materials must take into account the overall safety and health basis for current operations. No changes should be implemented without adequate review and input from environmental, safety and health professionals on-site.

As with any waste minimization/pollution prevention activity, the overall objective is to reduce the overall amount and/or toxicity (and therefore risk) of a current waste generation practice. The Environmental Protection Agency hierarchy of pollution prevention actions favors source reduction over recycle, and favors these actions over treatment (including volume reduction) and disposal. Where activities intended for waste minimization/pollution prevention would increase the volume of waste, the toxicity of waste, or the treatment/disposal costs, such actions should not be taken.

This strategy document is not intended to be a complete and comprehensive study of low-level waste generation, treatment methods, or waste minimization options. A comprehensive study that provides "trade-offs" between treatment, recycling and source reduction activities would require a separate effort as part of the Research and Development (R&D) Task in Section XI of the Revised Implementation Plan. Similarly, the concept of "indexing" waste generation to production activities to measure the impact of specific waste minimization activities versus waste generation changes due to reduced production will be included in future R&D tasks for Recommendation 54-2.

This report presents the results of an evaluation conducted to identify common LLW generating activities and identifies successful LLW minimization recommendations that can be implemented to reduce the generation of LLW and meet the Department's LLW reduction goal. This evaluation revealed that LLW minimization potential differed depending on a site's mission and that DOE sites can be viewed as having one of two mission types: "operating" or "environmental restoration."

Site status was identified according to the DOE program under which the sites operate. From annual reports, the most commonly identified lead organizations were Defense Programs (DP), Energy Research (ER), and Environmental Management (EM). For the purposes of this report, "operating" sites were defined as primarily operating as production or laboratory facilities under DP or ER. "Environmental restoration" sites are defined as performing primarily restoration and

site cleanup activities under EM. Savannah River Site (SRS) transitioned from DP to EM landlord responsibility in 1995. During meetings with site officials it was determined that SRS is currently performing more like a restoration site. Due to this finding, SRS has been included in the environmental restoration analyses for this document.

Waste generation and waste minimization data were collected from seven DOE facilities, including both operating facilities and restoration facilities as follows:

- **Operating:**
 - Idaho National Engineering Laboratory (INEL)
 - Los Alamos National Laboratory (LANL)
 - Oak Ridge National Laboratory (ORNL)
- **Restoration:**
 - Fernald
 - Hanford
 - Rocky Flats
 - Savannah River Site (SRS)

These sites were selected because they represent both EM and DP sites and are located in a broad range of geographic areas.

The information collected in this study indicated that a total of seven major LLW generating activities offered minimization potential for the two types of facilities. The waste generating activities (and each one's major waste minimization recommendations), in order of their overall waste minimization potential, are:

- **Operating sites:**
 - Suspect waste¹—downposting and controlled entry
 - PPE use—segregation and entry restrictions
 - Effluent treatment—procedural changes and carbon regeneration
 - Miscellaneous—segregation for volume reduction
- **Restoration sites:**
 - Remedial activities—reuse and leave in place
 - Decommissioning—recycle/reuse and free release
 - Site investigation—revise techniques and revise decontamination procedures

¹For the purposes of this document, suspect waste is waste that, due to the area in which it originated, is presumed to be radiologically contaminated but has not been proved (or disproved) to be radiologically contaminated.

The primary approaches for LLW minimization for remediation activities may be administrative. These would include personnel training; procedural requirements for waste minimization consideration to take place at specified points in the remedial action decision making, design, and implementation process; transfer of information to make project personnel aware of innovative LLW minimization approaches taken for certain kinds of remedial actions; and inclusion of pollution prevention coordinators or staff throughout the planning process.

Another finding of this evaluation was that, based on Fernald waste generation data, as more sites implement full-scale restoration activities, LLW generation has the potential to increase significantly.

Based on data collected and evaluated, the information derived from the case studies in Table E.1 should be implemented across the DOE complex. These activities when implemented, will support the Department's Pollution Prevention Goals issued on May 3, 1996. Copies of this report will be provided to DOE sites for use in reducing the waste from both routine operations and cleanup/stabilization activities in the future.

Table E.1. Recommended LLW approaches

Generating category	Example waste minimization approach	Site	Reduction	Cost Savings
Suspect waste	Downpost laboratory building	Y-12	441,180 lb/year	\$1,000,000/year
	Control entry of packaging into radiological area	Y-12	20,000 lb/year	\$94,500/year
PPE use	Survey and segregate clean PPE	FUSRAP	Unknown	Unknown
	Restrict entry of personnel into contaminated areas	LANL	Unknown	Unknown
Effluent treatment	Change of process in over filtered area	ORNL	2,600 gal/year (21,892 lb/year)	\$2,600/year
Miscellaneous	Segregate waste for proper management	INEL	2,426 ft ³	\$335,140
Remediation	Reuse excavated soil	LANL	6,400 lb	\$15,481,740
	Leave pond sludge in place	LANL	2,000 yd ³	\$667,500
Decommissioning	Recycle steel from building decommissioning	Fernald	3,458 yd ³ (1,420,000 lb)	Unknown
	Decontaminate and sell equipment	Fernald	240,000 lb	\$72,500
Investigation	Use well micropurging method	Fernald	6,000 gal/year (50,520 lb/year)	\$52,000/year
	Use reusable decontamination tests	INEL	65,000 ft ³	\$2.4 million

FUSRAP = Formerly Utilized Sites Remedial Action Program
 INEL = Idaho National Engineering Laboratory
 LANL = Los Alamos National Laboratory
 LLW = low-level radioactive waste
 ORNL = Oak Ridge National Laboratory
 PPE = personal protective equipment

1. INTRODUCTION

The U.S. Department of Energy (DOE) generates a significant volume of low-level radioactive waste (LLW) from environmental restoration, decommissioning (formerly known as decontamination and decommissioning), and various ongoing research and defense activities. This waste must be disposed of in facilities specifically engineered for LLW. LLW disposal facilities are expensive and capacities are limited. The costs involved in treating, storing, and handling LLW are not insignificant, particularly those costs associated with construction and licensing/permitting of treatment, storage, and disposal facilities.

In response to the requirements of DOE Orders 5400.1 and 5820.2A, Chapter III, and to reduce the personnel and environmental risks and costs associated with the management of LLW and other wastes, DOE facilities have established waste minimization/pollution prevention (P2) programs. The goal of these programs is to reduce the generation of waste at the source, reuse or recycle waste that is generated, minimize costs and risks of treatment of wastes that cannot be prevented or recycled, and identify innovative disposal options that minimize the impact to the environment while minimizing cost.

Although these P2 programs address LLW, on September 8, 1994, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 94-2, "Conformance with Safety Standards at DOE Low-Level Nuclear Waste Disposal Sites," which concluded that DOE's LLW P2 program required improvement. Part of this recommendation calls for "studies of enhanced methods that can be used to reduce the volume of waste to be disposed of..." (Conway 1994). In response to Recommendation 94-2, DOE developed and submitted to DNFSB an Implementation Plan that included plans to "...undertake an evaluation of its current LLW minimization efforts [which will] identify efforts that are successful in reducing the amounts of LLW requiring disposal with the purpose of developing a strategy for extending successful practices to other applications" (DOE 1995). This report is a result of that evaluation. To further respond to Recommendation 94-2, a mixed low-level radioactive waste (MLLW) strategy document is currently being prepared to supplement the findings of this report. The MLLW report is expected to be completed by the end of calendar year 1996.

In addition, on May 3, 1996, DOE issued a policy statement establishing DOE's P2 goals. This policy statement established a goal of reducing LLW from routine operations by 50% by the end of December 1999, based on the 1993 baseline amount for the Department.

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1.1 OBJECTIVE AND SCOPE

This report presents the results of an evaluation conducted as part of DOE's fulfillment of the commitments made in the Implementation Plan related to LLW reduction. For the purpose of this report, LLW is defined as waste typically contaminated with small amounts of radioactivity dispersed in large amounts of material. LLW is generated in most processes involving radioactive materials in the DOE complex, including decommissioning projects. The goal of this report is to identify common LLW generating activities and develop LLW waste minimization options that have waste minimization applicability for all of the DOE sites. The findings of this evaluation can be used to assist DOE sites in reaching DOE's 50% reduction goal for routine LLW.

Based on the Implementation Plan (April 1996), the strategy of this document is to identify successful waste minimization activities, by the use of case studies, for LLW. Therefore, activities such as those listed below, that would move in a more specific direction, were not included:

- life cycle analyses,
- material balances,
- specific isotope analyses, or
- Curie balances.

However, each site should consider these issues when considering implementation of waste minimization options. Specifically, waste minimization options that generate a higher cost or are more hazardous or more difficult to manage (e.g., MLLW or a higher LLW classification) should not be implemented.

This document is not intended to be a complete and comprehensive study of LLW generation, treatment methods, or waste minimization options. It is not the intent of this document to explore "trade-offs" of activities to show their benefits, such as cost/benefit of source reduction techniques vs simple volume reduction techniques and disposal. A comprehensive study that provides the trade-offs between treatment, recycling, and source reduction activities would require a separate effort as part of the Research and Development Task in Section XI of the Revised Implementation Plan. Similarly, the concept of indexing waste generation rates to production activities to measure the impact of specific waste minimization activities vs waste generation changes due to reduced production will be included in future research and development tasks for DNFSB Recommendation 94-2.

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This document also does not include a review of potential health and safety impacts of waste minimization options. However, it is recommended that any waste minimization options that involve process changes should first be reviewed by the Environmental Safety and Health organization at the appropriate site. Any process changes should have a Safety Analysis Review (SAR) and a Safety Authorization Basis performed for the facility before any changes in operational procedures or processes are implemented.

1.2 SUMMARY

This evaluation revealed that LLW minimization potential differed depending on a site's mission and that DOE sites can be viewed as having one of two mission types: "operating" or "environmental restoration." For the purposes of this report, "operating" sites were defined as primarily operating under Defense Programs (DP) or Energy Research (ER), and environmental restoration sites operate primarily under Environmental Management (EM). Savannah River Site (SRS) is an exception. SRS is operating under DP, but during meetings with site officials it was determined that SRS is currently operating like an EM site. Due to this finding, SRS has been included in the environmental restoration analyses for this document.

Waste generation and waste minimization data collected from seven DOE facilities, including both operating facilities and restoration facilities as follows:

- Operating sites:
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 - Fernald
 - Hanford
 - Rocky Flats
 - SRS

Next, waste generation rates and successful waste minimization approaches were identified by the project team by reviewing annual reports for 1991, 1992, 1993, and 1994. Phone calls were made to the sites to help identify processes that generate LLW waste. These generating processes were then evaluated and categorized. Waste generation data from annual reports were reported for routine waste and for cleanup/stabilization waste. While both types of waste are generated by almost all DOE facilities, routine wastes are predominate at operating sites, while cleanup/stabilization wastes are predominate at restoration sites.

A workshop was held on March 5, 1996, and a task team evaluated the LLW generating activities, the LLW minimization approaches that have been implemented, and other LLW minimization activities that are currently under development. The waste minimization activities were reviewed and evaluated according to the following criteria:

- economic feasibility,
- quantity of reduction,
- quantity of generation,
- technical risk,
- U.S. Environmental Protection Agency (EPA) hierarchy,
- compliance, and
- application potential.

LLW minimization activities were recommended to be implemented throughout the DOE complex. Finally, case studies that described how some of the approaches have been implemented were developed to support the recommendations.

Figure 1.1 shows how this project was implemented. The project began with the identification of specific approaches, and then the specific approaches were used to identify general approaches in order to assist in making recommendations more applicable to multiple DOE facilities.

1.3 REPORT CONTENT

This report summarizes the findings of this evaluation. Section 2 presents and evaluates the LLW generation data for the seven sites and relates reported waste categories to processes generating the waste, and Section 3 contains process descriptions and evaluates waste minimization data for each generating process. Section 4 presents the proceedings and findings of a LLW task team workshop that was held to evaluate the LLW minimization approaches. Section 5 presents case studies for each of the recommendations developed by the task team. Section 6 presents a summary of Sections 2 through 5. Appendixes A through G contain data that supplement Sections 2 through 5.