



Department of Energy

Washington, DC 20585

December 26, 1996

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

Dear Mr. Chairman:

Enclosed is the "Mixed Low-Level Radioactive Waste Minimization Evaluation and Strategy." This report is a companion document to the "Low-Level Waste Minimization Evaluation and Strategy" that was submitted to you on August 30, 1996.

The Mixed Low-Level Waste Strategy contains 14 case study examples that Department of Energy (DOE) sites have implemented to reduce waste generation. These examples of waste minimization activities can be effective in reducing waste from routine operations, as well as from environmental restoration and decommissioning operations.

Mixed waste is expensive to manage and dispose, and the commercial nuclear industry has made great strides in reducing mixed waste generation. I am encouraging all DOE sites that generate mixed low-level waste to use these proven techniques, wherever appropriate. I have also today issued guidance to all DOE sites to incorporate pollution prevention principles into their contract award and fee evaluation processes.

In addition to supporting our Department-wide waste reduction goals, the Mixed Low-Level Waste Strategy supports the Office of Environmental Management in achieving its Ten Year Plan. One of my seven implementing principles for the Ten Year Plan concerns minimizing our generation of wastes. Accordingly, copies of the strategy have been transmitted to the Operations Offices for incorporation into their site plans.

Alvin L. Alm
Assistant Secretary for
Environmental Management

1 Enclosure

cc: Mark Whitaker, S-3.1



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U. S. Department of Energy

Mixed Low-Level Radioactive Waste Minimization Evaluation and Strategy

November 1996



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ACRONYMS AND INITIALISMS

| | |
|--------|---|
| CCMC | Chemical Commodity Management Center |
| DETF | Dilute Effluent Treatment Facility |
| DNFSB | Defense Nuclear Facilities Safety Board |
| DOE | U.S. Department of Energy |
| DP | Defense Programs |
| EM | Environmental Management |
| EPA | U.S. Environmental Protection Agency |
| ER | Energy Research |
| FFCAct | Federal Facility Compliance Act of 1992 |
| HEPA | high-efficiency particulate air |
| INEL | Idaho National Engineering Laboratory |
| K-25 | Oak Ridge K-25 Site |
| LANL | Los Alamos National Laboratory |
| LDR | Land Disposal Restriction |
| LLW | low-level radioactive waste |
| MLLW | mixed low-level radioactive waste |
| MWIR | Mixed Waste Inventory Report |
| ORNL | Oak Ridge National Laboratory |
| P2 | pollution prevention |
| PCB | polychlorinated biphenyl |
| PPE | personal protective equipment |
| PPOA | Pollution Prevention Opportunity Assessment |
| R&D | Research and Development |
| RCRA | Resource Conservation and Recovery Act |
| RMMA | Radioactive Material Management Area |
| SRS | Savannah River Site |
| STP | Site Treatment Plan |
| TSCA | Toxic Substances Control Act |
| Y-12 | Oak Ridge Y-12 Plant |

EXECUTIVE SUMMARY

On September 8, 1994, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 94-2, "Conformance with Safety Standards at the DOE Low-Level Nuclear Waste Disposal Sites," which concluded that 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 1995h). A Revised Implementation Plan, dated April 1996, has been provided to the DNFSB and was accepted in August 1996.

The *Low-Level Radioactive Waste Minimization Evaluation and Strategy* (DOE/ORO-2043) report supports the overall strategy for reducing low-level radioactive waste at U.S. Department of Energy (DOE) sites as outlined in the 1996 Pollution Prevention Program Plan, issued on May 3, 1996. This report supplements the DOE/ORO-2043 report findings by presenting additional recommendations for mixed low-level radioactive waste (MLLW). Many of the recommendations made in the DOE/ORO-2043 report (especially those for personal protective equipment use, investigation activities, remediation, and decommissioning) are also applicable to MLLW. While this document is not a stand-alone strategy document, it provides tactical methods for sites to use to meet the overall MLLW 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 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 amount and/or toxicity (and, therefore, risk) of a current waste generation practice. The U.S. 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 MLLW 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 94-2.

This report presents the results of an evaluation conducted to identify common MLLW generating activities and identifies successful MLLW minimization recommendations that can be implemented to reduce the generation of MLLW and meet the Department's MLLW reduction goal. The DOE/ORO-2043 report 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." The same view of site missions was applied to this report for MLLW minimization potential.

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 report.

The DOE/ORO-2043 report identified the following LLW generating activities (and the major waste minimization recommendation for each activity), in order of their overall waste minimization potential for each type of site:

- Operating sites:
 - Suspect waste¹—down posting² and controlled entry
 - Personal protective equipment 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 documentation procedures

Most of these recommendations also apply to MLLW, depending on whether the contamination at the site is strictly LLW or if it is MLLW.

Additional MLLW generation and waste minimization data were collected from 11 DOE facilities, including both operating facilities and restoration facilities as follows:

¹For the purposes of this report, 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.

²For the purposes of this report, any consolidation of radiological activities to reduce the size of radiological buffer areas.

- **Operating sites:**
 - Idaho National Engineering Laboratory
 - Los Alamos National Laboratory
 - Oak Ridge National Laboratory
 - Oak Ridge Y-12 Plant

- **Restoration sites:**
 - Fernald
 - Hanford
 - Oak Ridge K-25 Site
 - Paducah Site (formerly Paducah Gaseous Diffusion Plant)
 - Portsmouth Gaseous Diffusion Plant
 - Rocky Flats
 - Savannah River Site

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

Three recommendations were identified for MLLW and should be applied at the site level. These activities will affect the greatest number of MLLW streams generated by each site. The site level recommendations are:

- administrative approaches,
- chemical traffic controls, and
- down posting.

Note that although down posting was identified in the DOE/ORO-2043 report, it is further discussed for MLLW due to its effectiveness and to show how it fits in a site level approach.

In addition to the site level options, the following options may be more applicable to specific sites and specific activities. The following waste generating activities were identified for MLLW reduction:

- **Laboratory activities**
 - modify equipment
 - reuse waste

- **Equipment maintenance**
 - modify equipment
 - recycle waste

- Facility maintenance
 - modify procedures
 - reuse waste

- Waste management
 - modify sampling procedures
 - divert storm water
 - reuse material
 - segregate waste
 - modify equipment
 - modify treatment procedures

These four activities were found to be common to most DOE sites regardless of whether they are operating or restoration sites.

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 along with the seven identified for LLW in DOE/ORO-2043, will support the Department's Pollution Prevention Goals issued on May 3, 1996. Copies of this report will be provided to DOE sites for their use in reducing the waste from both routine operations and cleanup/stabilization activities in the future.

Table E.1. Case study examples of MLLW minimization options

| Generating category | Case study | Reduction | Potential cost savings | Implementation cost |
|---------------------------|--|---------------------------|------------------------|---------------------|
| Site level | | | | |
| Administrative Approaches | No case study | | | |
| Chemical traffic controls | Established and staffed a Chemical Commodity Management Center to track and control chemical purchases and usage | 16,500 lb/year | \$250,000/year | NA |
| Down posting ^a | Down posting laboratory building | 441,180 lb/year | \$1,000,000/year | \$79,535 |
| Activity-specific | | | | |
| Laboratory activities | Modified laboratory equipment to reduce MLLW waste generation | 0.6 m ³ /year | \$46,000/year | \$172 |
| | Reused acid for cleaning glassware in laboratories | 4.13 m ³ /year | \$82,000/year | NA |
| Equipment maintenance | Modified existing equipment to use fabric filter belts and eliminated the use of paper belts | 1,350 ft ³ | \$360,000/year | \$50,000 |
| | Recycled ethylene glycol for reuse in equipment | NA | NA | NA |
| Facility maintenance | Modified the number of times building exhaust filters were changed | 500 ft ³ | \$180,000 | \$150,000 |
| | Allowed paint thinner to settle and be reused | 1,000 gal | \$40,000 | NA |

Table E.1 (Continued)

| Generating category | Case study | Reduction | Potential cost savings | Implementation cost |
|---------------------|--|---------------------------|------------------------|---------------------|
| Waste management | Revised Part A permit to allow for longer storage of waste, thereby reducing the number of samples taken | 7.5 m ³ | \$200,000 | \$40,000 |
| | Segregated material from existing waste and reduced the amount of MLLW disposed of | 119.5 m ³ | \$355,000/year | <\$100 |
| | Reused lead shielding during another project | 50 ft ³ | NA | NA |
| | Installed canopies over dikes and reduced the volume of MLLW | 287,000 gal | \$1,704,000 | NA |
| | Upgraded facility to provide on-demand pressurized water and reduced the MLLW generated | 1.6 m ³ | \$4,400 | \$2,500 |
| | Used in-stock chemicals to neutralize waste | 201 ft ³ /year | NA | \$1,000-10,000 |

NA = data not available

*The case study specifics are not included in this document but may be obtained from DOE/ORO-2043.

1. INTRODUCTION

Mixed waste contains both radioactive and hazardous components as defined by the Atomic Energy Act and Resource Conservation and Recovery Act (RCRA), respectively, as well as any radioactive mixture that is contaminated with polychlorinated biphenyls (PCBs). This report addresses only mixed wastes that contain low-level radioactive and RCRA hazardous components and does not address those wastes that contain transuranic, high-level components or PCBs.

The U.S. Department of Energy (DOE) generates large volumes of mixed low-level radioactive waste (MLLW) from environmental restoration, decommissioning, and various ongoing research and defense programs. In addition, DOE has in storage significant volumes of MLLW from past operations. According to the Federal Facility Compliance Act of 1992 (FFCA), DOE must treat and dispose of MLLW in compliance with Land Disposal Restrictions (LDRs) and other RCRA requirements. MLLW treatment and disposal are expensive and capacities are limited. In fact, significant development of treatment facilities would be necessary to treat the MLLW already in storage. In addition, the costs to treat, store, and handle the low-level radioactive waste (LLW) portion of MLLW are significant, particularly the costs associated with construction, licensing, and permitting of treatment/storage/disposal facilities.

To reduce the personnel and environmental risks and costs associated with the management of MLLW and other wastes, DOE facilities have established waste minimization/pollution prevention (P2) programs. The objectives of these programs follow the U.S. Environmental Protection Agency (EPA) hierarchy, which is to reduce the generation of waste at the source, to reuse or recycle waste that is generated, to maximize the benefits of treatment of wastes that cannot be prevented or recycled, and to identify innovative disposal options that minimize the impact on the environment while minimizing cost.

Although these P2 programs address MLLW, 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." This recommendation concluded that DOE's 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 1995h). While MLLW was not specifically addressed in Recommendation 94-2, DOE has decided to address MLLW as part of its minimization evaluation and strategy for LLW.

In addition, on May 3, 1996, DOE issued a policy statement establishing DOE's P2 goals. This policy statement established a goal for routine waste to reduce total releases and off-site transfers for treatment and disposal of toxic chemicals, including MLLW, based on a 1993 baseline by 50% by 1999.

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. The *Low-Level Radioactive Waste Minimization Evaluation and Strategy* report (DOE/ORO-2043) addresses the minimization of LLW. The objective of this MLLW report is to supplement the LLW minimization recommendations by identifying common MLLW generating activities and developing MLLW minimization recommendations that can be implemented throughout the DOE complex. The findings of this evaluation should also be used to assist DOE sites in reaching DOE's 50% reduction goal for routine MLLW.

For this evaluation, data were collected on MLLW generation processes and minimization approaches that have been implemented at various DOE facilities. Then, MLLW generating activities associated with the minimization approaches were identified, general MLLW minimization options were identified and evaluated, and recommendations for MLLW minimization activities to be implemented throughout the DOE complex were developed. Finally, case studies of approaches that have been implemented were developed to support the recommendations. Appendix A presents detailed MLLW minimization approach data.

The initial data on MLLW generation and minimization approaches were collected for 11 sites:

- Operating sites:
 - Idaho National Engineering Laboratory (INEL)
 - Los Alamos National Laboratory (LANL)
 - Oak Ridge National Laboratory (ORNL)
 - Oak Ridge Y-12 Plant (Y-12)

- Restoration sites:
 - Fernald
 - Hanford
 - Oak Ridge K-25 Site (K-25)
 - Paducah Site (formerly Paducah Gaseous Diffusion Plant)
 - Portsmouth Gaseous Diffusion Plant (Portsmouth)
 - Rocky Flats
 - Savannah River Site (SRS)

The data were primarily collected through a review of annual reports on waste generation and waste minimization, retrieval of information from the Internet FFCAct Bulletin Board, phone interviews with site personnel, and a review of documentation and information provided by site contacts. Waste generation data from annual reports were documented for routine waste and for cleanup/stabilization waste. While both types of waste are generated by almost all DOE facilities, it was established during the LLW minimization evaluation that routine wastes are priority for operating sites, while cleanup/stabilization wastes are priority for restoration sites. However, this report shows that the MLLW generating processes cannot be distinctly identified as routine or cleanup/stabilization related to either operating or restoration sites.

1.2 REPORT CONTENT

The findings of the MLLW evaluation are provided in the following sections of this report. Section 2 presents and evaluates the MLLW generation data for the 11 sites, and Section 3 discusses the MLLW minimization options. Section 4 presents the findings and recommendations of the evaluation of MLLW minimization options. Section 5 presents case studies for each of the recommendations developed by the task team. Section 6 presents a summary of the report. Appendices A through D contain data that supplement Sections 2 through 5.

2. MLLW GENERATION

MLLW generation data from the 11 sites for 1991, 1992, 1993, and 1994 were obtained from annual reports on waste generation and waste minimization. This section describes the reporting categories for MLLW and relates those reporting categories to processes generating MLLW. To the extent possible, generation rates related to each waste category are presented. However, this information is limited because it is not readily available from literature or from site tracking programs.

2.1 METHODOLOGY

The objective of this evaluation was to analyze available data for MLLW generation and identify MLLW generating processes at DOE facilities. The 11 sites previously identified were chosen so that collected data would represent the spectrum of DOE activities, missions, and field offices. They were also chosen because they were among the highest generators of MLLW.

Generation data were primarily collected from the *Annual Report on Waste Generation and Waste Minimization Progress, 1991-1992*, which provides a summary of waste generation for all DOE facilities, and the 1993 and 1994 annual reports on waste generation and waste minimization progress for each of the 11 sites.

For comparative purposes, the 11 DOE sites were subdivided into two groups. The first group currently consists of INEL, LANL, ORNL, and Y-12. These sites are referred to as operating sites. These sites have active, multi-program missions such as basic and applied research laboratories, as well as scientific and engineering capabilities in support of national energy and defense programs. The operating sites also have active restoration and decommissioning programs, but these are not the primary missions at these sites. The second group currently consists of Fernald, Hanford, K-25, Paducah, Portsmouth, Rocky Flats, and SRS. These sites are referred to as the restoration sites. A major part of the mission at these sites is remediation, deactivation, and decommissioning. Although SRS was identified as an operating site in the 1994 annual report, it was established at a previous workshop that SRS had transitioned to primarily a restoration mission. Also, the groupings varied from year to year depending on their site status at the time of reporting. Comparisons were made by site from year to year, among sites within a certain group, and between the two groups.

2.2 MLLW GENERATION DATA

Each site reports its MLLW in six different categories: liquid, solid, inventory, routine, cleanup/stabilization, and process wastewater. These categories are independent of the waste generating process and specific management method for the waste. The latter four terms as used in the annual reports are defined below.

- *Inventory waste* is defined as the total amount of waste in inventory at a site packaged for treatment, storage, and disposal, including wastes generated in all previous years.
- *Routine waste* is defined as waste produced from any type of production, analytical, and/or research and development laboratory operations; treatment, storage, and disposal operations; "work for others"; or any other periodic and recurring work considered ongoing in nature.
- *Cleanup/stabilization waste*¹ is defined as one-time operations waste, such as wastes produced from restoration activities, including primary and secondary wastes associated with retrieval and remediation operations; "legacy wastes"; and decommissioning/transition operations.
- *Process wastewater* is any water produced during manufacturing or processing operations that comes into direct contact with or results from the production or use of any new material, intermediate product, finished product, by-product, or waste product. This determination is independent of the level and/or nature of the contaminants.

For the purposes of this report, the quantity of the liquid plus the solid waste is equal to the quantity of routine plus cleanup/stabilization waste. The liquid plus the solid plus the process wastewater quantities equals the total MLLW generated for a given year. The inventory amount is independent of the total quantity listed.

Generation data for 1991 and 1992 were reported only as liquid and solid MLLW volumes. Annual reports for 1993 and 1994 contain more descriptive information with regard to the different categories of MLLW, such as MLLW inventories, routine MLLW, cleanup/stabilization MLLW, and process wastewater. Tables 2.1 through 2.4 summarize this information by year (1991, 1992, 1993, and 1994) for each facility. These tables identify sites as operating or restoration based on information in the annual reports, which identified them as having a mission of Defense Programs (DPs) (operating site) or Environmental Management (EM) (restoration site). The data in Tables 2.1 through 2.4 are presented graphically in Appendix B.

¹This waste includes waste generation from remediation activities.

Table 2.1. MLLW generated or in inventory at 11 DOE sites—CY 1991^a

| DOE facility | 1991 MLLW volumes (m ³) | | | | | |
|--------------------------|-------------------------------------|--------------|-----------|-----------|-----------------------|--------------------|
| | Liquid | Solid | Inventory | Routine | Cleanup/stabilization | Process wastewater |
| Operating sites | | | | | | |
| INEL | 0 | 52 | NR | NR | NR | NR |
| LANL | 0 | 170 | NR | NR | NR | NR |
| ORNL | 9 | 10 | NR | NR | NR | 2,049 |
| Paducah | 0 | 137 | NR | NR | NR | NR |
| Portsmouth | 221 | 645 | NR | NR | NR | NR |
| Rocky Flats | 0 | 554 | NR | NR | NR | NR |
| SRS | 0 | 33 | NR | NR | NR | NR |
| Y-12 | 2,757 | 734 | NR | NR | NR | NR |
| Restoration sites | | | | | | |
| Fernald | 0 | 81 | NR | NR | NR | NR |
| Hanford | 1,178 | 581 | NR | NR | NR | NR |
| K-25 | 56,931 | 209 | NR | NR | NR | NR |
| Total | 63,132 | 2,987 | NR | NR | NR | NR |

^aData shown in this table represents waste generated by Defense Programs, Environmental Management, Energy Research, and Nuclear Energy

Table 2.2. MLLW generated or in inventory at 11 DOE sites—CY 1992^a

| DOE facility | 1992 MLLW volumes (m ³) | | | | | |
|--------------------------|-------------------------------------|--------------|-----------|-----------|-----------------------|--------------------|
| | Liquid | Solid | Inventory | Routine | Cleanup/stabilization | Process wastewater |
| Operating sites | | | | | | |
| INEL | 0 | 93 | NR | NR | NR | NR |
| LANL | 0 | 81 | NR | NR | NR | NR |
| ORNL | 3 | 9 | NR | NR | NR | 1,524 |
| Paducah | 0 | 824 | NR | NR | NR | NR |
| Portsmouth | 386 | 353 | NR | NR | NR | NR |
| SRS | 0 | 20 | NR | NR | NR | NR |
| Y-12 | 1,724 | 481 | NR | NR | NR | NR |
| Restoration sites | | | | | | |
| Fernald | 0 | 141 | NR | NR | NR | NR |
| Hanford | 2,415 | 440 | NR | NR | NR | NR |
| K-25 | 77,697 | 265 | NR | NR | NR | NR |
| Rocky Flats | 0 | 440 | NR | NR | NR | NR |
| Total | 83,744 | 2,873 | NR | NR | NR | NR |

DOE = U.S. Department of Energy
 INEL = Idaho National Engineering Laboratory
 LANL = Los Alamos National Laboratory
 MLLW = mixed low-level radioactive waste

NR = not reported
 ORNL = Oak Ridge National Laboratory
 SRS = Savannah River Site

^aData shown in this table represents waste generated by Defense Programs, Environmental Management, Energy Research, and Nuclear Energy

Table 2.3. MLLW generated or in inventory at 11 DOE sites—CY 1993^a

| DOE facility | 1993 MLLW volumes (m ³) | | | | | |
|--------------------------|-------------------------------------|--------------|---------------|--------------|-----------------------|--------------------|
| | Liquid | Solid | Inventory | Routine | Cleanup/stabilization | Process wastewater |
| Operating sites | | | | | | |
| INEL | 0 | 8 | 1,140 | 7 | 2 | 0 |
| LANL | 0 | 45 | 1,160 | 45 | 0 | 0 |
| ORNL | 4 | 8 | 69 | 20 | 1 | 1,524 |
| Portsmouth | 374 | 1,146 | 10,000 | 626 | 894 | 11,112 |
| SRS | 115 | 18 | 3,110 | NR | 133 | 0 |
| Y-12 | 219 | 290 | 11,900 | 410 | 98 | 11,140 |
| Restoration sites | | | | | | |
| Fernald | 16 | 11 | 3,110 | 25 | 3 | 126,000 |
| Hanford | 3,760 | 1,500 | 3,100 | 4,223 | 1,040 | 2,100 |
| Paducah | 122 | 89 | 1,170 | 176 | 35 | 0 |
| K-25 | 803 | 278 | 27,400 | 763 | 318 | 85,600 |
| Rocky Flats | 0 | 489 | 3,090 | 489 | 0 | 0 |
| Total | 5,430 | 3,874 | 65,249 | 6,784 | 2,524 | 497,952 |

^aData shown in this table represents waste generated by Defense Programs, Environmental Management, Energy Research, and Nuclear Energy.

Table 2.4. MLLW generated or in inventory at 11 DOE sites—CY 1994^a

| DOE facility | 1994 MLLW volumes (m ³) | | | | | |
|--------------------------|-------------------------------------|--------------|----------------|--------------|-----------------------|--------------------|
| | Liquid | Solid | Inventory | Routine | Cleanup/stabilization | Process wastewater |
| Operating sites | | | | | | |
| INEL | 1 | 344 | 78,400 | 23 | 322 | 0 |
| LANL | 0 | 76 | 665 | 26 | 49 | 0 |
| ORNL | 13 | 5 | 36 | 123 | 2 | 2,113 |
| SRS | 738 | 3 | 3,410 | 741 | 0 | 0 |
| Y-12 | 156 | 105 | 17,100 | 241 | 20 | 10,900 |
| Restoration sites | | | | | | |
| Fernald | 47 | 35 | 2,520 | 2 | 80 | 0 |
| Hanford | 2,500 | 2,310 | 3,870 | 570 | 1,73740 | 0 |
| K-25 | 6,980 | 222 | 35,700 | 504 | 6,694 | 85,100 |
| Paducah | 0 | 82 | 3,760 | 0 | 83 | 0 |
| Portsmouth | 1,460 | 327 | 4,710 | 0 | 1,787 | 0 |
| Rocky Flats | 21 | 267 | 3,580 | 275 | 13 | NR |
| Total | 11,906 | 3,778 | 153,751 | 4,890 | 10,788 | 98,180 |

DOE = U.S. Department of Energy

INEL = Idaho National Engineering Laboratory

LANL = Los Alamos National Laboratory

MLLW = mixed low-level radioactive waste

NR = not reported

ORNL = Oak Ridge National Laboratory

SRS = Savannah River Site

^aData shown in this table represents waste generated by Defense Programs, Environmental Management, Energy Research, and Nuclear Energy.

Because it is optional to report process wastewater generation, "0" entries for process wastewater may represent either actual zero generation or simply a lack of reporting. However, because the reporting of all other MLLW is required, the zeros in this category should actually represent zero. As shown in Tables 2.1 through 2.4, all 11 DOE sites reported some type of MLLW from 1991 to 1994.

The MLLW generation rate is based on the volume of waste received into treatment, storage, and disposal facilities within the given calendar year. This generation rate does not take into account those wastes being held at satellite storage facilities. Therefore, the annual generation rate is not necessarily correlated to process generation rates since MLLW is transferred to the storage and disposal facilities in batches.

2.3 MLLW GENERATING PROCESSES RELATED TO WASTE REPORTING CATEGORIES

The annual reports do not provide data that directly relate waste generating rates to individual processes. However, descriptions of waste minimization activities presented in the reports indicated the general types of processes that generated MLLW and presented significant minimization potential. A description of each of these generating processes is necessarily intertwined with a discussion of the steps taken to minimize MLLW generated by these processes. Hence, process descriptions are provided in Section 3 as waste minimization approaches are discussed. As demonstrated in Section 3, the identified MLLW minimization approaches can be related back to four major waste generating activities: laboratory activities, equipment maintenance, facility maintenance, and waste management. These activities are primarily associated with routine waste reporting.

2.4 FEDERAL FACILITY COMPLIANCE ACT-RELATED WASTE GENERATION

The FFCAct ended DOE's sovereign immunity from fines and penalties under the provisions of RCRA. At the time the FFCAct was passed and signed, MLLW in storage at DOE sites was generally not in compliance with RCRA mixed waste LDRs because of a lack of treatment capacity in the government and private sectors. Recognizing this lack of treatment capacity, the FFCAct delayed by 3 years (until October 6, 1995) the imposing of any fines or penalties related to the storage of mixed waste. During the 3-year hiatus, DOE was required to prepare and obtain regulatory approval for Site Treatment Plans (STPs) for choosing treatment technologies, developing the needed treatment capacity, and treating the mixed waste at any site where DOE generated or stored mixed wastes. DOE has 35 STPs and associated compliance orders covering 38 sites. Three of the sites involved in this study—K-25, ORNL, and Y-12—were combined into one STP for the Oak Ridge Reservation. One of the study sites, Hanford, was not required to

prepare a STP because it was subject to a Tri-Party Agreement with the State of Washington that already addressed mixed waste treatment. Each of the other sites in this study submitted its own STP.

In addition to approval by state or EPA regulators, the process of developing and submitting STPs was open to public participation. Members of the public were notified of draft STP availability and were given opportunities to comment to DOE and/or the regulators. A bulletin board of information about the FFCAct and DOE's compliance with it is available on the Internet through the EM homepage. In addition to reports and notices, the Mixed Waste Inventory Report (MWIR) and its 1995 database are available through the Internet. MWIR contains information about the physical, chemical, and radiological composition of each mixed waste stream at each DOE site. Administrative and possible treatment information are also available in MWIR. With few exceptions, each of these stored waste streams must be treated according to the approved site Implementation Plan.

Total volumes of MLLW in storage at each site (as of 1994) identified in the 1995 MWIR database are given in Table 2.5. The total volume of all waste streams is 109,762 m³. If the total is reduced by the volume of treated (stabilized) sludge in storage at K-25 (15,400 m³), the remaining total volume to be treated is 94,361 m³. DOE (1995) estimates that the total volume of MLLW in storage and projected to be generated in the next 5 years is 128,664 m³ at all DOE sites combined. Hence, the volume of waste in storage at the study sites represents a substantial portion of the total volume of MLLW requiring treatment.

Table 2.5. Mixed waste volumes in storage based on FY 1995 data

| Site | Waste volume in storage (m ³) |
|-------------|---|
| Fernald | 2,151 |
| Hanford | 6,330 |
| INEL | 25,440 |
| K-25 | 29,473* |
| LANL | 609 |
| ORNL | 2,997 |
| Paducah | 1,032 |
| Portsmouth | 7,515 |
| Rocky Flats | 13,550 |
| SRS | 7,200 |
| Y-12 | 13,465 |

*Includes 15,400 m³ of treated pond sludge that is ready for disposal.

3. MLLW MINIMIZATION OPTIONS

This section describes the methods and resources used to collect MLLW minimization approach data and annual waste reduction data, the approaches implemented that contributed to those reductions, and the relationship of the approaches to the processes generating the waste. As presented in Section 2, the priority waste for operating sites is routine waste, while the priority waste for restoration sites is cleanup/stabilization waste. For cleanup/stabilization activities, many of the same processes [personal protective equipment (PPE) use, investigation, restoration, and decommissioning] that generate LLW will also generate MLLW, depending on what the materials are contaminated with at the site/facility. Therefore, some of the same recommendations made for restoration facilities for LLW may also be applicable for MLLW. Additional information supporting the MLLW minimization recommendations can be found in Section 5 (Case Studies) and Appendix A. Section 5 and Appendix A data support the recommendations and provide additional information on the implementability of the recommended options. However, whether a site is operating or in restoration mode, the MLLW generating activities (laboratory activities, equipment maintenance, facility maintenance, and waste management) that are identified here will apply to all DOE facilities to some degree.

The DOE/ORO-2043 report identified the following activity-specific LLW minimization recommendations for operating sites and restoration sites:

- Operating sites:
 - Suspect waste—down posting and controlled entry
 - PPE use—segregation and entry restrictions
 - Effluent treatment—procedural changes and carbon regeneration
 - Miscellaneous—segregation for volume reduction

- Restoration sites:
 - Remediation activities—reuse and leave in place
 - Decommissioning—recycle/reuse and free release
 - Site investigation—revise techniques and revise decontamination procedures

These options for LLW may also be applicable for MLLW if the contaminant of concern is hazardous (i.e., making it MLLW) rather than LLW. For example, if a piece of PPE comes in contact with a medium that is contaminated with a radioactive constituent only, the PPE would

be considered LLW. If that same piece of PPE comes in contact with a medium that is contaminated with a radioactive constituent and a hazardous constituent, the PPE would then be considered MLLW. However, the same options identified for LLW PPE can also be applied to MLLW PPE.

In addition to the above recommendations identified in the DOE/ORO-2043 report, the options described in Section 3.2 of this report can also be implemented at either operating or restoration sites to help reduce MLLW generation.

3.1 METHODOLOGY

The initial objective of the evaluation was (1) to identify the MLLW minimization approaches that have been implemented at DOE facilities and the processes or activities affected by the approach and (2) to evaluate the success and general applicability of the approach. General descriptions of the approaches were initially collected from the annual reports for each of the 11 sites chosen for the study. These reports provided brief descriptions of the waste minimization approaches implemented. The descriptions include the approach taken, the activity or process affected, the waste stream affected, and the quantity of waste reduction realized. In addition, the 1994 reports provided some data on the time, investment, and cost savings associated with implementing the approach. Information for other DOE sites was included when it was appropriate and readily available. This information is presented in detail in Appendix A.

The MLLW generating processes were defined by identifying those processes affected by the reported MLLW minimization approaches. Although the list of MLLW generating processes in this report may not be comprehensive, it is considered to represent the processes with the most potential for minimization based on the success of the waste minimization activities implemented thus far.

3.2 MLLW APPROACHES FOR GENERATING PROCESSES

This section discusses MLLW generating processes and corresponding MLLW minimization options. Additional information can be found in Section 5 and obtained from site contacts listed in Appendix C. For the purpose of this report, waste minimization approaches and waste minimization options are defined as follows:

- waste minimization approach: a specific waste minimization activity that took place at a specific site (e.g., replace tape with Velcro strap at Hanford laboratory) and

- waste minimization option: a general method for achieving waste minimization, which may represent multiple site reported approaches (e.g., equipment modification).

3.2.1 Site-Level Options for Minimizing MLLW

Three options identified for MLLW should be applied at the site level and will affect the greatest number of MLLW streams generated by each site. These are:

- administrative approaches,
- chemical traffic controls, and
- down posting.

While these options are considered priority, the options listed in Section 3.2.2 should also be reviewed and considered for DOE sites to which they have applicability.

3.2.1.1 Administrative activities

To minimize future generation of incidental or secondary mixed waste from mixed waste treatment activities, restoration projects, or other planned activities, planning strategies can be effective in significantly reducing future generation of MLLW. These strategies were identified and developed from reports of successful approaches and some input from site management and DOE personnel.

After reviewing the annual reports, four administrative approach strategies were identified—planning/policy, organization, awareness/training, and tools development/information exchange. Each of these approaches are discussed in more detail below.

Planning/Policy. Planning/policy options could be implemented to be instrumental in reducing the future generation of mixed waste. The general options presented in Table 3.1 were identified in the annual reports.

Table 3.1. Planning/Policy options for MLLW minimization

| Option | Number of sites reporting |
|---|---------------------------|
| Develop plans to minimize overall waste generation and establish waste generating baselines and goals | 5 |
| Establish policy changes within programs that will impact and reduce waste generation | 3 |
| Initiate PPOAs for some programs | 1 |

MLLW = mixed low-level radioactive waste

P2 = pollution prevention

PPOA = Pollution Prevention Opportunity Assessment

Any waste management or waste generating program should have measurable waste reduction goals established and documented in their respective overall program plans. Establishing a mixed waste generation baseline from which to measure waste reduction progress would be an excellent starting point to give personnel a quantitative way to measure and monitor progress.

Establishing and implementing waste minimization policy guidance for future and existing programs is another good approach. One very good policy that could have an impact on future mixed waste generation is the requirement for waste generators to prepare and submit a plan prior to the actual generation of waste, such as that reported in the 1994 annual report for Portsmouth. This approach would require personnel to plan and think through projects before embarking on waste generating activities.

Another good approach to reduce the future generation of mixed waste is to conduct Pollution Prevention Opportunity Assessments (PPOAs) for needed activities. By conducting PPOAs, ways to reduce or eliminate waste streams can be identified and the findings incorporated into planning.

Numerous planning/policy approaches have been identified and could be applied to reduce the generation of future mixed waste as shown in Table A.1 in Appendix A.

Organization. Table 3.2 lists general organizational options that have been implemented and could be used at other DOE sites to reduce the future generation of mixed waste.

Table 3.2. Organizational options for MLLW minimization

| Option | Number of sites reporting |
|--|---------------------------|
| Include waste minimization or P2 personnel on project teams | 3 |
| Create waste minimization committees and appoint full-time waste minimization/P2 coordinator | 2 |

MLLW = mixed low-level radioactive waste

P2 = pollution prevention

The organizational options include forming committees to assist in identifying waste minimization opportunities and, as was identified in the LLW study, including P2 or waste minimization personnel on project teams. Placing P2 or waste minimization personnel on project teams ensures that P2 and waste minimization issues get addressed early in the project. A report (Burns 1995) prepared by LANL discuss the merits of placing P2 personnel on projects. In addition, committees or teams could be formed to evaluate MLLW generating activities and identify potential ways to eliminate or reduce the waste. By identifying these issues early, waste generation may be eliminated or the potential quantity of waste generation reduced. This option could definitely reduce the future generation of both MLLW and LLW. Table A.1 in Appendix A lists these approaches.

Awareness/Training. Implementing awareness/training programs is one of the more popular ways to reduce or eliminate the generation of waste, although it is difficult to conduct awareness training for waste generation activities. While there are numerous approaches listed (see Table A.1 in Appendix A), four common themes are listed in Table 3.3.

Table 3.3. Awareness/training options for MLLW minimization

| Option | Number of sites reporting |
|---|---------------------------|
| Sponsor P2 awareness weekly/monthly celebrations | 6 |
| Publicize and encourage participation in recycling programs | 4 |
| Establish award and incentive programs | 3 |
| Establish general P2 or waste minimization training | 11 |

MLLW = mixed low-level radioactive waste

P2 = pollution prevention

The most frequently reported option for encouraging waste minimization is training. All sites in the study reported some type of training program, ranging from a basic awareness module included in General Employee Training (GET) to project-specific training on how to implement source reduction. Training programs are to some degree an extension of the awareness programs, in that training makes personnel aware of current P2 initiatives and approaches they can use to prevent pollution and generate less waste. Training is developed and presented based on the level of personnel involved. A broader type of training is presented to the management level than is presented to shop level personnel. Management is presented with training that gives them a broad picture of what P2 is and how to implement P2 ideas at the shop level. Shop personnel are presented with a more streamlined, detailed type of training to help them evaluate their specific task and find ways to eliminate or reduce waste produced from their task.

Publicizing and encouraging participation in recycling programs is another prevalent option. While this is not a form of source reduction, it is a form of P2 and it encourages people to evaluate the waste they are generating and hopefully find a way to recycle or reuse the waste to make it in to a usable product. This approach would only work for MLLW if segregation is used to remove the hazardous waste component.

Sponsoring P2 awareness either in the form of a week- or month-long celebration with activities that encourage and teach personnel about P2 options is also a good approach. By showing people how P2 can affect not only their work but also how it affects their families and communities, a greater impact can be achieved, and in turn, hopefully, a higher awareness is gained.

Tools Development/Information Exchange. Table 3.4 lists tools development/information exchange options that have been implemented at various sites to reduce the future generation of mixed waste. These options are based on computerized database tracking or sharing P2 or waste minimization opportunities with other sites or companies.

Table 3.4. Tools development/information exchange options for MLLW minimization

| Option | Number of sites reporting |
|---|----------------------------------|
| Establish a computerized system for tracking waste or P2 project status | 5 |
| Develop process waste assessment (similar to PPOA) methodology | 1 |
| Meet with area companies to benchmark P2 programs and projects | 1 |
| Conduct special studies on alternate disposal practices | 1 |

MLLW = mixed low-level radioactive waste

P2 = pollution prevention

PPOA = Pollution Prevention Opportunity Assessments

Databases that either assist in tracking the progress of P2 options or waste minimization PPOAs may not assist in actually reducing waste generation, but they are good tools for analyzing and tracking waste reduction.

Software tools and general methodology guidance can be used during the planning stages of projects for option analysis and cost benefit analysis to help choose how to do a project. An example of this is the "Decision Methodology for Fernald Scrap Metal Disposition Alternatives" report. The methodology was divided into two phases: the life cycle analysis and the decision phase.

Information exchange approaches were documented at one site. This site implemented approaches, such as meeting with area companies to benchmark P2 opportunities, and conducted some special studies on alternatives to existing disposal practices. Information obtained from these benchmarking meetings and special studies were shared within their organizations and with other sites.

3.2.1.2 Chemical traffic controls

MLLW by definition (see Section 2) requires the presence of a hazardous component. One way to minimize the generation of MLLW is to eliminate the use of the hazardous substance or find a substitute for the hazardous material. This may be accomplished effectively by

implementing a chemical traffic control system. A chemical traffic control system includes specific waste minimization activities like material substitution programs and a hazardous material control tracking system.

Table 3.5 presents the two major MLLW minimization options that have been implemented, to prevent the introduction of a hazardous component to an otherwise non-hazardous (and, therefore, non-mixed) radioactive waste at the 11 sites in this study.

Table 3.5. Waste minimization options reported for hazardous material use

| Option | Number of sites reporting | Total reduction |
|--|---------------------------|--------------------|
| Substitute non-hazardous material for hazardous material | 5 | 166 m ³ |
| Eliminate use of the hazardous material | 2 | 1.1 m ³ |

Several sites reported unique instances of substituting a non-hazardous material for a hazardous material to reduce MLLW generation in a contamination area. All products containing hazardous constituents should be evaluated prior to use in a contamination area (e.g., substitute a non-hazardous paint stripper for a hazardous one). In addition, some sites identified specific opportunities to eliminate the use of the hazardous material (e.g., replacing a tank of methylene chloride with an ultrasonic cleaner using non-hazardous detergent). Regardless of use, when a hazardous chemical is stored in a contamination area and its shelf-life expires, it must then be disposed of as MLLW. Therefore, hazardous chemicals should not be stored in contaminated areas.

Although these approaches can be very effective when applied to only one specific activity, they can be implemented more effectively through a central organization responsible for identifying substitution and elimination opportunities and overseeing storage and chemical issuing practices. Implementation of a chemical traffic control system would ensure the evaluation of chemical purchases and reduce MLLW by identifying non-hazardous substitutes and controlling the quantities issued.

A detailed list of approaches reported in the annual reports is presented in Table A.2 in Appendix A.

3.2.1.3 Down posting

This option was identified in the DOE/ORO-2043 report but is discussed again in this report due to its applicability to MLLW and significant success where it has been implemented. Just as preventing the introduction of a hazardous component to an otherwise LLW prevents MLLW generation, so will the prevention of the potential introduction of a radioactive component to an otherwise RCRA hazardous waste.

DOE Order 5400.5 states that any property "shall be considered to be potentially contaminated if it has been used or stored in radiation areas that could contain unconfined radioactive material or that are exposed to beams of particles capable of causing activation." Suspect waste is generated in a radiological area; it is usually not economically feasible to ascertain by radiological monitoring, process knowledge, or sampling and analysis that the material does not contain radiological contamination. Requirements for the release of materials and equipment from radiological areas to other controlled areas are given in 10 Code of Federal Regulations 835.1101.

Furthermore, if the waste is known to originate from an area outside a designated Radioactive Material Management Area (RMMA), the waste can be classified as nonradioactive. DOE's Oak Ridge Y-12 Plant has taken an approach toward establishing, certifying, and maintaining non-RMMA (Procedure Y70-308, October 6, 1994). Wastes originating from these areas are, by definition, not radioactive. Hence, the production of suspect MLLW can be reduced by reducing the size and/or throughput of hazardous materials in known RMMAs or, if an approach similar to Y-12 is taken, maximizing the size and throughput of non-RMMAs.

MLLW reduction can be accomplished by reducing the hazardous waste generated in a contamination area, preventing hazardous materials from entering the contaminated area, or down posting areas from contamination to radiation or clean areas so that materials entering the area will not be considered suspect when they leave the areas. These approaches have proven to be very effective and implementable. This option has been implemented with much success at Y-12, SRS, Hanford, and INEL.

3.2.2 Activity-Specific Options

In addition to the site level options identified above and discussed in the DOE/ORO-2043 report, the following MLLW options may be more applicable to specific sites and activities and not necessarily to all DOE sites. It is recommended that the following options be reviewed

(laboratory activities, equipment maintenance, facility maintenance, and waste management) and implemented if applicable to the site.

3.2.2.1 Laboratory activities

The generation and minimization of MLLW associated with laboratory activities is discussed in this section. For this study, "laboratory" is either an analytical, research, or photographic lab.

Laboratory Activities MLLW Generation. Waste generating activities for this study included any type of activity that takes place within a laboratory setting. Activities that generate waste include the use of laboratory reagents that become mixed with a radioactive component or cleaning radioactively contaminated laboratory equipment. Laboratory waste is common to most DOE facilities.

Laboratory Activities MLLW Minimization. Laboratory-generated MLLW can be reduced through the chemical controls discussed above. Table 3.6 presents the two other MLLW options that have been implemented to reduce laboratory-generated waste at the sites in this study.

Table 3.6. Waste minimization options reported for laboratory activities

| Option | Number of sites reporting | Total reduction |
|--------------------------------------|---------------------------|--------------------|
| Modify laboratory equipment | 3 | 9.1 m ³ |
| Reuse or recycle laboratory material | 2 | 4.6 m ³ |

The majority of options implemented to reduce the generation of laboratory MLLW involve modification of laboratory equipment. If existing laboratory equipment can be modified or if new equipment is available that eliminates the need for a hazardous component, then the equipment should be either modified or replaced (e.g., placing Velcro straps on laboratory equipment to replace the use of strapping tape to hold samples in place while mixing).

Another option is to reuse or recycle material used in the laboratory (e.g., recycle and reuse the acid for cleaning glassware). However, in these cases, the reusable material may only be considered MLLW because it is classified as suspect waste. When reusing potentially radioactively contaminated material, careful consideration should be given to the possibility of cross-contamination (see Section 3.2.1 of DOE/ORO-2043).

A detailed list of approaches reported in the annual reports is presented in Table A.3 in Appendix A.

3.2.3 Equipment Maintenance

This section discusses the options for minimization of waste associated with equipment maintenance.

Equipment Maintenance MLLW Generation. MLLW is generated when maintenance is performed on equipment located in a radiological area or if maintenance is performed and the hazardous waste comes in contact with any contamination. One major way waste is generated is when fluids are changed out on equipment. The hazardous fluids sometimes become contaminated with radioactive materials, thus making them a mixed waste. Equipment maintenance activities that generate mixed waste are common to most DOE facilities.

Equipment Maintenance MLLW Minimization. Table 3.7 presents two MLLW options that have been implemented to reduce the generation of MLLW from equipment maintenance at sites in this study.

Table 3.7. Waste minimization options reported for equipment maintenance

| Option | Number of sites reporting | Total reduction |
|---|---------------------------|-------------------|
| Modify equipment | 4 | 20 m ³ |
| Reuse or recycle fluids used in equipment | 1 | 1 m ³ |

The main approach identified in this option involves the modification of existing equipment (e.g., installing a filtration system on chillers to eliminate the need to annually change out oil, eliminating the generation of waste oil contaminated with freon). Another approach identified was to recycle or reuse some fluids that are removed from the equipment. One standard fluid that is typically reused/recycled is ethylene glycol. However, in these cases, the reusable material may only be considered MLLW because it is classified as suspect waste. When reusing potentially radioactively contaminated material, give careful consideration to the possibility of cross-contamination (see DOE/ORO-2043).

A detailed list of approaches reported in the annual reports is presented in Table A.4 in Appendix A.

3.2.4 Facility Maintenance

This section discusses the generation and minimization of MLLW associated with facility maintenance activities.

Facility Maintenance MLLW Generation. Facility maintenance activities include cleaning floors, changing filters, painting, remodeling, or other activities necessary to maintain an operational facility. For example, spills on the floor due to either process tank overflows or machinery leaks (e.g., contaminated oil leaks) must be cleaned up with some type of absorbent material. Spills in dike areas must be pumped out or drained to an area and cleaned up. If the spill contains hazardous constituents and occurs in a radiological area, the spilled material and cleanup material are MLLW.

Other types of MLLW generation come from changing air filters. Most buildings have an air filtration system that uses some type of filter to purify or take contaminants out of the air. These filters must be changed periodically and may be classified as MLLW if used to filter air in a radiological area with a hazardous component (i.e., mercury contamination area). Facility maintenance activities that generate MLLW are common to most DOE facilities.

Facility Maintenance MLLW Minimization. Table 3.8 presents three MLLW options that have been implemented at some of the study sites in order to reduce the generation of facility maintenance waste.

Table 3.8. Waste minimization options reported for facility maintenance

| Option | Number of sites reporting | Total reduction |
|--|---------------------------|--------------------|
| Modify process or a piece of equipment within the facility | 3 | 0.3 m ³ |
| Treat waste within the facility | 1 | 3.4 m ³ |
| Reuse or recycle material within the facility | 1 | 3.7 m ³ |

Approaches that could reduce the amount of waste generated from facility maintenance activities are generally associated with either process modifications located within the building or to equipment that is located within the building. Processes that take place within a building may involve the use of tanks. Spills from these tanks could be eliminated by modifying the equipment to eliminate the possibility of an overflow. One process modification is to eliminate

the floor sweep waste from spill cleanup (e.g., terminate the use of saw dust and oil as a dust suppressant for floor sweeping of mixed waste).

Another way to minimize MLLW is to neutralize it, thereby removing the characteristic that makes it hazardous. In-place neutralization also reduces the cost to collect, transport, and store the waste.

Reusing or recycling cleaning or maintenance chemicals will also reduce facility maintenance MLLW (e.g., settle and reuse paint thinner in a contaminated area). If the solutions can be recycled or reused, the need to bring additional chemicals into the area is eliminated. However, in these cases, the reusable material may only be considered MLLW because it is classified as suspect waste. If the material were truly radioactively contaminated, reuse would not be technically appropriate.

A detailed list of approaches reported in the annual reports is presented in Table A.5 in Appendix A.

3.2.5 Waste Management

This section discusses the generation and minimization of waste associated with waste management activities. Waste management includes treatment, storage, disposal, and all other associated activities.

Waste Management MLLW Generation. Waste generated from waste management activities typically is divided into three areas—treatment, storage, and disposal. All three of these activities result in incidental wastes, such as PPE, from waste handling. Treatment activities normally generate a secondary waste stream, such as wastewater treatment sludge (see discussion in Section 3.3.1). Storage and disposal activities require the sampling and characterization of waste, which results in sample material and incidental wastes (e.g., gloves, bags, decontamination water, and paper). Waste management activities generating MLLW are common to most DOE facilities.

Waste Management MLLW Minimization. Table 3.9 presents six MLLW options that have been implemented to reduce the amount of waste generated from waste management activities.

Table 3.9. Waste minimization options reported for waste management

| Option | Number of sites reporting | Total reduction |
|--|----------------------------------|------------------------|
| Reuse or recycle chemicals used in process | 5 | 761 m ³ |
| Modify processes to eliminate waste | 2 | 10.2 m ³ |
| Segregate waste to reduce volume | 2 | 126 m ³ |
| Divert stormwater to prevent it from entering contaminated areas | 2 | 79.4 m ³ |
| Modify equipment | 5 | 250 m ³ |
| Treat waste | 1 | 1.3 m ³ |

As shown in Table 3.9, reuse and recycling of material (e.g., excess chemicals from a cleanup project were reused in biodenitrification and bio-oxidation processes) are the leading methods used across the DOE sites to reduce waste management related waste generation.

Modification of an existing process can reduce the amount of MLLW waste generated. For example, if sampling of each waste container is necessary, increasing the size of storage/transport tanks can reduce the number of samples taken, thereby reducing a related waste. Also, if appropriate, permits can be modified to allow material to be stored longer, thereby reducing the frequency of emptying large capacity tanks, which may be only half full at the end of 90 days.

Segregation of waste offers opportunities for reducing the amount of waste to be stored and treated. Characteristically hazardous waste can potentially be removed from MLLW containers to result in one hazardous waste stream and one LLW stream (less expensive than MLLW). This does require some additional labor if the waste is already drummed or stored. The key is to integrate segregation as a practice at the beginning of a project. This will allow the segregation to occur as the project progresses, not at the end [e.g., segregated hazardous component (lighter, aerosol can, etc.) from LLW containers]. Segregation is typically easier to conduct at the beginning of a project; however, benefits can also be gained by conducting it at the end.

The diversion of stormwater run-off prevents it from mixing with other wastes and reduces the quantity of waste generated. If stormwater does not enter tanks that contain mixed waste, the amount of water that has been diverted will not become a mixed waste. These modifications can include altering the slope of an asphalt pad, rerouting plant roof drains, and diverting stormwater around and away from contaminated areas.

Once again, modification of equipment or a process can also reduce the amount of waste generated. Various types of modifications can be applied to a process or a piece of equipment to reduce the generation of MLLW waste (e.g., installing a "Brine Cell" to oxidize a solution rather than adding a chemical that results in eight times the volume of waste).

Waste may also be prevented by using in-stock chemicals to neutralize the waste to the extent possible, preventing the need to dispose of the excess in-stock chemicals when they have passed the expiration date and if they are stored in a radiation area.

A detailed list of approaches reported in the annual reports is presented in Tables A.6 and A.7 in Appendix A.

3.3 MLLW MINIMIZATION FOR PLANNED WASTE GENERATING ACTIVITIES

3.3.1 Treatment of Stored Wastes in Compliance with FFCAct

As shown in Section 2.4, the 11 study sites had over 94,000 m³ of MLLW in storage at the end of CY 1994. These wastes must be treated in accordance with the provisions of Mixed Waste Treatment Compliance Plans that have been approved by EPA or the site's host state to avoid fines and penalties associated with RCRA. Treatment may be on-site in currently existing, proposed, or vendor-supplied systems; off-site at another DOE facility; or off-site at a commercial facility. "Treatment" in practically all cases means treatment of the RCRA-regulated component of the waste to meet LDRs or to destroy the hazardous characteristic. Treatment can be expected to produce incidental wastes that may be LLW or MLLW, such as PPE, discarded used parts or liners, or decontamination streams (liquids and sludges) associated with routine maintenance. These incidental wastes can be minimized by using approaches and recommendations developed and discussed in the DOE/ORO-2043 report.

General categories of MLLW treatment processes and their associated secondary wastes are shown in Table 3.10. Secondary wastes will be either MLLW themselves or LLW. Hence, proper planning is necessary to ensure that the volume of secondary waste is minimized for any treatment process. In addition, it should be noted that some treatment processes, such as cementation of sludges or debris, may result in significant volume increases of waste forms requiring disposal. Furthermore, the output of a treatment process may require further treatment (e.g., incinerator ash may require stabilization).

Table 3.10. MLLW treatment processes and associated secondary wastes

| Treatment process category | Potential secondary waste |
|---|-------------------------------------|
| Physical/chemical treatment of wastewaters and aqueous slurries | Sludges, filter cakes, spent resins |
| Stabilization | Wastewater |
| Organic destruction | Wastewater, fly ash, baghouse bags |
| Inorganic debris treatment | Wastewater |
| Alkali metal deactivation | Wastewater, sludge |
| Pyrophoric/explosive deactivation | Wastewater, ash |
| Mercury separation | Organics |
| Soil washing | Wastewater |

4. EVALUATION OF MLLW MINIMIZATION OPTIONS AND RECOMMENDATIONS

This section presents an evaluation of the MLLW minimization options presented in Section 3.3 and the recommendations developed from that evaluation. This evaluation was accomplished through a meeting with internal project personnel and additional input from site personnel. The objective of the evaluation was to develop MLLW minimization recommendations that can be implemented at numerous DOE facilities. The three options that were identified as priority for site level implementation (administrative activities, chemical traffic controls, and down posting) were not evaluated.

4.1 METHODOLOGY

The evaluation was performed by project personnel who brought experience from a similar evaluation performed for LLW at a one-day workshop attended by representatives from DOE-HQ and DOE and contractor personnel from seven DOE sites. (The LLW workshop is described fully in the DOE/ORO-2043 report.) The team reviewed a comprehensive table of MLLW generating processes and potential minimization options. The team also discussed criteria by which to evaluate the approaches and ranked the approaches for each generating category. The information used in the DOE/ORO-2043 evaluation are presented in Appendix D. The team then discussed the MLLW generating categories and evaluated corresponding waste minimization options. Evaluation criteria included the following:

- economic feasibility,
- quantity of reduction,
- quantity of generation,
- technical risk,
- EPA hierarchy,
- compliance, and
- application potential.

Each minimization option received a score of 1, 2, or 3 for each criterion, with 1 representing the least desirable option for that criterion, 2 representing an acceptable option, and 3 representing the most desirable option for that criterion. Table 4.1 shows the evaluation criteria, the scores, and rationale associated with particular rankings.

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- quantity of generation,
- technical risk,
- EPA hierarchy,
- compliance, and
- application potential.

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Table 4.1. Evaluation criteria and ranking rationale

| Criterion | Score | | | Comment |
|----------------|---|---|--|---|
| | 1 | 2 | 3 | |
| Economics | High investment; low savings | High investment/ high savings or low investment/low savings | Low investment/ high savings | Rankings were relative within each generating category |
| Reduction | Low reduction | High reduction | Eliminated | Rankings were relative within each generating category |
| Generation | Affects small waste stream | Affects medium waste stream | Affects large waste stream | Rankings were relative within each generating category |
| Technical risk | Great risk of not working as intended | Probably will work to some extent | Likely will work as expected or better | Rankings were consistent among all generating categories. A ranking of 3 was consistent among all generating categories because all options have been implemented and no technical risk was perceived |
| EPA hierarchy | Treatment or disposal | Reuse/recycle | Source reduction | Rankings were consistent among all generating categories. Each option was ranked based on whether it involved treatment or disposal, reuse/recycle, or source reduction |
| Compliance | Non-compliant | Compliant but requires DOE Order change to implement or modification of existing permits | Compliant | Rankings were consistent among all generating categories. As a general rule, a score of 3 was assigned to most options. The two exceptions will be discussed in their relevant sections |
| Potential | Limited applicability across DOE | Useful to approximately 50% of DOE sites | Useful to most DOE sites | Rankings were relative within each generating category |

4.2 SITE LEVEL RECOMMENDATIONS

Three recommendations were recognized and were found to be applicable. These three recommendations are:

- administrative,
- chemical traffic controls, and
- down posting.

These recommendations were generally applicable to all sites and were recommended without further evaluation.

4.3 ACTIVITY-SPECIFIC OPTIONS

Table 4.3 is a summary of the MLLW activity-specific generating categories and corresponding MLLW minimization options. For consistency, the evaluation of MLLW minimization options followed the same methodology used for the LLW evaluation. The results of the evaluation are presented in the following sections.

Table 4.3. Generating processes

| Generating process | Options |
|-----------------------|---|
| Laboratory activities | Equipment modification Reuse |
| Equipment maintenance | Equipment modification Material reuse |
| Facility maintenance | Process modification Reuse |
| Waste management | Sampling modification Waste segregation Stormwater diversion Equipment modification Treatment modification Reuse |

4.3.1 Laboratory Activities

Two potential options were identified for laboratory activities: equipment modification and reuse. The results of the evaluation are presented in Table 4.3.

Table 4.3. Options for laboratory activities

| Criterion | Option priority ranking | | Comments |
|-----------------|-------------------------|-----------|--|
| | Equipment modification | Reuse | |
| Economics | 1 | 2 | Equipment modification has a potentially large investment and will receive moderate savings; reuse does not require a large investment and would receive the same moderate savings |
| Reduction | 2 | 1 | Equipment modification option has potential to reduce a larger volume of waste than reuse |
| Generation rate | 2 | 2 | Both options affect a medium size waste stream |
| Technical risk | 3 | 3 | Options have been implemented and no technical risk was identified |
| EPA hierarchy | 3 | 2 | Each option was ranked based on whether it involved treatment or disposal, reuse/recycle, or source reduction |
| Compliance | 3 | 3 | Options are compliant |
| Potential | 1 | 3 | Reuse is implementable at more DOE facilities; equipment modification is more site-specific and may not generally apply to all sites |
| Total | 15 | 16 | |

4.3.2 Equipment Maintenance

Two potential options were identified for the equipment maintenance generating process: equipment modification and material reuse. The results of the evaluation are presented in Table 4.4.

Table 4.4. Options for equipment maintenance

| Criterion | Option priority ranking | | Comments |
|-----------------|-------------------------|----------------|--|
| | Equipment modification | Material reuse | |
| Economics | 2 | 2 | Both have perceived equal investment and savings potential |
| Reduction | 3 | 2 | Equipment modification could potentially eliminate the waste, whereas material reuse has a high reduction potential |
| Generation rate | 2 | 1 | Equipment modification could eliminate a medium waste stream, whereas reuse only has a small waste stream it could eliminate |
| Technical risk | 3 | 3 | Options have been implemented and no technical risk was identified |
| EPA hierarchy | 3 | 2 | Each option was ranked based on whether it involved treatment or disposal, reuse/recycle, or source reduction |
| Compliance | 3 | 3 | Options are compliant |
| Potential | 2 | 2 | Material reuse and equipment modification would be equally useful to approximately 50% of the DOE sites |
| Total | 18 | 15 | |

4.3.3 Facility Maintenance

Three potential options were identified for the facility maintenance generating process: process modification, material reuse, and treatment. The results of the evaluation are presented in Table 4.5.

Table 4.5. Options for facility maintenance

| Criterion | Option priority ranking | | | Comments |
|-----------------|-------------------------|----------------|-----------|---|
| | Process modification | Material reuse | Treatment | |
| Economics | 2 | 3 | 2 | Material reuse has a low cost and moderate savings, whereas process modification and treatment would require more money to implement with only moderate savings |
| Reduction | 2 | 2 | 2 | All options could potentially reduce a high quantity of waste |
| Generation rate | 2 | 3 | 2 | Process modification and treatment has the potential to eliminate a large waste streams versus material reuse, which has a limited waste stream it could affect |
| Technical risk | 3 | 3 | 3 | Options have been implemented and no technical risk was identified |
| EPA hierarchy | 3 | 2 | 1 | Each option was ranked based on whether it involved treatment or disposal, reuse/recycle, or source reduction |
| Compliance | 3 | 3 | 3 | Options are compliant |
| Potential | 2 | 2 | 2 | All options would be equally useful to approximately 50% of the DOE sites |
| Total | 17 | 18 | 15 | |

4.3.4 Waste Management

Six potential options were identified for waste management activities: sampling modification, waste segregation, storm water diversion, equipment modification, treatment modification, and reuse. The results of the evaluation are presented in Table 4.6.

Table 4.6. Options for waste management

| Criterion | Option priority ranking | | | | | | Comments |
|----------------|-------------------------|-------------------|-----------|----------------------|------------------------|------------------------|---|
| | Sampling modification | Waste segregation | Reuse | Stormwater diversion | Equipment modification | Treatment modification | |
| Economics | 2 | 3 | 2 | 2 | 1 | 2 | Waste segregation was identified as the option with the lowest investment cost and the highest savings. Sampling modification, reuse, treatment modification, and stormwater diversion were options that had potentially higher investment costs to implement but higher savings potentials. Equipment modification was deemed to be the most expensive to implement with the lowest savings identified |
| Reduction | 2 | 3 | 2 | 3 | 2 | 3 | Three of the options, sampling modification, reuse, and equipment modification, could potentially achieve a high reduction in waste. Waste segregation, stormwater diversion, and treatment modification are all options that could potentially reduce or eliminate a large quantity of waste |
| Generation | 1 | 2 | 3 | 3 | 2 | 3 | Sampling modification was identified as an option that affected a very small waste stream. Waste segregation and equipment modification could potentially affect a moderate size waste stream. Reuse, treatment modification, and stormwater diversion were options that could potentially affect the largest waste stream |
| Technical risk | 3 | 3 | 3 | 3 | 3 | 3 | Options have been implemented and no technical risk was identified |
| EPA hierarchy | 3 | 1 | 2 | 3 | 3 | 3 | Each option was ranked based on whether it involved treatment or disposal, reuse/recycle, or source reduction |
| Compliance | 3 | 3 | 3 | 3 | 3 | 3 | Options are compliant |
| Potential | 3 | 3 | 3 | 3 | 2 | 2 | Sampling modification, waste segregation, reuse, and stormwater diversion were all options identified that would be useful to most DOE sites. Equipment modification and treatment modification would apply to 50% of DOE sites |
| Total | 17 | 18 | 18 | 20 | 16 | 19 | |

4.4 MLLW MINIMIZATION RECOMMENDATIONS

In addition, after evaluating the activity-specific MLLW minimization options using the described criteria, the team determined that all options are recommended. This decision was based on the numbers generated from evaluating the MLLW minimization options. The rankings of the options were so close that it was decided that none of the options would be discarded.

In addition, administrative, chemical traffic control, and down posting are recommended as priority for site level implementation.

The next section presents case studies that support these recommendations. The case studies contain information for individual sites to make a determination if the option recommended is appropriate or applicable for their site.

5. MLLW MINIMIZATION CASE STUDIES

The objective of this section is to present sufficient information for the MLLW minimization options recommended in Section 4 to help DOE sites determine whether an option identified is feasible for their site. This section presents case studies developed to help illustrate how some of the recommendations in Section 4 have been implemented at various DOE sites. The case studies are based on data obtained from site contacts at several DOE facilities.

At least one case study is presented for each of the four generating categories identified for MLLW. In addition, one case study is presented for chemical traffic controls. Case studies for down posting are presented in the LLW report (DOE/ORO-2043) and are not repeated here. The case study presents a baseline of the existing data, briefly describes the MLLW minimization approach that was applied, and then discusses the results of the project. When available, the cost to implement the option as well as the cost savings and the waste reduction amount are also given.

5.1 OBJECTIVE AND METHODOLOGY

The objective of this activity was to develop case studies that verify the implementability and applicability of the MLLW minimization recommendations developed in Section 4 and to provide some insight on implementation issues to assist other DOE sites in identifying where and how to implement the suggested recommendations.

Projects to potentially use as case studies were identified from annual reports and discussions with site representatives. The appropriate site personnel were contacted for information in addition to that found in the annual reports. The primary contact for each recommendation is listed in Appendix C. This list provides contacts that may be useful for obtaining additional information or answering questions about their successes or failures in implementing MLLW minimization options.

5.2 MLLW MINIMIZATION CASE STUDIES

There were four waste generating categories identified for MLLW. They include laboratory activities, equipment maintenance, facility maintenance, and waste management. Also, a case

study is presented for chemical traffic controls. A case study for down posting is presented in DOE/ORO-2043 and is not repeated here. A summary of that case study is presented in Table 6.1.

5.2.1 Chemical Traffic Controls

The case study for this recommendation was implemented at SRS.

Contact. Keith Stone; (803) 557-6317

Baseline. In December 1994, the SRS established and fully staffed a Chemical Commodity Management Center (CCMC). The commodity management center is a site organizational tool used to provide a central, focused approach for the acquisition, inventory control, and distribution and redistribution of materials/equipment used throughout the site. The site recognized that with greater than 50,000 chemical materials and greater than 10,000 products requiring Material Safety Data Sheets increased management control would offer the opportunity for significant reductions in chemical procurement and associated waste management and P2.

MLLW Minimization Approach. The CCMC began accepting chemicals in April 1995. The CCMC is recognized as "the source" for chemicals at the site. Twenty-eight just-in-time contracts have been awarded. These type contracts significantly reduce on-site chemical inventories, avoid expiration of chemical shelf-life, and reduce liabilities associated with warehousing chemicals. Also, an on-line, real-time chemical tracking system was implemented. A more streamlined procurement procedure and reduced procurement cycle time for 8000 chemicals was also established. This streamlined approach essentially eliminated routine CCMC reviews for a wide variety of chemicals.

Results. This MLLW minimization activity achieved a cost avoidance of greater than \$250K in 1995 for excess chemical redistribution on-site and off-site. In the last quarter of CY 1995, the CCMC received greater than 9000 lb of chemicals into excess and dispersed greater than 7500 lb of chemicals for reuse in lieu of disposal.

5.2.2 Laboratory Activities

The recommendations identified for laboratory activities were equipment modification and reuse. The case studies for these recommendations are presented below.

5.2.2.1 Equipment modification

At Hanford, a project was implemented to install Velcro straps on a Chemical Vortex Shaker.

Contact. Mary Betsch; (509) 372-1627

Baseline. Before samples can be subdivided for various analytical tests, they must be vortexed (shaken vigorously) for a specified amount of time to ensure homogeneity. The design of the laboratory equipment does not accommodate the variety of glass vial sizes used in laboratories, so the chemists used green industrial strength tape to secure the vials.

MLLW Minimization Approach. The green industrial strength tape was replaced with a reusable and adjustable Velcro strap. The velcro strap is used to secure glass vials to the laboratory equipment. This approach eliminated 1.5 rolls of green tape used daily.

Results. This MLLW minimization activity reduced the amount of solid MLLW, primarily tape, by 0.6 m³ annually. Annual cost savings from the purchase and disposal of tape totaled \$46,193. The cost to implement this approach was \$172.00.

5.2.2.2 Reuse

At Y-12, a project was implemented to reuse the acid for cleaning laboratory glassware. This reuse project was associated with suspect waste and is, therefore, not specific to MLLW. Refer to Section 5.2.1 of the DOE/ORO-2043 report for other approaches related to eliminating the suspect classification of waste.

Contact. Shelia Poligone; (423) 241-2568

Baseline. Various laboratories at Y-12 use acid for cleaning/leaching glassware, which is discarded after one use.

MLLW Minimization Approach. Acid for cleaning laboratory glassware is recycled and used for cleaning.

Results. This MLLW minimization activity reduced the amount of liquid MLLW waste by 4.13 m³. Annual cost savings was approximately \$82,000. Also, an unquantifiable amount was saved procuring supplies, mixing acid solutions, and disposing of wastes. The cost to implement this approach is not available.

5.2.3 Equipment Maintenance

The two recommendations for maintenance on equipment are equipment modification and material use. The case studies for these recommendations are presented below.

5.2.3.1 Equipment modification

There were two case studies identified for equipment modification (one for SRS and one for Y-12).

Contact. Keith Stone; (803) 557-6317

Baseline. The Dilute Effluent Treatment Facility (DETF) is an end-of-pipe industrial wastewater treatment facility that uses precipitation and filtration. The wastewater is pressure filtered through a Tyvek filter media. The Tyvek media is a disposable sub-micron media that is used only once in the filtration cycle. After the filtration cycle is completed and the filter cake discharged, the Tyvek is re-rolled and then discarded to a B-25 metal 90-ft³ storage box as a listed F006 mixed waste.

MLLW Minimization Approach. To eliminate the single-use Tyvek filter paper, a very tight weave fabric belt that is flushed by an air/water spray after the filter cake discharges was needed. A national search was conducted, and a new filter aid manufacturer that consistently achieved the stringent DETF acceptance criteria was identified. Eight different sub-micron filter belt fabrics were tested in DETF process simulations. Approval to perform full-scale demonstration on three of the belts was obtained and approval to convert to the cleanable belts was obtained.

Results. This MLLW minimization approach achieved a 93% reduction in mixed waste generation, primarily the elimination of filter paper rolls, by 289 ft³/year. The DETF routinely generated 2.6 mixed waste used filter paper rolls per batch. As of February 1993, the DETF has two more years of supernate processing. If the conversion to the cleanable belts did not occur, DETF would have generated 15 B-25 boxes of mixed waste (1350 ft³). By converting to the cleanable belts, the used filter paper waste stream has been greatly reduced. Only one box of

B-25 waste, versus 15, will be generated in 2 years of operation. A total cost savings of \$360,000 was realized. The cost to implement this approach, including research and development, totaled \$50,000.

Another project involving equipment modification was also implemented at Y-12. Hydraulically driven centrifuges were replaced with electrically driven units. This MLLW minimization approach reduced the amount of MLLW by approximately 200 gal/year of waste hydraulic oil. The annual cost savings, assuming \$7/gal to treat the hydraulic oil, is estimated to be \$1400. Implementation costs are not available.

5.2.3.2 Material reuse

At Y-12, a project was implemented to recycle ethylene glycol. This reuse project was associated with suspect waste and is, therefore, not specific to MLLW. Refer to Section 5.2.1 of the DOE/ORO-2043 report for other approaches.

Contact. Shelia Poligone; (423) 241-2568

Baseline. Ethylene glycol is used in various pieces of equipment at Y-12. The ethylene glycol is periodically drained from equipment during servicing.

MLLW Minimization Approach. The ethylene glycol drained from equipment being serviced at Y-12 is later placed back into the equipment.

Results. The MLLW reduction achieved, the annual cost, and the implementation cost are not available.

5.2.4 Facility Maintenance

The recommendations identified for facility maintenance were process modification and reuse. The case studies for these recommendations are presented below.

5.2.4.1 Process modification

At ORNL, a project was implemented to reduce the number of filter change-outs in Building 4508.

Contact. Susan Michaud; (423) 576-1562

Baseline. Building exhaust filters make up a significant part of hazardous waste for the Metal & Ceramics Division located in Building 4508. A team was chartered to develop recommendations to ensure that hazardous waste in the form of building exhaust filters is minimized to the extent possible. Building 4508 is a two-floor building with 150 people evenly distributed between the two floors. The energy consumption for Building 4508 totals about 40,000 MBtu/year, with about 80% being used for heating, ventilation, and air-conditioning. Prior to 1990, the filters were changed out annually regardless of their condition. Starting in 1990, the filters have been changed out when the filter becomes loaded with particulate matter.

MLLW Minimization Approach. Based on the study, the team recommended the following activities:

- perform a detailed survey of building ductwork to determine whether current high-efficiency particulate air (HEPA) filters are necessary;
- evaluate the results of the detailed study;
- replace HEPA filters with less expensive filters, based on the technical approval of the results of the evaluation;
- implement variable-speed fan control;
- perform an engineering evaluation of rebalancing air flow; and
- consider implementing a laboratory policy that requires installation of local HEPA filtration as an integral part of laboratory equipment.

Results. The MLLW minimization approach resulted in the reduction of about 500 ft³ in 1992. An annual cost savings of \$180,000 was estimated. The implementation cost of \$150,000 included labor to test laboratory hoods.

5.2.4.2 Reuse

A project at ORNL involved the reuse of paint thinner. The case study for this recommendation is presented below. This reuse project was associated with suspect waste and is, therefore, not specific to MLLW. Refer to Section 5.2.1 of the DOE/ORO-2043 report for other approaches.

Contact. Susan Michaud; (423) 576-1562

Baseline. Paint thinner was used daily for a large project at ORNL.

LLW Minimization Approach. The paint thinner was allowed to settle out and was then reused.

Results. The MLLW reduction achieved was 1000 gal and a cost savings of \$40,000 was realized. The cost of implementation was not available.

5.2.5 Waste Management

The six recommendations developed for waste management are sampling modification, waste segregation, stormwater diversion, equipment modification, treatment modification, and reuse. The case studies for these recommendations are presented below.

5.2.5.1 Sampling modification

The Hanford site implemented a project that involved modifying a Part A permit to allow longer storage times.

Contact. Mary Betsch; (509) 372-1627

Baseline. The T-Plant helps facilities reuse equipment by offering decontamination services for items such as gas cylinders, trucks, and railcars. Tanks at the T-Plant were emptied every 90 days, regardless of the volume, resulting in additional PPE waste, rinsate, and decontamination materials.

MLLW Minimization Approach. The T-plant revised its Part A permit to allow for the storage of waste. As a result, rather than emptying the tank system every 90 days regardless of the volume, waste is allowed to accumulate until the tank system is full. Final approval for the Part A permit revision will not occur until 1999.

Results. This MLLW minimization approach reduced the amount of MLLW, primarily PPE, rinsate, and decontamination materials, by 7.6 cm³. An annual cost savings of \$200,000 was realized. The cost to implement this approach was \$40,000.

5.2.5.2 Waste segregation

The Hanford site implemented a project to reduce the waste designation of some waste from MLLW to LLW.

Contact. Mary Betsch; (509) 372-1627

Baseline. Thirty-three boxes located at the Tank Farm contained some type of material that prevented the waste from being classified as LLW.

MLLW Minimization Approach. The 33 boxes at the Tank Farm were sorted and the material that kept it from being classified as MLLW was removed and disposed of as LLW. This changed the waste designation from MLLW to LLW.

Results. The MLLW minimization approach resulted in the reduction of 119.5 m³ of waste. A net annual savings of \$354,800 was realized. The cost to implement this approach was <\$100.

5.2.5.3 Stormwater diversion

Y-12 implemented a project to reduce the amount of rainwater accumulation, thereby reducing the volume of treatable wastewater.

Contact. Shelia Poligone; (423) 241-2568

Baseline. The Oak Ridge area experiences an average annual rainfall of 56.5 in. and evaporative loss of 24 in. There are 15 dikes and tanker-trailer staging areas within the Y-12 Plant western exclusion area. The practice is to pump the dikes after significant rains, which

reduces the impact of evaporative losses by an estimated 50%. The removed water attributed to rainwater accumulation is estimated conservatively at 38,300 ft³. This potential occupies a minimum of fifty-eight 5000-gal tanker-trailer transfers per year.

MLLW Minimization Approach. This project proposed to install sheltering canopies over the 15 dikes and tanker-trailer staging areas. This project anticipates reducing the volume of treatable chemical and/or radiation wastewater, attributed to collected rainwater, at the 15 existing liquid collection sites by 287,000 gal/year. This will further reduce the resource burden for sampling, pumping, pre-treatment storage, and hauling, thus reducing the number of tanker-trailers and personnel engaged in liquid waste handling.

Results. This MLLW minimization activity reduced the amount of MLLW, primarily stormwater run-off, by 287,000 gal/year. An annual cost savings from reduced disposal costs totaled over \$1,704,000. The cost to implement this approach is not available.

5.2.5.4 Equipment modification

Hanford implemented a project to reduce the waste flush water from a railcar loading operation.

Contact. Mary Betsch; (509) 372-1627

Baseline. The existing railcar system at the 340 Facility is awkward and does not provide adequate controls to meter the water used during operations. This operation is performed approximately every 90 days.

MLLW Minimization Approach. An upgrade to the 340 Facility is planned. The upgrade will provide on-demand pressurized water with standard control valves that optimize the amount of flush water used.

Benefits. This MLLW minimization activity may eliminate 400 L of mixed waste during railcar transfer. Annual cost savings were \$4400 and the implementation cost was \$2500.

5.2.5.5 Treatment modification

The SRS implemented a project to neutralize waste using in-stock chemicals.

Contact. Keith Stone; (803) 557-6317

Baseline. Zinc bromide and other chemicals are located at various sites at SRS.

MLLW Minimization Approach. Chemicals currently in stock at SRS were used to neutralize existing waste. This allowed the waste to be disposed of as LLW versus MLLW and reduced in-stock unused chemicals.

Results. This MLLW minimization approach annually reduced the amount of MLLW, primarily waste acids. The cost to implement this approach, including manpower to neutralize the waste, is \$1,000-\$10,000. The annual cost savings is not available.

5.2.5.6 Reuse

Y-12 implemented a project to reuse lead for shielding.

Contact. Shelia Poligone; (423) 241-2568

Baseline. No baseline is available.

MLLW Minimization Approach. The lead was reused during evaporator restart.

Results. This MLLW minimization activity eliminated 50 ft³ of MLLW. Annual cost savings and the cost to implement this approach are not available.

6. SUMMARY

MLLW generation and waste minimization data were collected from 11 DOE facilities, including both operating facilities and restoration facilities. Initial waste minimization options that were identified as priority to keep LLW and hazardous waste segregated (in an effort to prevent MLLW from being generated) and to improve future operations were (1) administrative activities, (2) chemical traffic controls, and (3) down posting. Table 6.1 presents case study information for these priority recommendations. Note that the down posting case study information is obtainable from the DOE/ORO-2043 report.

Evaluation of the collected data determined that four major MLLW generating activities presented minimization potential. They are listed below:

- laboratory activities;
- equipment maintenance;
- facility maintenance; and
- waste management.

These activities were found to be common to most DOE sites, regardless of whether they are operating or restoration sites. MLLW minimization options were identified for the generating activities and were evaluated based on a specific set of criteria. Based on the evaluation of the MLLW minimization options, the difference in the scores for the MLLW minimization options was insignificant. Therefore, all the options are recommended and none were eliminated.

Table 6.2 summarizes the information in this report for each recommendation developed for the operating sites and restoration sites. The table presents some indication of the ease of implementation, general applicability, and level of technology development. The case study results, waste reduction, and economic benefit potential for each recommendation are also presented in summary form.

In addition to these recommendations, note that multiple other approaches are reported in annual reports and recommended in PPOA reports, as summarized in Section 3 and Appendix A. Approaches recommended in these reports should also be considered when evaluating MLLW minimization activities.

Table 6.1. Priority recommendations for MLLW minimization case study results

| Generating category | Recommended option | Approach ^a | Case study results | | |
|-----------------------------|---|-----------------------|--------------------|------------------------|---------------------|
| | | | Reduction | Potential cost savings | Implementation cost |
| Chemical traffic control | Comprehensive chemical traffic control system | 17 | 16,500 lb/year | \$250,000/year | \$1,000,000 |
| Administrative down posting | No case study | | | | |
| Down posting ^b | Down posting laboratory building | 13 | 441,180 lb/year | \$1,000,000/year | \$79,535 |

^aThe number of times each recommendation was reported as an implemented approach in annual reports and other site data.

^bInformation from DOE/ORO-2043.

Table 6.2. Recommended MLLW options and corresponding case study results

| Generating category | Recommended option | Approach ^a | Case study results | | |
|-----------------------|------------------------|-----------------------|---------------------------|------------------------|---------------------|
| | | | Reduction | Potential cost savings | Implementation cost |
| Laboratory activities | Equipment modification | 4 | 0.6 m ³ /year | \$46,193/year | \$172 |
| | Reuse | 2 | 4.1 m ³ /year | \$82,000/year | NA |
| Equipment maintenance | Equipment modification | 4 | 1,350 ft ³ | \$360,000/year | \$50,000 |
| | Material reuse | 1 | NA | NA | NA |
| Facility maintenance | Process modification | 4 | 500 ft ³ | \$180,000 | \$150,000 |
| | Reuse | 1 | 1,000 gal | \$40,000 | NA |
| Waste management | Sampling modification | 2 | 7.5 m ³ | \$200,000 | \$40,000 |
| | Waste segregation | 2 | 119.5 m ³ | \$354,800 | <\$100 |
| | Reuse | 6 | 50 ft ³ | NA | NA |
| | Stormwater diversion | 3 | 287,000 gal/year | \$1,704,000 | NA |
| | Equipment modification | 2 | 400 L/year | \$4,400 | \$2,500 |
| | Treatment modification | 4 | 201 ft ³ /year | NA | \$1,000-\$10,000 |

NA = not available

^aThe number of times each recommendation was reported as an implemented approach in annual reports and other site data.

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Appendix A

MLLW MINIMIZATION APPROACHES

Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|-----------------|--|------------------|---------------------|---------------------|-------------------------|------------|
| Planning/Policy | Issued Waste Minimization and Pollution Prevention Plan Update setting measurable waste reduction goals | NR | NR | NR | 1991-1992 Annual Report | Fernald |
| Planning/Policy | Developed an overall waste minimization plan | NR | NR | NR | 1991-1992 Annual Report | ORNL |
| Planning/Policy | Updated WM/P2 Plan to include program goals and specific plans for WM to act as a guide for employees | NR | NR | NR | 1994 Annual Report | Fernald |
| Planning/Policy | Established a Waste Management Authority to prohibit waste generation with sufficient pre-planning and approval | NR | NR | NR | 1994 Annual Report | INEL |
| Planning/Policy | Developed waste generation baseline, established method of measuring waste reduction progress, and identified priority waste types, and waste generating facilities (to be incorporated into the Site P2 Awareness Plan) | NR | NR | NR | 1994 Annual Report | LANL |
| Planning/Policy | Established a program to reduce the number and size of radiological areas | NR | NR | NR | 1993 Annual Report | Portsmouth |
| Planning/Policy | Established a program to reduce the amount of wastewater and drill cuttings generated from groundwater monitoring wells | NR | NR | NR | 1994 Annual Report | Paducah |
| Planning/Policy | Implemented policy change to reduce the amount of waste generated from soil cuttings and well casings | NR | NR | NR | 1994 Annual Report | Paducah |
| Planning/Policy | Established a policy requiring all waste generators to prepare and submit for approval a generator's waste management plan prior to actually generating waste | NR | NR | NR | 1994 Annual Report | Portsmouth |
| Planning/Policy | Implemented the K-25 Site P2 Procedure | NR | NR | NR | 1994 Annual Report | K-25 |
| Planning/Policy | Initiated a study to assess the site's needs for PPOAs | NR | NR | NR | 1994 Annual Report | K-25 |

NR = not reported

Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--------------------|--|------------------|---------------------|---------------------|-------------------------|-------------|
| Planning/Policy | Revised and issued the K-25 Site P2 Program Plan | NR | NR | NR | 1994 Annual Report | K-25 |
| Planning/Policy | Prepared PPOAs for several waste streams and completed a draft PPOA for one waste stream and issued an ORO-wide PPOA for fluorescent bulbs | NR | NR | NR | 1994 Annual Report | K-25 |
| Planning/Policy | Revised the Site P2 Council Charter and developed and provided P2 Performance Measures for the Division P2 program | NR | NR | NR | 1994 Annual Report | K-25 |
| Planning/Policy | Formulated and participated in the development of the High Value Team to select and fund high-value P2 projects | NR | NR | NR | 1994 Annual Report | K-25 |
| Organization | Created a CERCLA Waste Minimization Committee | NR | NR | NR | 1991-1992 Annual Report | Fernald |
| Organization | Included waste minimization personnel in formal review process for new process designs and process modifications | NR | NR | NR | 1991-1992 Annual Report | LANL |
| Organization | Appointed full-time Waste Minimization/Pollution Prevention Program Manager | NR | NR | NR | 1991-1992 Annual Report | Paducah |
| Organization | Organized completed PPOA reports into a library | NR | NR | NR | 1993 Annual Report | INEL |
| Organization | Included WM personnel in planing and implementation of Plant 7 D&D | NR | NR | NR | 1994 Annual Report | Fernald |
| Organization | Formed a three-site P2 Data Tracking Team to identify data tracking elements | NR | NR | NR | 1994 Annual Report | K-25 |
| Awareness/Training | Advertised waste minimization slogans on mugs and recycling bins, promoted employee awareness at staff meetings, and sponsored Earth Day display | NR | NR | NR | 1991-1992 Annual Report | Rocky Flats |
| Awareness/Training | Developed articles, displays, and a videotape to increase employee awareness | NR | NR | NR | 1993 Annual Report | Rocky |
| Awareness/Training | Developed a book of P2 success stories and participated in a public Earth Day Celebration | NR | NR | NR | 1993 Annual Report | Hanford |

Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--------------------|--|------------------|---------------------|---------------------|--------------------|------------|
| Awareness/Training | Developed a charge-back system based on waste generation to make generators more aware of the need to reduce waste and to fund additional waste minimization efforts | NR | NR | NR | 1993 Annual Report | LANL |
| Awareness/Training | Began publishing "Reuse News" in May 1994 | NR | NR | NR | 1994 Annual Report | Fernald |
| Awareness/Training | Initiated the charge-back program | NR | NR | NR | 1994 Annual Report | LANL |
| Awareness/Training | Conducted seminars on P2 and held open-panel discussions on source reduction, recycling, and P2 | NR | NR | NR | 1993 Annual Report | K-25 |
| Awareness/Training | Held a Pollution Prevention Awareness Month and presented project awards | NR | NR | NR | 1993 Annual Report | K-25 |
| Awareness/Training | Established a "Pollution Prevention Awareness Month," an idea/suggestion hotline, and a surplus material exchange program and participated in "Adopt-a-Highway" and the Environmental Fair | NR | NR | NR | 1993 Annual Report | K-25 |
| Awareness/Training | Supplied pamphlets and signs for P2 reduction to waste generators | NR | NR | NR | 1993 Annual Report | K-25 |
| Awareness/Training | Established recycling programs | NR | NR | NR | 1993 Annual Report | Portsmouth |
| Awareness/Training | Conducted P2 campaigns that coincide with Earth Day | NR | NR | NR | 1993 Annual Report | Portsmouth |
| Awareness/Training | Established numerous recycling programs | NR | NR | NR | 1994 Annual Report | Y-12 |
| Awareness/Training | Established a P2 celebration month and issued a year-long "Pollution Solutions" newsletter | NR | NR | NR | 1994 Annual Report | Y-12 |
| Awareness/Training | Coordinated outreach activities that included sponsoring a booth at the Environmental Fair and presentations at local schools to increase P2 awareness | NR | NR | NR | 1994 Annual Report | Y-12 |

NR = not reported

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Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--------------------|--|------------------|---------------------|---------------------|-------------------------|------------|
| Awareness/Training | Established a strong recycling program | NR | NR | NR | 1993 Annual Report | Paducah |
| Awareness/Training | Implemented a recycling program with over 95% participation rate | NR | NR | NR | 1994 Annual Report | Portsmouth |
| Awareness/Training | Instituted an employee awareness program | NR | NR | NR | 1994 Annual Report | Portsmouth |
| Awareness/Training | Initiated and implemented recovery and recycling programs and also implemented 12 projects involving source reduction | NR | NR | NR | 1993 Annual Report | Y-12 |
| Awareness/Training | Sponsored a booth at the Environmental Fair and conducted a campaign to encourage P2 at home, work, and in the community | NR | NR | NR | 1993 Annual Report | Y-12 |
| Awareness/Training | Issued a P2 awareness newsletter and placed P2 hints/tips on the computerized information system | NR | NR | NR | 1993 Annual Report | Y-12 |
| Awareness/Training | Conducted a Site P2 Awareness Month | NR | NR | NR | 1994 Annual Report | K-25 |
| Awareness/Training | Presented a waste minimization and recycling program to a local area high school | NR | NR | NR | 1994 Annual Report | K-25 |
| Awareness/Training | Participated in the Environmental Fair to gain an understanding of the environmentally related work that takes place on the ORR | NR | NR | NR | 1994 Annual Report | K-25 |
| Awareness/Training | Conducted a mini fair on recycled products | NR | NR | NR | 1994 Annual Report | K-25 |
| Awareness/Training | Initiated Pollution Prevention and Waste Minimization Awareness Program with video, waste minimization article publication, "reuse days", Earth Week activities, employee awards, training, and community outreach | NR | NR | NR | 1991 1992 Annual Report | Fernald |

NR = not reported

Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--------------------|--|------------------|---------------------|---------------------|-------------------------|---------|
| Awareness/Training | Incorporated waste minimization concepts in waste generator training and an overall increased employee awareness of waste minimization/pollution prevention concepts | NR | NR | NR | 1991-1992 Annual Report | ORNL |
| Awareness/Training | Sponsored awareness training | NR | NR | NR | 1991-1992 Annual Report | SRS |
| Awareness/Training | Enhanced Training and Public Outreach Programs, including pollution prevention awareness training as part of new employee orientation | NR | NR | NR | 1991-1992 Annual Report | INEL |
| Awareness/Training | Provided training, incentive awards, and articles to increase awareness and support of the need for pollution prevention | NR | NR | NR | 1993 Annual Report | LANL |
| Awareness/Training | Distributed "Prevent" newsletter and provided additional training, presentations, and assistance programs | NR | NR | NR | 1993 Annual Report | INEL |
| Awareness/Training | Developed a WM/P2 Policy, added a WM awareness section to General Employee Training, developed an educational program for engineers and project managers, and advertised WM at Earth Week activities | NR | NR | NR | 1993 Annual Report | Fernald |
| Awareness/Training | Included P2 training in General Employee Training, developed a P2 awareness program including awards and recognition, information exchange, and training; provided PPOA training; and published "ORNL Recyclers" quarterly | NR | NR | NR | 1993 Annual Report | ORNL |
| Awareness/Training | Developed and implemented P2 Awareness Training for K-25 Site Managers | NR | NR | NR | 1994 Annual Report | K-25 |
| Awareness/Training | Developed waste minimization orientation training for all new employees and managers | NR | NR | NR | 1991-1992 Annual Report | LANL |

NR = not reported

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Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--------------------|--|------------------|---------------------|---------------------|-------------------------|------------|
| Awareness/Training | Performed process waste assessment training for waste minimization coordinators and upper management | NR | NR | NR | 1991-1992 Annual Report | INEL |
| Awareness/Training | Performed process waste assessments | NR | NR | NR | 1991-1992 Annual Report | Y-12 |
| Awareness/Training | Performed waste generator waste minimization training | NR | NR | NR | 1991-1992 Annual Report | Paducah |
| Awareness/Training | Performed waste minimization training for over 95% of employees | NR | NR | NR | 1991-1992 Annual Report | Portsmouth |
| Awareness/Training | Sponsored multiple waste minimization training courses | NR | NR | NR | 1993 Annual Report | Rocky |
| Awareness/Training | Provided P2 and Facility Design training to engineers and project managers | NR | NR | NR | 1993 Annual Report | Hanford |
| Awareness/Training | Incorporated WM Applications and Life-Cycle Cost Analysis into Site Engineer Training program | NR | NR | NR | 1994 Annual Report | Fernald |
| Awareness/Training | Tailored P2 training to D&D/ER personnel | NR | NR | NR | 1994 Annual Report | Hanford |
| Awareness/Training | Developed and implemented training modules for P2, waste assessment, and recycling | NR | NR | NR | 1993 Annual Report | K-25 |
| Awareness/Training | Established P2 and waste minimization training | NR | NR | NR | 1993 Annual Report | Portsmouth |
| Awareness/Training | Developed and implemented P2 training programs | NR | NR | NR | 1994 Annual Report | Y-12 |
| Awareness/Training | Conducted training for P2 and waste minimization | NR | NR | NR | 1993 Annual Report | Paducah |
| Awareness/Training | Trained division employees in "P2 - The Bottom Line" | NR | NR | NR | 1994 Annual Report | K-25 |
| Tools Development | Developed more user friendly process waste assessment methodology | NR | NR | NR | 1991-1992 Annual Report | LANL |

Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|-------------------|---|------------------|---------------------|---------------------|-------------------------|---------|
| Tools Development | Established a computerized waste tracking system to provide information necessary for waste minimization analyses | NR | NR | NR | 1991-1992 Annual Report | Y-12 |
| Tools Development | Developed a PPOA software tool to assist in option analysis and cost benefit analysis | NR | NR | NR | 1993 Annual Report | LANL |
| Tools Development | Participated in efforts to develop a PPOA database and cost modeling effort | NR | NR | NR | 1993 Annual Report | LANL |
| Tools Development | Developed a computer-based waste minimization program and produced a site WM video | NR | NR | NR | 1993 Annual Report | SRS |
| Tools Development | Developed WM criteria into "lines of inquiry" to provide a mechanism for generator self-assessment | NR | NR | NR | 1994 Annual Report | SRS |
| Tools Development | Updated P2 database and established a P2 success database | NR | NR | NR | 1993 Annual Report | K-25 |
| Tools Development | Developed a P2 database to track the status, cost, etc., of the various P2 projects and activities for Y-12 | NR | NR | NR | 1993 Annual Report | Y-12 |
| Incentives | Established a Waste Minimization Incentive Award Program | NR | NR | NR | 1991-1992 Annual Report | LANL |
| Incentives | Offered employee awards for pollution prevention | NR | NR | NR | 1993 Annual Report | Rocky |
| Incentives | Presented awards to winners of contests with themes of P2 awareness, source reduction, and training | NR | NR | NR | 1993 Annual Report | K-25 |
| Incentives | Presented 12 P2 awards for numerous accomplishments | NR | NR | NR | 1994 Annual Report | K-25 |
| Material Control | Eliminated all non-essential MLLW generating processes in response to the MLLW moratorium (for liquid, solid, and process wastewater) | NR | NR | NR | 1993 Annual Report | INEL |
| Material Control | Developed program to review all requisitions for toxic or hazardous chemicals to identify possible non-hazardous or non-toxic substitutes | NR | NR | NR | 1994 Annual Report | Fernald |

NR = not reported

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Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--|---|------------------|---------------------|---------------------|--------------------|------------|
| Material Control | Conducted treatment demonstrations that reduced the waste generated as well as a significant savings for treatment, storage, and disposal | NR | NR | NR | 1994 Annual Report | Portsmouth |
| Material Control | Donated used computer equipment to a local area high school for reuse | NR | NR | NR | 1994 Annual Report | K-25 |
| Material Control | Identified processes and activities generating waste in each division | NR | NR | NR | 1994 Annual Report | K-25 |
| Information Exchange | Joined forces and offered a video conference to provide information on the challenges of developing markets for the growing quantities of recycled materials in the country | NR | NR | NR | 1993 Annual Report | Y-12 |
| Information Exchange | Established a formal P2 council to promote P2 activities within their organizations and with the other sites on the ORR | NR | NR | NR | 1993 Annual Report | Y-12 |
| Information Exchange | Met with area companies to benchmark P2 opportunities | NR | NR | NR | 1993 Annual Report | Y-12 |
| Information Exchange | Conducted a special study on alternatives to the current disposal practice of burning used oil as hazardous waste at the K-25 Site TSCA Incinerator | NR | NR | NR | 1993 Annual Report | Y-12 |
| CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act | | | | | | |
| D&D = decontamination and decommissioning | | | | | | |
| INEL = Idaho National Engineering Laboratory | | | | | | |
| LANL = Los Alamos National Laboratory | | | | | | |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |
| ORNL = Oak Ridge National Laboratory | | | | | | |
| ORO = Oak Ridge Operations | | | | | | |
| ORR = Oak Ridge Reservation | | | | | | |
| P2 = pollution prevention | | | | | | |
| PPOA = Pollution Prevention Opportunity Assessment | | | | | | |

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Table A.1. MLLW minimization planning/administrative approaches

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|-------------------------------------|-----------------------------|------------------|---------------------|---------------------|--------|------|
| TSCA = Toxic Substances Control Act | | | | | | |
| WM = waste management | | | | | | |
| | | | | | | |
| | | | | | | |

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NR = not reported

Table A.2. MLLW minimization approaches for hazardous material use

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|-------------------|--|----------------------|---------------------|---------------------|-------------------------|---------|
| Chemical controls | Developed controls to prevent hazardous materials and organics from entering the radioactive liquid waste stream going to the radioactive liquid waste treatment plant | NR | NR | NR | 1993 Annual Report | LANL |
| Chemical controls | Evaluated all input materials containing hazardous constituents for non-hazardous substitutes | NR | NR | NR | 1991-1992 Annual Report | Paducah |
| Chemical controls | Implemented a chemical and hazardous materials control and tracking system | NR | NR | NR | 1993 Annual Report | Y-12 |
| Chemical controls | Changed to aqueous cleaners for degreasing | 165 gal | NR | NR | 1993 Annual Report | K-25 |
| Chemical controls | Replaced methylene chloride with ultrasonic cleaners | 300 gal | NR | NR | 1993 Annual Report | K-25 |
| Chemical controls | Replaced oil-based with soy-based inks | 0.236 m ³ | NR | NR | 1994 Annual Report | K-25 |
| Chemical controls | Substituted reusable lead plates for lead packaging used to package film in radiographic work for well testing | NR | NR | NR | 1993 Annual Report | K-25 |
| Chemical controls | Switched to a non-hazardous paint stripper | 550 gal | NR | NR | 1994 Annual Report | LANL |
| Chemical controls | Substituted a non-hazardous reagent for health and safety sampling and analysis | 1,100 gal | NR | NR | 1993 Annual Report | LANL |
| Chemical controls | Changed out 3117 gal of RCRA oils, replacing with non-RCRA oils | NR | NR | NR | 1993 Annual Report | Y-12 |
| Chemical controls | Eliminated the use of toluene diisocyanate | NR | NR | NR | 1993 Annual Report | Y-12 |

Table A.2. MLLW minimization approaches for hazardous material use

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|---|--|---------------------|---------------------|---------------------|-------------------------|------------|
| Chemical controls | Replaced "Kathene" containing chromates with chromate free "Kathene" (previously used as a rust inhibitor)- liquid | 1.42 m ³ | NR | NR | 1994 Annual Report | Y-12 |
| Chemical controls | Replaced "Kathene" containing chromates with chromate free "Kathene" (previously used as a rust inhibitor)- solid | 163 m ³ | NR | NR | 1994 Annual Report | Y-12 |
| Chemical controls | Substituted non-hazardous solvent in foam gun cleaning operations | 1.53 m ³ | NR | NR | 1994 Annual Report | Y-12 |
| Chemical controls | Replaced freon 113 with non-hazardous detergents for metal degreasing | NR | NR | NR | 1993 Annual Report | Y-12 |
| Chemical controls | Replaced solvent degreasers with ultrasonic cleaners and non-hazardous solvents | NR | NR | NR | 1993 Annual Report | Y-12 |
| Chemical controls | Initiated a hazardous material substitution program | NR | NR | NR | 1991-1992 Annual Report | Portsmouth |
| LANL = Los Alamos National Laboratory | | | | | | |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |
| RCRA = Resource Conservation and Recovery Act | | | | | | |

Table A.3. MLLW minimization approaches for laboratory activities

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--|--|----------------------|---------------------|---------------------|--------------------|---------|
| Equipment modification | Replaced the use of tape with a permanent Velcro strap to restrain sample containers during mixing in the laboratory | 0.6 m ³ | \$46,193 | 0 | 1994 Annual Report | Hanford |
| Equipment modification | Installed Automatic Digestion System to reduce acid used and released per digestion | 0.35 m ³ | NR | NR | 1994 Annual Report | K-25 |
| Equipment modification | Installed discharge mass spec instrument for urine analysis. New equipment requires no photographic plates and developing solutions eliminate 67% of corrosive waste and reduce labor by 50% | 0.53 m ³ | \$27/sample | NR | 1994 Annual Report | Y-12 |
| Equipment modification | Installed electrolytic silver recovery units on photographic processing units | 2,000 gal | NR | NR | 1993 Annual Report | K-25 |
| Reuse | Identified a method to reuse shielding from a gamma counting chamber | 0.453 m ³ | NR | NR | 1994 Annual Report | SRS |
| Reuse/recycle | Recycled and reused acid for cleaning glassware | 4.13 m ³ | \$91,600 | NR | 1994 Annual Report | Y-12 |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |

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Table A.4. MLLW minimization approaches for equipment maintenance

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--|---|---------------------|---------------------|---------------------|-------------------------|-------------|
| Equipment modification | Developed a new method with a closed recirculating loop to reduce the waste generation by 98% when calibrating the liquid waste flow meters at the TSCA Incinerator | 2,570 gal | NR | NR | 1991-1992 Annual Report | K-25 |
| Equipment modification | Installed a filtration system on six chillers, eliminating the need to annually change out the oil (contaminated with freon) | 360 gal | NR | NR | 1993 Annual Report | Rocky Flats |
| Equipment modification | Replaced filter paper take up rolls with reusable filter belts | 289 ft ³ | NR | NR | 1993 Annual Report | SRS |
| Equipment modification | Replace hydraulic with electric centrifuges, eliminating waste hydraulic oil | 200 gal | NR | NR | 1994 Annual Report | Y-12 |
| Reuse/recycle | Recycled ethylene glycol | 250 gal | NR | NR | 1993 Annual Report | Y-12 |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |
| SRS = Savannah River Site | | | | | | |
| TSCA = Toxic Substances Control Act | | | | | | |

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Table A.5. MLLW minimization approaches for facility maintenance

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--|---|--------------------|---------------------|---------------------|-------------------------|------------|
| Process modification | Determined that a building was overfiltered and overcirculated, allowing a reduction in air filter waste | 80% | \$180,000 | \$250,000 | 1994 Annual Report | ORNL |
| Process modification | Terminated the use of saw dust and oil as a dust suppressant for floor sweeping (especially reducing PCB mixed waste) | NR | NR | NR | 1991-1992 Annual Report | Portsmouth |
| Process/equipment modification | Modified surge tank to eliminate overflow, eliminating floor solution waste | 0.3 m ³ | NR | NR | 1993 Annual Report | Hanford |
| Process modification | Performed in-container neutralization of zinc bromide at the staging area | 3.4 m ³ | NR | NR | 1994 Annual Report | SRS |
| Reuse | Settled and reused paint thinner | 990 gal | NR | NR | 1991-1992 Annual Report | K-25 |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |
| ORNL = Oak Ridge National Laboratory | | | | | | |
| SRS = Savannah River Site | | | | | | |

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Table A.6. MLLW minimization approaches for waste management activities

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|------------------------|--|---------------------|---------------------|---------------------|-------------------------|------------|
| Divert stormwater | Diverted stormwater from entering the mixed waste tank system | 41.4 m ³ | \$132,000 | \$480,000 | 1994 Annual Report | Hanford |
| Divert stormwater | Diverted stormwater run-off from entering waste tank and mixing with mixed waste by altering asphalt slope | 38 m ³ | \$750,000 | NR | 1993 Annual Report | Hanford |
| Divert stormwater | Closed coal yard and rerouted steam plant roof drains to reduce influent into the CNF | NR | NR | NR | 1993 Annual Report | K-25 |
| Equipment modification | Installed a more efficient water flushing system for railcar loading operations | 16,00 L | \$0 | \$44,000 | 1994 Annual Report | Hanford |
| Equipment modification | Installed a "Brine Cell" to oxidize cyanide-bearing solution rather than adding sodium hypochlorite, which results in eight times the volume of waste | NR | NR | NR | 1993 Annual Report | Y-12 |
| Process modification | Revised permit to allow waste storage longer than 90 days, thereby reducing the frequency of emptying the waste tank and reducing handling related waste such as PPE, rinsate, and decontamination materials | 7.6 m ³ | \$200,000 | NR | 1993 Annual Report | Hanford |
| Process modification | Installed sump/filtration/pipeline to replace 350-gal polypropylene tanks for transportation of MLLW to CNF, reducing sampling waste | 2.63 m ³ | NR | NR | 1994 Annual Report | K-25 |
| Process modification | Discontinued coagulation treatment of steam plant wastewater, reducing MLLW sludge | 11.4 m ³ | NR | NR | 1994 Annual Report | K-25 |
| Process modification | Terminated Liquid Effluent Control Facility operations, eliminating sludge | NR | NR | NR | 1991-1992 Annual Report | Portsmouth |

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Table A.6. MLLW minimization approaches for waste management activities

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|----------------------|---|--------------------|---------------------|---------------------|--------------------|-------------|
| Process modification | Eliminated use of powdered activated carbon from wastewater treatment facility by changing monitoring methods | 5,700 kg | NR | NR | 1993 Annual Report | Rocky Flats |
| Process Modification | Neutralized waste using in-stock chemicals and disposed of LLW versus MLLW | 46 ft ³ | NR | NR | 1993 Annual Report | SRS |
| Process modification | Eliminated direct steam heating of bioreactor, eliminating condensate waste | 25,000 gal | NR | NR | 1993 Annual Report | Y-12 |
| Process modification | Made modifications to the treatment facilities to reduce generation of sludges | 227 m ³ | NR | NR | 1994 Annual Report | Y-12 |
| Segregation | Segregated hazard waste (aerosol cans) from LLW containers | 120 m ³ | \$354,820 | 0 | 1994 Annual Report | Hanford |
| Segregation | Implemented sampling and analysis program to segregate hazardous contaminant containing samples from strictly radioactive samples | 1,650 gal | NR | NR | 1993 Annual Report | LANL |
| Reuse | Recovered and reused solidified Aluminum Nitrate Nonahydrate | 2.1 m ³ | \$22,900 | NR | 1993 Annual Report | Hanford |
| Reuse | Reused lead for shielding during evaporator restart | 50 ft ³ | NR | NR | 1993 Annual Report | SRS |
| Reuse (recover) | Improved radionuclide production process to allow additional radionuclides to be recovered and sold off-site | NR | \$300,000 | NR | 1993 Annual Report | LANL |
| Reuse - process | Eliminated vapor degreasing, improved the rinse and racks, and recovered and reused some bath solutions in | 200,000 gal | NR | NR | 1993 Annual Report | LANL |

Table A.6. MLLW minimization approaches for waste management activities

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--|---|------------------|---------------------|---------------------|--------------------|------|
| Reuse chemicals | Implemented a chemical clearinghouse for chemical exchange | NR | NR | NR | 1993 Annual Report | K-25 |
| Reuse chemicals | Reused chemicals from cleanup of closed areas in biodenitrification and bio-oxidation processes | NR | \$4,000 | NR | 1993 Annual Report | Y-12 |
| CNF = Central Neutralization Facility | | | | | | |
| LANL = Los Alamos National Laboratory | | | | | | |
| LLW = low-level radioactive waste | | | | | | |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |
| PPE = Personal Protective Equipment | | | | | | |
| SRS = Savannah River Site | | | | | | |

Table A.7. MLLW minimization approaches for waste treatment activities

| Option type | Waste minimization approach | Annual reduction | Annual cost savings | Implementation cost | Source | Site |
|--|---|---------------------|---------------------|---------------------|-------------------------|-------------|
| Divert stormwater | Diverted stormwater from entering the mixed waste tank system | 41.4 m ³ | \$132,000 | \$480,000 | 1994 Annual Report | Hanford |
| Divert stormwater | Closed coal yard and rerouted steam plant roof drains to reduce influent into the CNF | NR | NR | NR | 1993 Annual Report | K-25 |
| Divert stormwater | Diverted stormwater run-off from entering waste tank and mixing with mixed waste by altering asphalt slope | 38 m ³ | \$750,000 | NR | 1993 Annual Report | Hanford |
| Equipment modification | Installed a more efficient water flushing system for railcar loading operations | 1,600 L | \$0 | \$44,000 | 1994 Annual Report | Hanford |
| Equipment modification | Installed a "Brine Cell" to oxidize cyanide-bearing solution rather than adding sodium hypochlorite, which results in eight times the volume of waste | NR | NR | NR | 1993 Annual Report | Y-12 |
| Process modification | Discontinued coagulation treatment of steam plant wastewater, reducing MLLW sludge | 11.4 m ³ | NR | NR | 1994 Annual Report | K-25 |
| Process modification | Terminated Liquid Effluent Control Facility operations, eliminating sludge | NR | NR | NR | 1991-1992 Annual Report | Portsmouth |
| Process modification | Eliminated use of powdered activated carbon from wastewater treatment facility by changing monitoring methods | 5,700 kg | NR | NR | 1993 Annual Report | Rocky Flats |
| Process modification | Eliminated direct steam heating of bioreactor, eliminating condensate waste | 25,000 gal | NR | NR | 1993 Annual Report | Y-12 |
| Process modification | Made modifications to the treatment facilities to reduce generation of sludges | 227 m ³ | NR | NR | 1994 Annual Report | Y-12 |
| Treatment | Neutralized waste using in-stock chemicals and disposed of LLW versus MLLW | 46 m ³ | NR | NR | 1993 Annual Report | SRS |
| CNF = Central Neutralization Facility | | | | | | |
| LLW = low-level radioactive waste | | | | | | |
| MLLW = mixed low-level radioactive waste | | | | | | |
| NR = not reported | | | | | | |
| SRS = Savannah River Site | | | | | | |

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Appendix B
DETAILED DATA

Appendix B

DETAILED DATA

Appendix B discusses the generation rates for liquid, solid, routine, and cleanup/stabilization for the 11 study sites. This information is graphically depicted and detailed in this appendix.

B.1 Liquid MLLW Generation Rates

The liquid MLLW generation rates for the restoration sites are presented in Fig. B.1. K-25 was by far the single largest generator for three of the four years. This can be attributed to the large quantity of process wastewater associated with the Toxic Substances Control Act (TSCA) Incinerator. According to the 1991-1992 annual report, approximately 98% of the MLLW was generated by the TSCA Incinerator facility wastewaters. Hanford was the only other restoration site to report any significant generation of liquid MLLW. Hanford reported a steady increase from 1991 to 1993 and then experienced a slight decline in 1994.

The liquid MLLW generation rates for the operating sites are presented in Fig. B.2. Y-12 was the single largest generator in 1991 (2757 m³). ORNL also reported a small quantity in 1991 (9 m³). Both ORNL and Y-12 showed a steady decline in liquid MLLW generation from 1991 to 1994. LANL reported no liquid MLLW generation for 1991, 1992, 1993, and 1994, and INEL only reported 1 m³ in 1994.

B.2 Solid MLLW Generation Rates

The solid MLLW generation rates for the restoration sites are presented in Fig. B.3. Solid MLLW has remained fairly constant from 1991 through 1994 at the restoration sites. The largest generator was Hanford in both 1993 and 1994. This can be attributed to the large cleanup effort currently underway at the facility.

The solid MLLW generation rates for the operating sites are presented in Fig. B.4. Y-12 was the single largest generator of MLLW (1991). The generation of MLLW at Y-12 shows a steady decline from 1991 to 1994 (from a high of 734 m³ in 1991 to a low of 105 m³ in 1994). The generation of MLLW at INEL has fluctuated sporadically over the last 4 years. ORNL reported a decline in solid MLLW generation from 1991 to 1994.

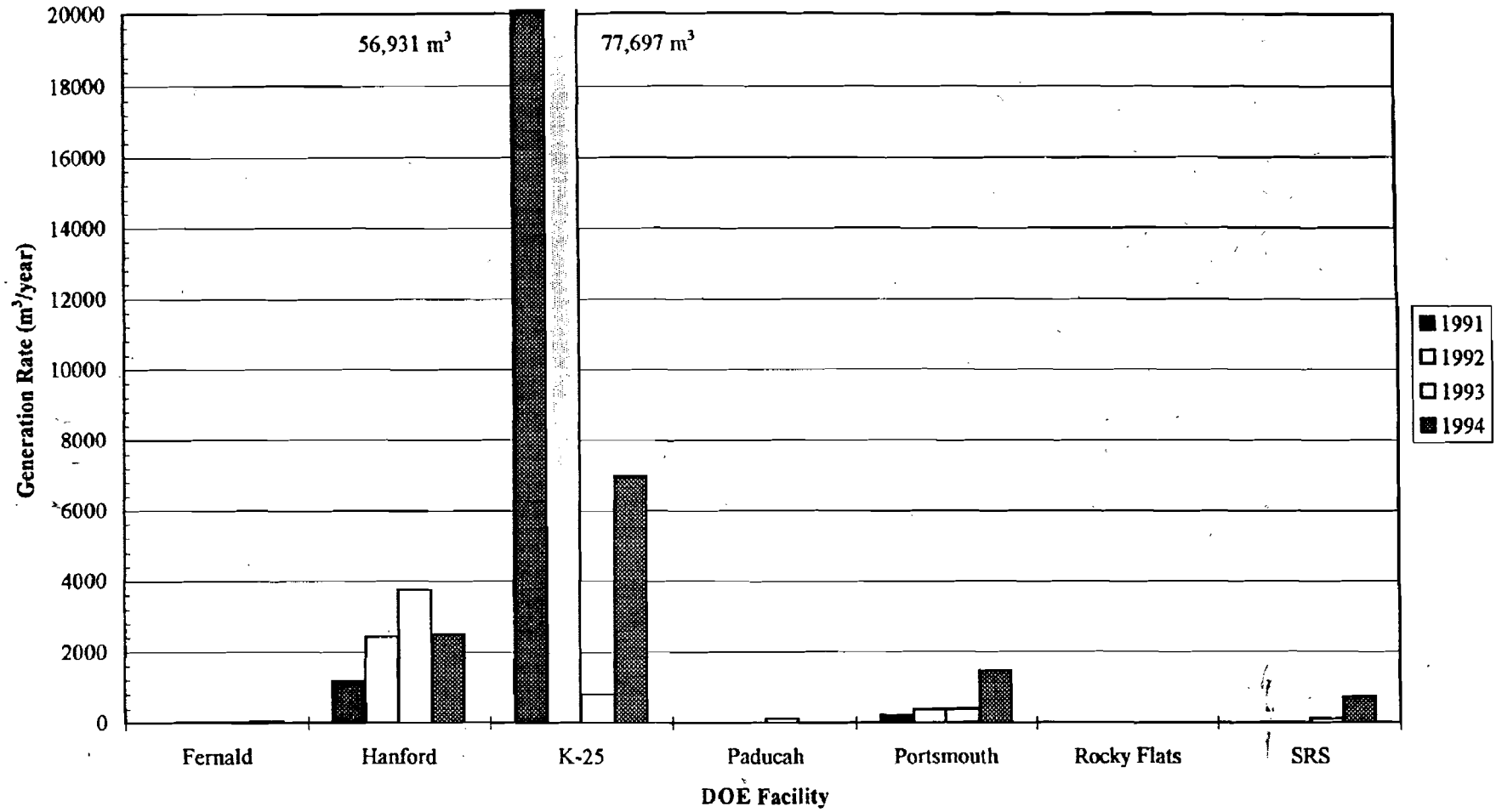


Fig. B.1. Liquid MLLW generation rates for restoration sites.*

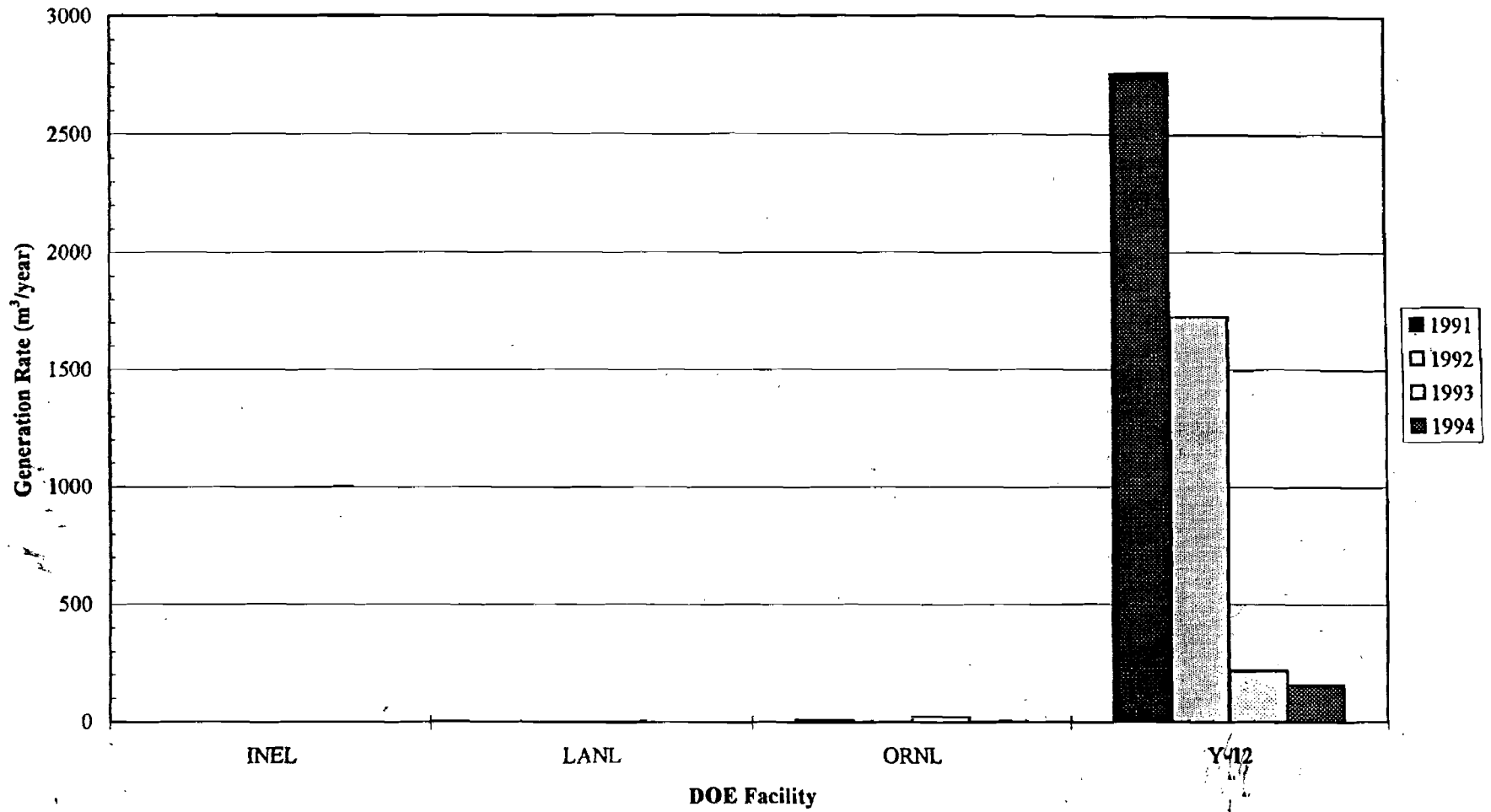


Fig. B.2. Liquid MLLW generation rates for operating sites.*

*Site waste generation amounts fluctuate with changes in activity levels.

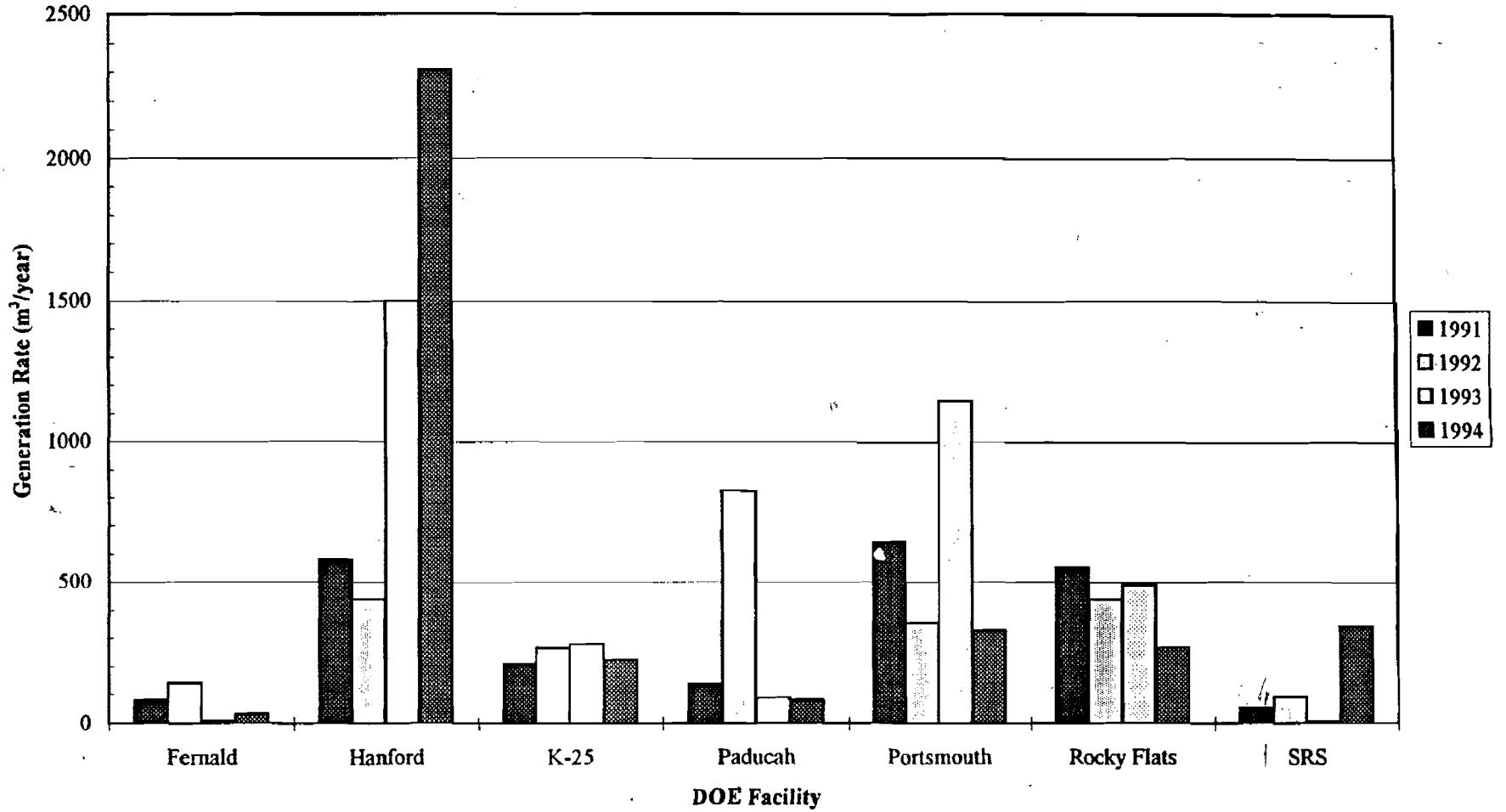


Fig. B.3. Solid MLLW generation rates for restoration sites.*

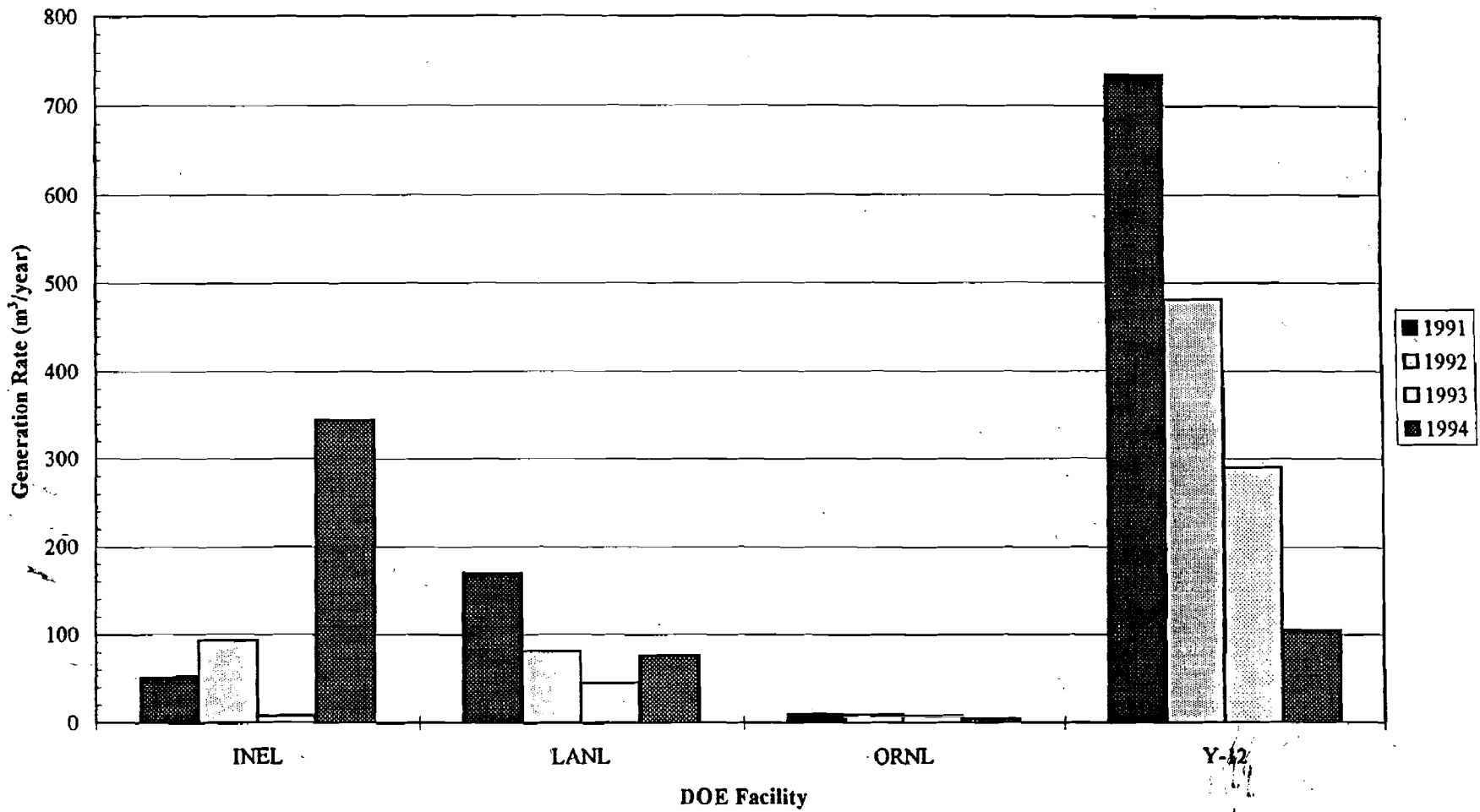


Fig. B.4. Solid MLLW generation rates for operating sites.*

*Site waste generation amounts fluctuate with changes in activity levels. For INEL, waste generation figures for 1994 reflect actual waste disposal amounts

B.3 Inventory

The inventory of MLLW is the total amount of waste in storage and disposal facilities at the site at the end of the calendar year. The inventories of MLLW at most facilities increased from 1993 to 1994, except at Fernald, ORNL, and Portsmouth. The largest inventory reduction was at Portsmouth, it dropped from 10,000 in 1993 to 4710 m³ in 1994. The reduction in inventory was due to the transfer of waste to the TSCA Incinerator for treatment. The largest inventory increase was at INEL. The inventory at INEL increased from 1140 m³ in 1993 to 78,400 m³ in 1994. This increase can be attributed to a reclassification of previously assumed TRU waste to LLW, not from the actual generation of additional waste. The inventories of MLLW at each site are presented in Fig. B.5.

B.4 Routine Generation Rates

In the 1993 and 1994 annual reports, solid MLLW was further subdivided into routine and cleanup/stabilization waste generation. The amounts for routine waste generation are shown for all sites in Figs. B.6 and B.7 for 1993 and 1994. For the operating sites, Portsmouth and SRS generated the largest quantities in 1993 and 1994 (626 m³ and 741 m³, respectively). In most cases, the operating sites typically generated, on an average, less than 200 m³ per site. Hanford, one of the restoration sites, generated the largest quantity in both 1993 and 1994. All of the restoration sites reported decreases in routine MLLW generation from 1993 to 1994.

B.5 Cleanup/Stabilization Generation Rates

Three of the operating sites decreased in cleanup/stabilization MLLW generation from 1993 to 1994 and three sites increased. The largest change was from Portsmouth, which went from 894 m³ in 1993 to 1787 m³ in 1994, whereas all of the restoration sites reported increases in cleanup/stabilization MLLW generation from 1993 to 1994. K-25 reported the largest quantity of cleanup/stabilization MLLW generated in 1994 (6694 m³). This was a 95% increase over 1993 (318 m³).

B.6 Process Wastewater Generation Rates

Large volumes of process wastewater were reported from K-25 in 1993 and 1994 and Fernald in 1993. K-25 operations primarily consist of remediation and decommissioning, and all wastewaters generated from these activities are reported as process wastewaters treated prior to discharge.

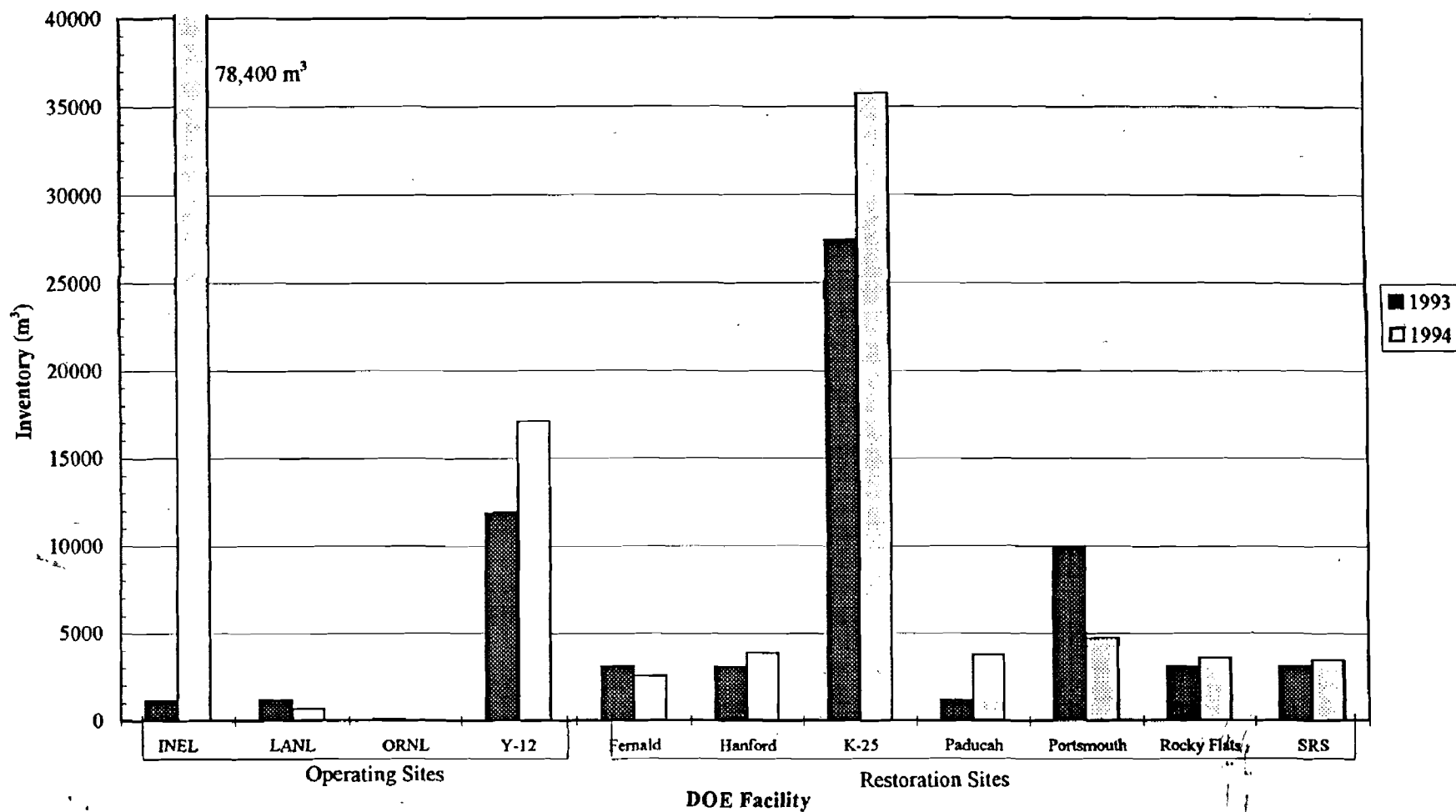


Fig. B.5. MLLW inventories for 11 DOE sites (1993-1994).

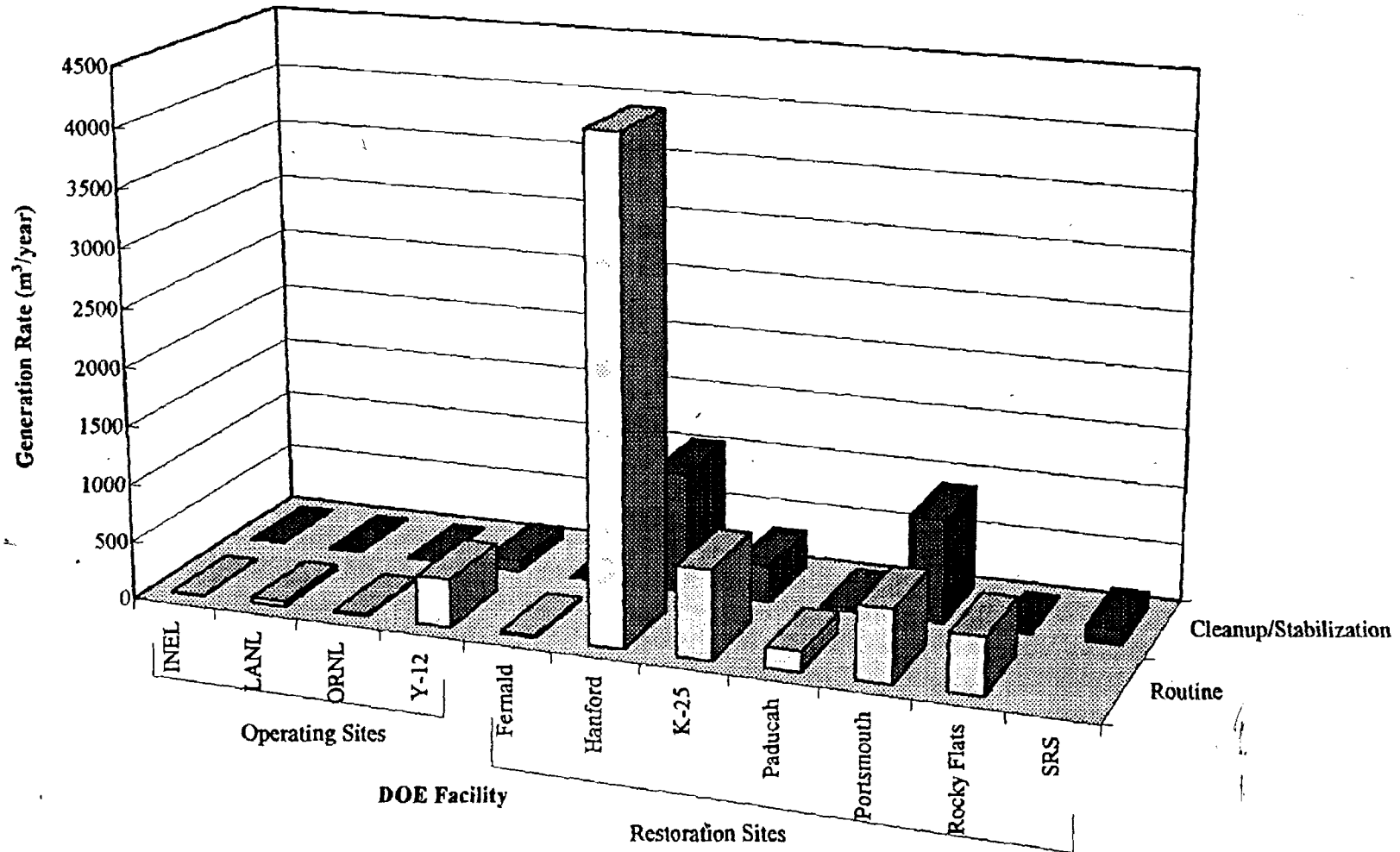


Fig. B.6. Routine versus cleanup/stabilization MLLW generation in 1993.

Appendix C
POINTS OF CONTACT

Appendix C

CASE STUDY POINTS OF CONTACT

| Generating category (in order of importance) | P2 recommendation | Case study source | Site/Program affiliation | Phone number | Fax number | Email address |
|--|---------------------------|-------------------|--------------------------|----------------|----------------|----------------------|
| Hazardous material use | Chemical traffic controls | Keith Stone | SRS | (803) 557-6317 | | KEITH.STONE@SRS.GOV |
| Laboratory activities | Equipment modification | Mary Betsch | Hanford | (509) 372-1627 | | MARY_D_BETSCH@RL.GOV |
| | Reuse | Sheila Poligone | ORR | (423) 241-2568 | (423) 241-2857 | SS9@ORNL.GOV |
| Equipment maintenance | Equipment modification | Keith Stone | SRS | (803) 557-6317 | | KEITH.STONE@SRS.GOV |
| | Material reuse | Sheila Poligone | ORR | (423) 241-2568 | (423) 241-2857 | SS9@ORNL.GOV |
| Facility maintenance | Process modification | Susan Michaud | ORR | (423) 576-1562 | (423) 241-2843 | SUN@ORNL.GOV |
| | Reuse | Susan Michaud | ORR | (423) 576-1562 | (423) 241-2843 | SUN@ORNL.GOV |
| Waste management | Sampling modification | Mary Betsch | Hanford | (509) 372-1627 | | MARY_D_BETSCH@RL.GOV |
| | Waste segregation | Mary Betsch | Hanford | (509) 372-1627 | | MARY_D_BETSCH@RL.GOV |
| | Stormwater diversion | Sheila Poligone | ORR | (423) 241-2568 | (423) 241-2857 | SS9@ORNL.GOV |
| | Equipment modification | Mary Betsch | Hanford | (509) 372-1627 | | MARY_D_BETSCH@RL.GOV |
| | Treatment modification | Keith Stone | SRS | (803) 557-6317 | | KEITH.STONE@SRS.GOV |
| | Reuse | Sheila Poligone | ORR | (423) 241-2568 | (423) 241-2857 | SS9@ORNL.GOV |

ORR = Oak Ridge Reservation
P2 = Pollution Prevention
SRS = Savannah River Site

Appendix C

POINTS OF CONTACT

| Operations office | Site/Facility name | Contact name | Telephone | Fax |
|-------------------|--|-------------------|----------------|----------------|
| AL | Grand Junction Projects Office | Dave Naske | (970) 248-6562 | (970) 248-6040 |
| AL | Inhalation Toxicology Research Institute | Mary Hall | (505) 845-1076 | (505) 845-1198 |
| AL | Kansas City Plant | Bill Schlosberg | (816) 997-3673 | (816) 997-4208 |
| AL | Los Alamos National Laboratory | Linda Malinauskas | (505) 665-8292 | (505) 665-7913 |
| AL | Pantex Plant | James Luginbyhl | (806) 477-6507 | (806) 477-7979 |
| AL | Pinellas Plant | David Moore | (813) 545-6768 | (813) 541-8370 |
| AL | Sandia National Laboratories/CA | Sally Raubfogel | (510) 294-2341 | (510) 294-3418 |
| AL | Sandia National Laboratories/NM | Kylene Molley | (505) 284-3982 | (505) 844-3747 |
| AL | UMTRA | Bennett Young | (505) 845-5664 | (505) 845-4023 |
| AL | Waste Isolation Pilot Plant | Miriam Whatley | (505) 234-8296 | (505) 885-4562 |
| CH | Ames Laboratory | Kay M. Hannasch | (515) 294-9769 | (515) 294-2155 |
| CH | Argonne National Laboratory-East | Jim Thuot | (630) 252-4911 | (630) 252-9642 |
| CH | Argonne National Laboratory-West | Debbie Krischner | (208) 533-7700 | (208) 533-7344 |
| CH | Battelle Columbus Laboratories | Jim Eide | (614) 424-3785 | (614) 424-3954 |
| CH | Brookhaven National Laboratory | Glen Todzia | (516) 344-7488 | (516) 344-3223 |
| CH | Fermi National Accelerator Laboratory | Kevin Moss | (630) 840-8203 | (630) 840-3390 |
| CH | Princeton Plasma Physics Laboratory | Mark Snyder | (609) 243-3395 | (609) 243-3366 |
| GO | National Renewable Energy Laboratory | Deborah Turner | (303) 275-4746 | (303) 275-4788 |
| HQ | Alaska Power Administration | Rob Waldman | (907) 586-7546 | (907) 586-7270 |
| HQ | Bonneville Power Administration | Rebecca Redeker | (503) 230-7603 | (503) 230-3314 |
| HQ | Morgantown Energy Technology Center | Jason M. Cook | (304) 285-4718 | (304) 285-4403 |

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Appendix C

POINTS OF CONTACT (Continued)

| Operations office | Site/Facility name | Contact name | Telephone | Fax |
|-------------------|---|------------------------|----------------|----------------|
| HQ | Naval Petroleum & Oil Shale Reserves (CO, UT, WY) | David Miles (x5071) | (307) 261-5161 | (307) 261-5817 |
| HQ | Naval Petroleum Reserves - California | Del Walker | (805) 763-6533 | (805) 763-6171 |
| HQ | Pittsburgh Energy Technology Center (PETC) | David L. Schwartz | (412) 892-6298 | (412) 892-6228 |
| HQ | Southeastern Power Administration | Jim B. Lloyd | (706) 213-3850 | (706) 213-3884 |
| HQ | Southwestern Power Administration | Dave Dossett | (918) 595-6752 | (918) 595-6656 |
| HQ | Strategic Petroleum Reserve Office (SPRO) | Eileen Hollander | (504) 734-4830 | (504) 734-4070 |
| HQ | Superconducting Super Collider Laboratory | J. D. Duskocil (x2543) | (214) 935-9000 | (214) 923-7487 |
| HQ | Western Area Power Administration | Dee Adams | (303) 275-1718 | (303) 275-1727 |
| HQ | Western Environmental Technology Office | Gene Ashby | (406) 494-7298 | (406) 494-7290 |
| HQ | Yucca Mountain Project Office | Scott A. Wade | (702) 794-5459 | (702) 794-5467 |
| ID | Idaho National Engineering Laboratory | John Griffin | (208) 526-6997 | (208) 526-1458 |
| NV | DOE Operations Office | Bob Barner | (702) 295-7500 | 701-295-6392 |
| NV | Bechtel Nevada | Amo Sanchez | (702) 295-2985 | (702) 295-5229 |
| NV | North Las Vegas Facility/Nevada Test Site | | | |
| OAK | Energy Technology Engineering Center | Karin King | (510) 637-1638 | (510) 637-1646 |
| OAK | Lawrence Berkeley National Laboratory | Shelley A. Worsham | (510) 486-6123 | (510) 486-4776 |
| OAK | Lawrence Livermore National Laboratory | John Celeste | (510) 422-1685 | (510) 422-1395 |
| OAK | Stanford Linear Accelerator Center | Richard Cellamare | (415) 926-3401 | (415) 926-3175 |
| OH | Fernald Environmental Management Project | Pete Yerace | (513) 648-3161 | (513) 648-3076 |
| OH | Mound Plant | Rob Rothman | (513) 865-3823 | (513) 865-4489 |
| OH | RMI Diffusion Plant | Scott Altmeyer | (216) 993-2018 | (216) 993-1961 |
| OH | West Valley Demonstration Project | Ahmad Al-Daouk | (716) 942-4629 | (716) 942-4703 |

Appendix C

POINTS OF CONTACT (Continued)

| Operations office | Site/Facility name | Contact name | Telephone | Fax |
|-------------------|--|---------------------|----------------|----------------|
| OH | FERMCO | Scott Osborn | (513) 648-5665 | (513) 648-5527 |
| OR | FUSRAP | Jason Darby | (423) 241-6343 | (423) 576-0956 |
| OR | Oak Ridge Institute for Science and Education | Tom Wantland | (423) 576-3333 | (423) 576-7047 |
| OR | Oak Ridge K-25 Site | Belgin Barkenbus | (423) 241-2773 | (423) 576-7668 |
| OR | Oak Ridge National Laboratory | Susan R. C. Michaud | (423) 576-1562 | (423) 241-2843 |
| OR | Oak Ridge Y-12 Plant | Sheila Poligone | (423) 241-2568 | (423) 241-2857 |
| OR | Office of Scientific and Technical Information | William T. Edmonds | (423) 576-3382 | (423) 576-2865 |
| OR | Paducah Gaseous Diffusion Plant | Howie Morehead | (502) 441-5191 | (502) 441-5177 |
| OR | Portsmouth Gaseous Diffusion Plant | Mitch Newman | (614) 897-2331 | (614) 897-6274 |
| OR | Thomas Jefferson National Accelerator Facility | Linda Even | (804) 249-7308 | (804) 249-7146 |
| OR | Weldon Spring Site Remedial Action Project | Tom Pauling | (314) 441-8086 | (314) 441-0739 |
| RL | Hanford Site | Mary Betsch | (509) 372-1627 | (509) 376-5560 |
| RL | Pacific Northwest National Laboratory | Jill Engel | (509) 372-0307 | (509) 376-6663 |
| RF | Oxnard Facility | Alder Zonarx | (303) 966-3054 | (303) 966-6406 |
| RF | Rocky Flats Environmental Technology Site | Randy Leitner | (303) 966-3537 | (303) 966-3578 |
| SR | Savannah River Site - Westinghouse | Keith Stone | (803) 557-6317 | (803) 557-6306 |

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Appendix D
LLW EVALUATION CRITERIA

Appendix D

EVALUATION CRITERIA

Decision Matrix

| | <u>Score</u> |
|--------|--------------|
| Low | 1 |
| Medium | 2 |
| High | 3 |

Criteria Definition

1. **Economic Feasibility**—The cost of implementing the option verses the cost savings resulting from that implementation.
 - a. **Low**—Cost of implementation is significantly greater than the savings derived from implementation.
 - b. **Medium**—Cost of implementation is roughly equal to savings.
 - c. **High**—Cost of implementation is much less than the savings derived from option implementation.

2. **Quantity of Reduction**—The amount of reduction in either volume or weight of the waste stream with option implementation.
 - a. **Low**—A small volume or weight reduction (0-25%).
 - b. **Medium**—A significant volume or weight reduction (26-50%).
 - c. **High**—A major volume or weight reduction (51-100%).

3. **Quantity of Generation**—The size of the waste stream at a site versus the overall LLW stream quantity.
 - a. **Low**—Less than 10% of the total LLW.
 - b. **Medium**—11-40% of the total LLW.
 - c. **High**—41-100% of the total LLW.

4. **Technical Risk**—The likelihood that an option when implemented will perform as projected.
 - a. **Low**—Risk is great that the option will not work as projected.
 - b. **Medium**—The option will probably work to reduce waste generation to some degree.
 - c. **High**—The option will work totally as provided or exceed expectations.

5. **EPA Hierarchy**—How the option meets the EPA hierarchy of source reduction, reuse/recycle, treatment, and disposal.
 - a. **Low**—Disposal and treatment.
 - b. **Medium**—Reuse/Recycling.
 - c. **High**—Source reduction.

6. **Compliance**—The options ability to meet federal, state, and local laws and regulations and also comply with DOE orders and regulations.
 - a. **Low**—Does not comply with local, state, or federal laws and regulations.
 - b. **Medium**—Complies with laws and regulations but must have a DOE order change in order to implement.
 - c. **High**—Complies with all laws, regulations, and DOE orders.