Idaho National Engineering Laboratory

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Potential Pollution Prevention and Waste Minimization for Department of Energy Operations

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Potential Pollution Prevention and Waste Minimization for Department of Energy Operations

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Roger Scott, Department Manager — 10-19-95 Date

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Chris Ischay — 10-19-95 Date

EXECUTIVE SUMMARY

With the tightening of budgets and limited resources, it is important to ensure operations are carried out in a cost-effective and productive manner. Implementing an effective Pollution Prevention strategy can help to reduce the costs of waste management and prevent harmful releases to the environment. This document provides an estimate of the Department of Energy's waste reduction potential from the implementation of Pollution Prevention opportunities. A team of Waste Minimization and Pollution Prevention professionals was formed to collect the data and make the estimates. The report includes a list of specific reduction opportunities for various waste generating operations and waste types. A generic set of recommendations to achieve these reduction opportunities is also provided as well as a general discussion of the approach and assumptions made for each waste generating operation. The results of this evaluation are located in Table 1.

CONTENTS

TABLE

ACRONYMS

BDAT	Best Demonstrated Available Technology
BEMR	Baseline Environmental Management Report
CFC	chlorofluorocarbons
CFR	Code of Federal Regulations
CHC	chlorinated hydrocarbons
DOE	U.S. Department of Energy
EM	U.S. Department of Energy, Assistant Secretary for Environmental Management
ER	Environmental Restoration
FY	Fiscal Year
HLW	high-level waste
HAZ	hazardous waste
INEL	Idaho National Engineering Laboratory
IWPF	Idaho Waste Processing Facility
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LLW	low-level waste
MLLW	Mixed low-level waste
MOA	Memorandum of Agreement
NiCad	nickel cadmium
ORR	Oak Ridge Reservation
P2	Pollution Prevention
PPOA	pollution prevention opportunity assessment
RBA	radiological buffer area
RCA	radioactive control area
RCRA	Resource Conservation and Recovery Act
RL	radioluminescent
TDD	Task Description Document
TRU	transuranic
TSCA	Toxic Substance Control Act
WMin	Waste Minimization

Potential Pollution Prevention and Waste Minimization for Department of Energy Operations

1. INTRODUCTION

The Waste Minimization Division (EM-334) of the U.S. Department of Energy (DOE), directed the Idaho National Engineering Laboratory (INEL) to lead a cross-complex project to determine the potential range of volume reduction for various DOE facilities due to pollution prevention (P2) and waste minimization (WMin) activities.

This report contains those potential reduction ranges and provides limited data to identify, prioritize, and estimate the potential volume reductions from WMin/P2 activities.

The information contained in this report is one of many pieces of information used to support the EM-30 waste minimization milestone within the U.S. Department of Energy, Assistant Secretary for Environmental Management (EM) strategic plan, which states:

> "EM-30 [will] determine the potential for Waste Management Cost Savings from Waste Minimization and Pollution Prevention at DOE facilities by 9/95."

1.1 Purpose of This Document

This document presents the potential reduction possible through P2 and WMin. The methods used to determine the potential reduction ranges possible for various DOE waste generating processes are also described. The analysis and results are presented by waste generating activity and waste type. A list of recommended actions for both the field operations and DOE is included.

The P2 and WMin activities noted within this document are not meant to be an all inclusive or exhaustive list by any means. Many excellent P2 and WMin activities that have been developed and implemented within DOE and other government agencies are not included within this document. Many additional P2 activities have been implemented since its publication. And many more will be developed throughout the course of DOE operations.

2. CONTENTS OF THE REPORT

This report contains the following information:

- Description of the approach
- Summary of the results
- Actions which DOE and its contractors may take to help achieve the reduction range
- A detailed presentation of the information gathered by the participating core team. This is divided into the following:
  - Waste type
  - Potential reduction range
  - Rationale behind the reduction range
  - Actions which the field can take to achieve the reduction range
- Appendices giving detailed examples of WMin/P2 activities which further support the rationale.

3. APPROACH

The following section describes the approach used by each of the core sites to determine the potential reduction range.

3.1 Core Team Members

EM-334 initiated the Potential Reduction Range Project to analyze WMin/P2 information associated with the DOE waste generating processes. A team of WMin/P2 professionals was formed with representatives from the following sites:

- Idaho National Engineering Laboratory (INEL)
- Kansas City Plant (KCP)
- Los Alamos National Laboratory (LANL)
- Oak Ridge Reservation (ORR).

This team collectively developed a method for determining the potential reduction ranges possible from WMin/P2.

Each of the site representatives was responsible for a different analysis within the report. KCP had responsibility for developing the range, rationale, and actions for waste operations hazardous waste (HAZ). ORR had responsibility for developing the range, rationale, and actions for low-level waste (LLW), mixed low-level waste (MLLW), transuranic waste (TRU), and high-level waste (HLW). LANL had responsibility for developing the range, rationale, and actions for all deactivation and stabilization waste types. INEL had responsibility for developing the range, rationale, and actions for all transitional activities waste types. Spent nuclear fuel was not covered in this report.

3.2 Methodology

Each participant was asked to determine the potential reduction range possible as a result of WMin/P2 for each of their assigned waste types. The information was to include high- and low-range reduction potentials, assumptions used in determining the ranges, the rationale behind the ranges, and actions that the field and DOE could take to achieve these ranges.

The 1995 Baseline Environmental Management Report (BEMR) lists six waste types that DOE must manage over the next 40 years. These are: (a) hazardous, (b) low-level, (c) mixed low-level, (d) transuranic, (e) high-level waste, and (f) spent nuclear fuel. Potential reduction ranges were determined for each waste type (excluding spent nuclear fuel), by operations activities.

Two methodologies were used in determining the range.

The first methodology used information gathering, analysis, and extrapolation to determine the potential reduction range. Information gathered included successful implementation of waste minimization techniques at various DOE sites, preliminary results from case studies being conducted at various DOE sites, site surveys which asked for an accounting of waste minimization accomplishments during Fiscal Year (FY)94–FY95, and examining facility-specific Memorandum of Agreements (MOA).

Additionally, other existing tools and information were utilized in this effort. These included helpful information was derived from: (a) Pollution Prevention Opportunity Assessments (PPOAs) conducted on processes unique to particular projects, (b) P2 facility design checklists, (c) meeting notes from the WMin/P2 Tools Workshop, Performance and Tracking Parameters Working Group (held July 19 and 20, 1994) and (d) the "Draft Input for Development of Pollution Prevention and Waste Minimization Guidance for Environmental Restoration Activities." A literature search for any other relevant information was also conducted. Resources and successes both within and outside the DOE complex were studied.

As a final check on the validity of the reduction estimates an informal survey of personnel active in WMin and waste management, Environmental Restoration (ER), and deactivation and stabilization was conducted. Also, interviews were held with individuals from commercial waste treatment, decontamination, and recycling companies. Although there was not a complete consensus that the estimates were totally valid, there did seem to be a general feeling that the estimates were reasonable.

The second methodology was used exclusively on waste operations low-level, mixed low-level, transuranic, and high-level wastes. This entailed conducting a telephone survey with P2 site coordinators at each of the primary waste generators as depicted in the BEMR. The P2 site coordinators were requested to provide documentation on P2 options implemented and completed PPOAs. The principal sites contacted were ORR, Savannah River Site (SRS), Hanford Site, and INEL. The documentation provided by each site was then aggregated by waste type. An analysis was conducted on every P2 project document submitted to determine four data points: (a) estimated volume reduction, (b) estimated percent of waste reduction, (c) estimated P2 implementation cost, and (d) the estimated cost savings. The volume reduction data points were then averaged for each waste type, when sufficient data existed, to enable development of an estimated range, a mean value, and the range of those projects which fall within a 95% confidence interval for each waste type.

Because of the sample size used in this method, some of the ranges are much higher than may be truly practical. The range potential using this methodology is much more accurate over common projects, but in reality, reflects a less accurate range for the true nature of the complex as a whole.

3.3 Results

Table 1 displays the low, mean, and high potential reduction percentages possible due to WMin/P2. The rationale behind how the ranges were determined is described in detail in Sections 4, 5, and 6. Waste Operations (WO), Environmental Restoration (ER), and transition (T) are listed as sources.

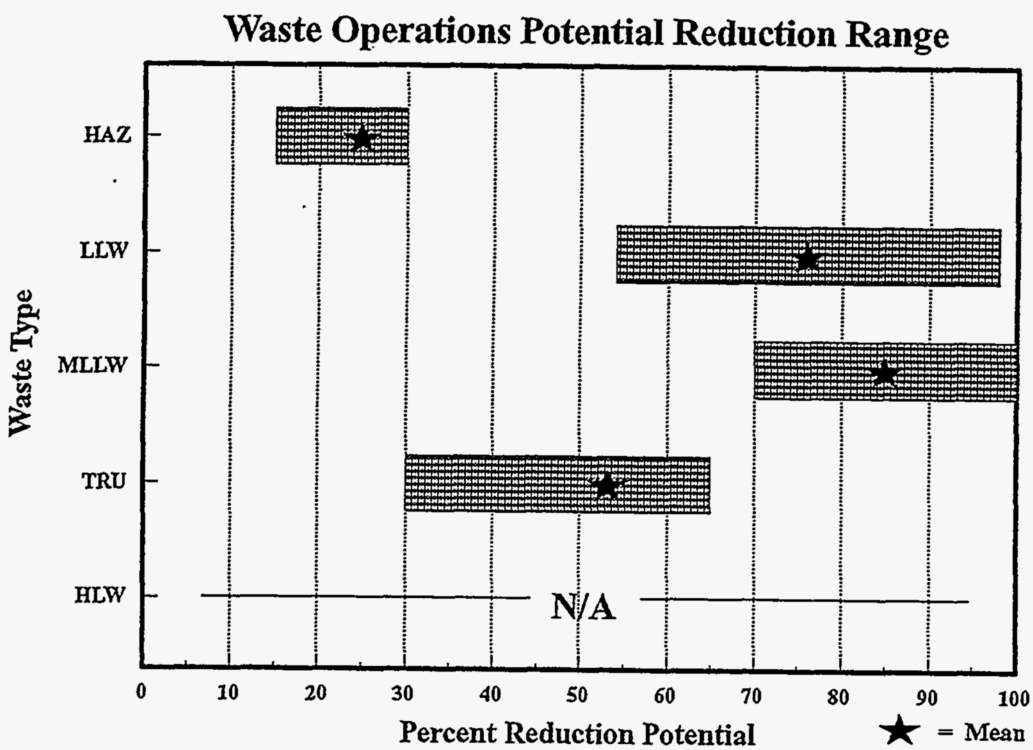
Ranges marked "N/A" may indeed have possible, potential reductions; however, not enough information is available at this time to determine a reduction range. Within the body of this document, each waste category contains an explanation as to why there was or was not a range associated with a waste type.

The calculations of Mean reduction for waste operations LLW and TRU are located in Sections 4.2.1 and 4.4.1 respectively. The mean number for all other ranges is based on averages.

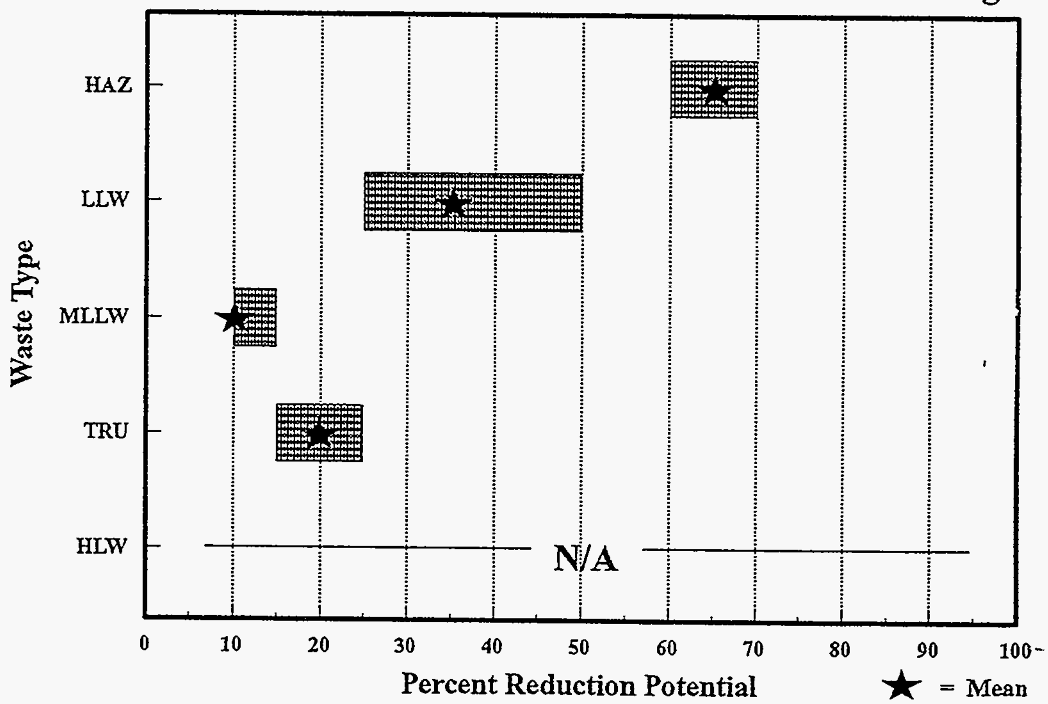
Represented graphically, each waste generating activity has a potential reduction range. On the following three graphs, the star indicates the mean possible for that particular waste type. The mean and how it was calculated, is described in the previous section.

Table 1. Low, Mean, and High Potential Reductions (by%).

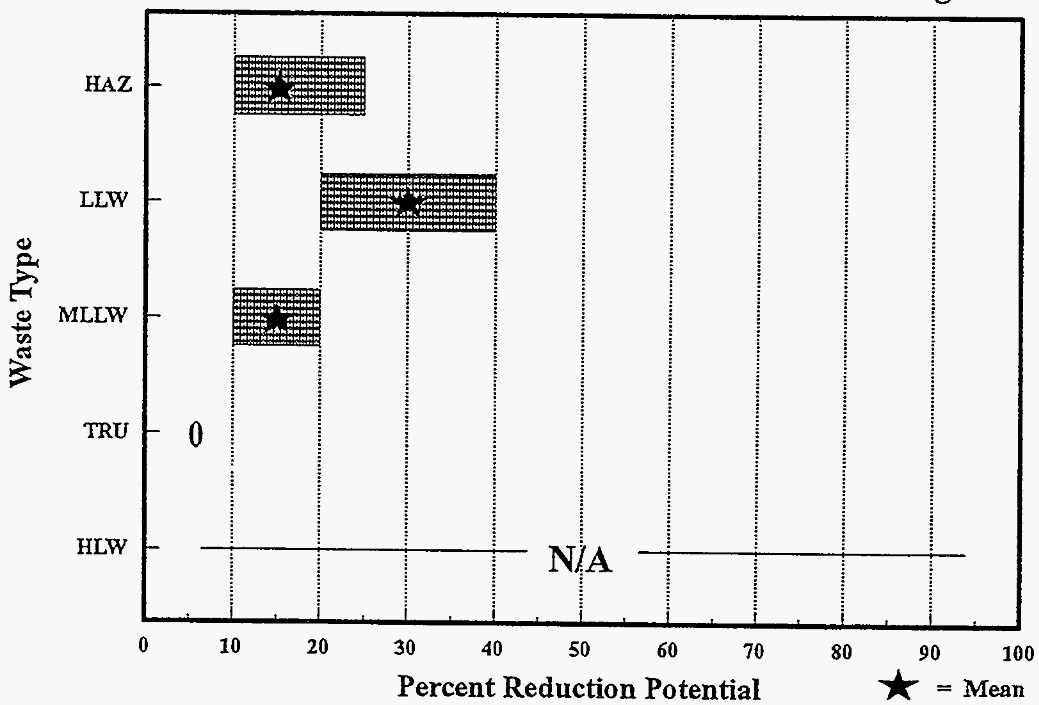
Source	HAZ%	LLW%	MLLW%	TRU%	HLW%
WO - Low	15	54	70	30	N/A
-Mean	25	76	85	53	N/A
-High	30	98	100	65	N/A
ER -Low	60	25	10	15	N/A
-Mean	65	35	10	20	N/A
-High	70	50	15	25	N/A
T -Low	10	20	10	0	N/A
-Mean	15	30	15	0	N/A
-High	25	40	20	0	N/A



Environmental Restoration Potential Reduction Range



Transition Activities Potential Reduction Range



3.4 Potential DOE Actions

Sections 4, 5, and 6 contain the actions each site can take to help achieve the ranges listed in Table 1. However, there are some actions which are not within the control of the sites.

In order to even further assist the generators in achieving the highest potential reductions possible, a list of actions that DOE might take to help the generators was developed. This list, in conjunction with the actions listed for each waste type, provides a sound foundation to achieving the potential reduction in Table 1. These items are ranked subjectively and based on generator input and past history.

The potential actions are as follows:

- Place a heavy tax on waste generation and give significant rewards for waste minimization or elimination. Eliminate the boundaries between funding sources to provide P2 incentives to the generators.

- Establish a P2 incentive program that enables each site to use the funds they saved through WMin/P2 activities to fund other P2 projects, site improvements, other programs, and so on.

- Require WMin/P2 achievements as a part of the eligibility requirement for award fee in the Management and Operations contracts.

- Require WMin/P2 reviews as part of the Senior Management Performance Appraisal System. Allow bonus incentives for meeting or exceeding established performance goals.

- Convert DOE waste type accounting to Activity Based Accounting.

- Provide a source to fund high return on investment P2 projects.

- Encourage a regulatory limit for materials potentially contaminated in-depth; consider both controlled and non-controlled release.

- Create a low-rad contaminated metals market within the complex by subsidizing the purchase of, and requiring the use of, waste containers and shielding blocks made from remelted contaminated metals.

- Establish marketing capabilities and capacities for equipment and materials under a controlled release program.

- Establish reasonable free release criteria for use at all DOE sites.

- Sponsor replacement product testing and dissemination of acceptable replacements to procurement departments at the sites and encourage using these alternatives.

- Encourage and facilitate stronger links between the DOE Headquarters (HQ) Technology Development Division and field units.

- Transfer successful WMin/P2 technologies to other applicable sites throughout the complex.

- Require increased reductions in the purchase of hazardous materials.

- Incorporate WMin/P2 requirements in design processes throughout DOE.

- Provide guidance and procedures for microscale chemistry.

- Establish an overall goal for reduction of liquid effluent.

- Provide an HQ single point of contact subject matter expert in ER/Deactivation /WMin.

- Optimize reporting requirements for waste management at each site. Standardize P2 data collection information for all sites.

- Set minimum acceptance criteria for landlord operations to meet prior to shifting responsibility to the deactivation and stabilization program (i.e., all recyclable metals must be removed, unused chemicals will be exchanged)

- Drive for codification of P2 requirements at the Federal level.

3.5 Conclusions

While the study results are preliminary, they serve as a good basis for identifying waste minimization actions and provide limited data for achieving the volume reduction estimates.

With the tightening of budgets and limited resources, it is very important to operate in a cost-effective and optimized environment. Implementing an effective P2 strategy can help reduce the costs of waste management and prevent harmful releases to the environment. The waste reduction ranges and opportunities presented here provide an estimate of the Department of Energy's waste reduction potential from the implementation of P2.

4. WASTE OPERATIONS REDUCTION OPPORTUNITIES

Mission: To manage, account for, and dispose of DOE waste in a safe and environmentally sound manner. Waste management protects human health and the environment "today" by managing the existing waste properly and "tomorrow" by minimizing the creation of additional wastes.

The following sections contain information on the potential waste reduction due to P2/WMin. Each of the five waste types (HAZ, LLW, MLLW, TRU and HLW) has a description of waste generating activities, the potential range reduction, the assumptions used when the reduction was determined, and the rational behind the reduction percentage. The hazardous, low-level, and transuranic waste types have specific actions listed to help achieve the reduction goal. Finally, the recommendation section contains general reduction methods which can be applied across all of the waste types.

4.1 Hazardous Waste

The major hazardous waste-generating activities are as follows:

- Stockpile Support Manufacturing
- Research & Development
- Maintenance
- Waste Management
- Dismantlement
- Environmental Monitoring

4.1.1 Range

Low: 15%
High: 30%

4.1.2 Assumptions

- The major hazardous waste generating activities remain the same over this estimate.
- The potential reduction range is not only based on volume or quantity reductions. It also includes reductions in a waste stream's toxicity or level of hazard.

4.1.3 Rationale (by waste generating activity)

Stockpile Support Manufacturing

1) CHC/CFC Reductions: A five-year stretch goal was established to eliminate to the greatest extent possible, the use of chlorinated hydrocarbons (CHCs) and chlorofluorocarbons (CFCs). At the end of this goal, 96% had been eliminated from use. This avoided a material purchase cost of $1,000,000 per year alone, not including disposal costs.

2) Water Conservation Practices in Plating Shops: The use of conductivity meters to determine when fresh water is needed has greatly reduced the volume of water expended and therefore reduced hazardous waste. Also, cold evaporators can separate sewage water from other hazardous waste. Installation of conductivity meters has decreased water usage by 75% and avoided 54,000,000 lbs per year in hazardous waste. Implementation costs are less than $5,000.

3) Inventory and Out of Shelf-Life Waste Reductions: The U.S. Air Force takes a "pharmacy" approach to dispensing hazardous substances, distributing chemicals only as needed in specific amounts. As a result, an Air Force Logistics Center reduced its hazardous materials expenditures from 14 million to four million dollars in just two years, a 70% cost reduction.

4) Chemical Management: Effective control over the toxicity and amount of hazardous materials purchased is achieved by reviewing all purchase requisitions of a chemical nature. These requisitions are examined to ascertain if the product is available as surplus elsewhere on site, if a less hazardous substitute is available, or if less of the product will suffice. This initiative required $70,000 to implement and saves $15,000 annually in waste disposal costs.

Waste Management

1) Waste Segregation and Reuse: The Thermal Emulsion Breaker separates hazardous, machining oils from water. The implementation of this action saves 668,000 lbs of water per year from being disposed of as hazardous waste. Using chilled water and implementing recycling instead of using city water will save 33,300,000 lbs of water per year, with an estimated implementation cost of $4,000.

2) Hazardous Waste Reduction: The Debris Rinsing Process makes use of a Debris rule in the Federal Register. This rule allows waste that is treated according to the best demonstrated available technology (BDAT) listed in 40 Code of Federal Regulations (CFR) 268.45 to no longer be treated as hazardous waste. More than 5,000 lbs of hazardous waste was eliminated. The first year implementation costs were approximately $14,000.

3) Volume Reduction and Hazardous Material Elimination: Sludge dryers were installed to decrease the volume of sludge waste by 67%. Implementation costs were approximately $320,000. An alternate precipitant was chosen to eliminate the use of approximately 100,000 lbs of a hazardous material.

4) Expanding Recycling Programs: Major recycling programs include paper, scrap metal, precious metals, lumber, solvents, tires, and printed circuit boards. Additional programs include toner cartridges, lead batteries, carbon, nickel cadmium (NiCad) batteries, kitchen grease, and photographic film packaging. Recycling options for corrugated fiberboard and office supplies are being considered. In total, 965 metric tons were recycled in 1993. This amounted to an annual savings of more than $227,000 (including operating costs).

5) Source Reduction: The concentration of an acid used in a Frame Waste Recovery Process was decreased. The acid concentration was reduced from 64% to 50%, this resulted in a decrease in use of 237,000 lbs of this acid per year, at an implementation cost of $1000–$10,000.

6) Reclamation: Unused sodium metal was excessed to an off-site customer. As a result, 16 cubic meters of potential hazardous waste was avoided and $448,000 was saved in disposal costs, and $2,000 of revenue was received.

7) Hazardous Waste Segregation: A research project has demonstrated a way to use high-pressure (supercritical/liquid) carbon dioxide (CO_2) to remove the oils, greases, and organic solvents from rags, wipes, swabs, coveralls, gloves, and other materials. The project results indicate that all of the solvents and most of the oils tested can be removed. Implementation costs are estimated at $250,000 to $350,000, depending on the waste streams involved.

Research & Development

1) An analytical laboratory identified waste streams that might be non-hazardous and made an effort to separate these from hazardous streams. Testing was used to confirm the waste type. As a result, 1576 lbs of hazardous waste was avoided and that which could be reused was sent back to the laboratory. Implementation costs were estimated at $10,000–$50,000.

2) Laboratory procedures were revised to decrease the quantity of stock solutions prepared. A sample preparation technique of serial dilution was used to decrease sample size. This resulted in a combined decrease of 83% in hazardous waste from this procedure.

Maintenance

1) The Maintenance Group donated all paints from their excess inventories for the annual Housekeeping Day. Normally, supplies for this special event would be ordered and purchased. Because of this, 546 lbs of hazardous waste disposal was avoided.

2) An extensive evaluation was performed on maintenance supplies for janitorial support. This evaluation showed 168 different cleaning products, with an estimated 99% of these being regulated. An initiative was implemented to reduce the number of cleaners used, replace aerosols with pump-type/non-hazardous cleaners, and manage the surplus of regulated products that were being eliminated. Vendors were invited on site to demonstrate environmentally safe products for the Custodial Service Staff. As a result, the use, generation, and disposal of hazardous waste cleaning products were eliminated, saving 3.4 cubic meters of waste and $6,344 in disposal costs.

4.1.4 Actions

Specific actions which the field can take to reduce Hazardous Waste:

- * Establish stretch goals to eliminate use of CHCs and CFCs. Replace CHCs and CFCs with non-hazardous alternatives. Replace equipment and/or methods used with CHCs and CFCs.
- * Use counter-flow and/or cascade rinsing practices to reduce water consumption.
- * Use microscale chemistry in analytical laboratories. Change procedures to reduce sample sizes.
- Use aqueous machining coolants and recycle for longer use.
- Use cold evaporators to separate sewage water from other hazardous waste.
- Establish water purity requirements and use water conductivity meters to decrease water consumption.
- Use in-line filter to directly reuse rinse and/or waste water in that process.
- Use lime slurry as a precipitant to avoid the need for sulfuric acid neutralization to meet municipal requirements.

- Replace wet chemical photographic processing (developing and imaging) with digital, computer-generated processing.

- Purchase metals in near-net-shape form to minimize machining waste.

- Eliminate hexavalent chromium, cadmium, cyanide, and suspected carcinogens in plating and surface finishing processes. Substitute with less-hazardous alternatives.

- Replenish plating tanks instead of dumping contents and requesting new make-up solution. Use in-line analyzers to continuously keep tanks within specification limits.

- Use reverse osmosis/deionized water for rinsing to avoid sludge generation.

- Recirculate and reuse chilled water instead of dumping it down the drain.

- Minimize use of toluene diisocyanate and methylenedianiline in polymer processes.

- Utilize sludge dryers to remove moisture and therefore reduce the volume of hazardous waste shipped.

* "Action" items are ranked in priority order based on the value-added in meeting three metrics: 1) cost avoidance, 2) volume reduction, and 3) health and safety risk analysis. Items shown with an "*" are considered essential for field operations to assess their applicability, and wherever possible, implement across DOE to increase waste avoidance/reduction.

4.2 Low-Level Waste

4.2.1 Range

- Share of LLW Projects examined with 100% estimated volume reduction (8 out of 17) = 47%

- Potential reduction estimates from the nine LLW Projects examined with less than 100% Estimated Volume Reduction:

  - Mean: 76%
  - Range: 54% to 98%
  - 95% Confidence Interval: 58% to 93%

4.2.2 Assumptions

- Data provided refers to LLW resulting from both waste generators and waste management operations and facilities.

- "Reduction" means the reduction of the amount (volume) of waste generated. Toxicity is not considered.

- The LLW P2 project data presented herein are based on completed P2 Activity Report estimates of volumes and costs. The potential reduction ranges shown above for LLW are based on data from implemented P2 activities/results at one or more primary LLW generator sites.

- The type and efficacy of LLW P2 options implemented in the future will be equivalent to those of the near past.

- LLW P2 data are based on current missions across DOE, which are assumed to remain constant.

- This report will require periodic updates to validate volume/cost reduction estimates.

4.2.3 Rationale

The definitions for the categories of ranges listed above are as follows:

- The "Mean" represents the average value for projects shown as less than 100% estimated volume reduction.

- The "Range" represents the absolute upper and lower bound.

- The "95% Confidence Interval" represents the expected range derived from the ascending cumulative distribution of the projects.

Ranges shown for LLW were developed by reviewing 90 LLW P2 projects offered from the top three DOE sites where LLW is generated. The ranges are based on 17 implemented LLW P2 projects from these sites involving the following waste generating processes: (a) equipment maintenance, (b) waste operations, (c) facilities maintenance, and (d) field analysis. The projects examined included LLW P2 projects associated with generator organizations who rely on waste management to process their waste, and P2 projects carried out by process owners themselves. "Generator organizations" are those elements that report to Cognizant Secretarial Offices other than EM-1. Project data used provide actual amounts of volume reduction and estimated cost savings as denoted by the sites. While not all LLW projects used for data analysis are appropriate to every DOE site, the intent is to depict significant examples that provide valuable insight into LLW P2 efforts that have been actually implemented and sufficiently documented. In discussions with project personnel, P2 site coordinators indicated that documentation of volume reduction and estimated avoided cost has only recently been initiated. Given the limited information available, a simple algorithm based on multiplying a facility's estimated volume reduction (ft^3, ft^2, etc.) by a unit cost (dollars per ft^3, etc.) used by one of the sites was applied to establish cost estimates, when not provided by the site. The following examples of significant P2 implemented projects involving LLW represent cost savings ranging from a high of $38,000,000, with an estimated 100% volume reduction, to a low cost savings of $107,100, with an estimated 97% volume reduction. The LLW P2 project with the lowest volume reduction percentage submitted was an effort involving controlling B-25 box management, which yielded a 54% reduction.

The first example highlights the largest "big ticket" item shown under LLW. During reactor defueling, the fuel in the reactor vessel was replaced with the existing irradiated non-fuel core components. This eliminated the necessity of washing and disposing of these non-fuel components. Also, an ion exchange was installed in the fuel washing system allowing the water to be reused instead of being single passed in the washing system. Depleted ion exchange resins generated by the fuel washing activity undergo further waste volume reduction by incineration and compaction by a commercial vendor. The results of this project provided a one-time cost avoidance of $38,000,000 and eliminated the generation of approximately 20,900 ft^3 of radioactive solid waste by using the irradiated non-fuel core components. The ion exchange system saved an additional estimated $2,000,000 and reduced radioactive liquid waste (99.5%) from 700,300 liters to less than 3,800 liters. The implementation cost denoted by the site was "none."

The second example for LLW involves the lower end of the "significant" projects offered, that is, the effective use of standard waste containers. One site had a problem with spent jumpers being removed from an evaporator and being placed into a 12' × 12' × 20' carbon steel container for storage and permanent disposal as LLW. The steel box was made specifically for storage and permanent disposal of the spent jumpers. The length of the jumpers prohibited placement in standardized containers. The P2 effort initiated a method for operations personnel to cut the spent jumpers into a smaller size. A B-25 waste container was placed inside a windbreak to receive sections of the spent jumpers when cut. The new cut length of the spent jumpers allowed them to be placed inside the B-25 containers instead of the larger specially-constructed containers. The old method generated 2,900 ft^3 of LLW, whereas the new method only generates 90 ft^3, or a 97% reduction. The estimated savings are calculated to be $107,100, based on the cost per ft^3 for managing LLW at that specific site.

NOTE: Specific "Rationale" details on each significant project used to develop the LLW reduction ranges can be found in Appendix B.

4.2.4 Actions

Specific actions that the field can take to reduce Low-Level Waste:

- * During reactor refueling, the fuel in reactor vessels can be replaced with existing irradiated non-fuel core components, thus eliminating washing and disposing of non-fuel components as LLW.
- * An ion exchange can be installed in fuel washing systems allowing the water to be reused instead of being single passed in the washing system. Depleted ion exchange resins generated by the fuel washing activity then undergo further waste volume reduction through incineration and compaction by commercial off-site vendors.
- Surface mapping systems can minimize temporary capping requirements. Assess site requirements for performing this task.
- Transfer tritium-filled glass radioluminescent (RL) light tubes to Sanders Roe Brandhurst Technologies processing facility in Canada to recover and recycle residual tritium.
- Research the alternatives to burial of excess equipment as LLW. Obtain agreement from receiving organization to pay all necessary shipping costs to acquire equipment.
- Purchase a Mobile Surface Contamination Monitor that can mechanically perform radiation surveys, reducing the number of personnel required in radioactive areas and reducing Personal Protective Equipment/clothing cost requirements.

* "Action" items are ranked in priority order based on the value-added in meeting three metrics: 1) cost avoidance, 2) volume reduction, and 3) health and safety risk analysis. Items shown with an "*" are considered essential for field operations to assess their applicability and implement, wherever possible, across DOE to affect LLW P2 increased cost avoidance/reduction.

4.3 Mixed Low-Level Waste

4.3.1 Range

- Share of MLLW Projects examined with 100% estimated volume reduction (4 out of 5) = 80%

- Potential reduction estimate of the MLLW Projects examined with less than 100% estimated Volume Reduction = 70%

4.3.2 Assumptions

- Data provided refer to MLLW resulting from both waste generators and waste management operations and facilities.

- "Reduction" means the reduction of the amount (volume) of waste generated. Toxicity is not considered.

- The MLLW P2 project data presented herein are based on completed P2 Activity Report estimates of volumes and costs. The potential reduction ranges shown above for MLLW are based on limited data from implemented P2 activities/results at one or more primary MLLW generator sites.

- The type and efficacy of P2 MLLW options implemented in the future will be equivalent to those of the near past.

- MLLW P2 data are based on current missions across DOE, which are assumed to remain constant.

4.3.3 Rationale

Ranges shown for MLLW were developed by reviewing ten projects offered from the top three DOE sites where MLLW is generated. The ranges are based on five implemented MLLW P2 projects from these sites involving the following waste processes: equipment maintenance, waste operations, facilities maintenance, and field analysis. The projects examined included MLLW P2 projects associated with generator organizations that rely on waste management for their waste processing, and P2 projects carried out by process owners themselves. "Generator organizations" are those elements that report to Cognizant Secretarial Offices other than EM-1. Project data collected involved implemented projects only. Project data used provide actual amounts of volume reduction and estimated cost savings as noted by the sites. While not all projects used for data analysis are appropriate to every DOE site, the intent is to depict examples that provide valuable insight into MLLW P2 efforts that have been actually implemented and sufficiently documented. In discussions with project personnel, P2 site coordinators indicated that documentation of volume reduction and estimated avoided costs have only been recently initiated. Given the limited information available, a simple algorithm based on multiplying a facility's estimated volume reduction (ft^3, ft^2, etc.) by a unit cost (dollars per ft^3, etc.) used by one of the sites was applied to establish cost estimates, when not provided by the site. The following examples of significant P2 projects involving MLLW represent cost savings ranging from a high of $23,600,000, with an estimated 70% volume reduction, to a low of just less than $6,400,000, with an estimated 100% volume reduction.

The first example highlights the largest "big ticket" item shown under MLLW. An automated surface-mapping system mapped the waste storage silos at a DOE site allowing the minimum amount of clay to be deposited for a temporary cap. The data were used to measure cap thickness throughout the waste surface and verify that an environmental regulatory milestone was met. The project completed in 1991, at an estimated cost of $1,000,000, saved an estimated $23,600,000 in MLLW management/disposal costs. The project reduced 1,600,000 liters of MLLW from the site, and provided a 70% volume reduction in MLLW.

The second example involves the lower end for "significant" MLLW implemented projects. The P2 project involved a staging pad identified as a collection point for rainwater which ran off into a pit area and was subsequently pumped to a mixed waste tank system. Once in the tank system, the rainwater was considered MLLW and transferred to double-shelled tanks. The site's P2 initiative involved erecting a shelter over the concrete slab to shed the rain before it collected on the slab, thus preventing rainwater accumulation in the pit area. This action prevents approximately 41,300 liters of MLLW each year, based on an annual rainfall of 7 inches (18 cm). The site estimated that by avoiding this MLLW generation, a cost savings of $132,000 is achieved annually. The site estimated the project's payback to be 3.6 years based on an implementation (construction) cost of $480,000.

NOTE: Additional MLLW P2 projects used to develop MLLW reduction ranges can be found in Appendix C.

4.3.4 Actions

Actions associated with this waste type are considered crosscutting to all waste types and are found in the recommendations section at the end of Section 4.

4.4 Transuranic Waste

4.4.1 Range

- Share of TRU Projects examined with 100% estimated volume reduction (1 out of 6) = 17%

- Potential reduction estimates from the five TRU Projects examined with less than 100% estimated volume reduction:

  - Mean: 53%
  - Range: 30% to 65%
  - 95% Confidence Interval: 30% to 65%

4.4.2 Assumptions

- Data provided refer to TRU resulting from both waste generators and waste management operations and facilities.

- "Reduction" means the reduction of the amount (volume) of waste generated. Toxicity is not considered.

- The TRU P2 project data presented herein are based on data from documentation regarding estimates of volumes and cost from the sites involved with TRU waste generation. The potential reduction ranges for TRU are based on limited data from implemented P2 activities/results.

- The type and efficacy of TRU P2 options implemented in the future will be equivalent to those of the near past.

- TRU P2 data are based on current missions across DOE, which are assumed to remain constant.

- This portion will require periodic updates to validate volume/cost reduction estimates.

4.4.3 Rationale

The definitions for the categories of ranges listed in "Ranges" above are as follows:

- The "Mean" represents the average value for projects shown as less than 100% estimated volume reduction.

- The "Range" represents the absolute upper and lower bound.

- The "95% Confidence Interval" represents the expected range derived from the ascending cumulative distribution of the projects.

Ranges shown for TRU were developed by reviewing each of the eight projects offered from the DOE sites where TRU waste is generated/managed. The relatively small number of projects presented/examined included TRU P2 projects associated with generator organizations that rely on waste management for their waste processing, and P2 projects carried out by operations themselves. "Generator organizations" are those elements that report to Cognizant Secretarial Offices other than EM-1. Project data collected involve implemented projects only. Data regarding estimated cost savings and estimated implementation were nearly nonexistent. While the TRU projects used for data analysis were appropriate to only a few DOE sites, the intent is to depict examples that provide valuable insight into TRU P2 efforts that have been actually implemented and sufficiently documented. The following examples of P2 projects involving TRU waste represent volume reductions ranging from a high of 100% to a low of 30%.

The "high-end" example for TRU waste involved a P2 project where a valve located over a 15-inch plastic port bag of a glovebox leaked into the bag during process operations. This leakage created TRU and LLW. The site took the initiative to relocate the valve. This action eliminated the unnecessary generation of TRU waste. The site estimated the action saves four drums of waste per year at a disposal cost savings of $9,200 annually for the one valve. This one-time P2 occurrence activity could apply to other such valves/equipment components across DOE operations.

The "low-end" example involved procedural changes for management of solid radioactive wastes including glovebox equipment generated during maintenance outages and repairs, gloves on ports, and plastic wastes being generated during seal-outs. The site changed procedures to require horsetailing of seal-out bags, and changed the procedure to increase mandatory life of glove bags and port gloves. The new procedure increasing glove life resulted in a 30% decrease in TRU wastes. The old procedure of increased frequency of changing the glove, whether worn or not, every 6 months or 18 months (depending on glove type) had caused three different facilities at the site to generate unnecessary wastes over the past 20–30 years. The estimated implementation cost at each of the three facilities was $130. No specific cost savings data were presented in any of the three duplicated projects submitted for multiple locations at the site.

NOTE: Specific "Rationale" details on each TRU project used to develop the reduction ranges can be found in Appendix D.

4.4.4 Actions

Specific actions which the field can take to reduce TRU volumes:

- * Replace scrap metal reduction using solvent extraction with thermal reduction methods. Benefits include reduction of carbon tetrachloride emissions and TRU solid wastes.

- * Extend the life of plastic bags and gloves to decrease change-out frequency.

- Seal ends of change-out bags and then horsetail, rather than horsetailing alone—allows bags to be changed less often.

- Plan seal-outs to maximize effort.

- Post inventories for all glovebox items (such as tools and containers) to eliminate the need to seal more items in.

- Improve assay capabilities to better segregate wastes.

- Segregate materials prior to entry into contamination zones.

* "Action" items are ranked subjectively in priority order based on analysis of the limited number of TRU P2 projects submitted. Items shown with an "*" are considered essential for field operations to assess their applicability and implement, wherever possible, across DOE to increase TRU P2 cost avoidance/reduction.

4.5 High Level Waste

4.5.1 Range

After coordinating with both P2 site coordinators at the sites that manage/generate the largest quantities of HLW, no documentation was submitted that would allow analysis of any implemented HLW P2 project(s). Therefore, no potential P2 reduction ranges are presented in this report.

One P2 site coordinator stated that the last HLW their site generated was in the late 1980s. He said that although they do have a high volume of calcine generated from the reprocessing of spent nuclear fuel, the site is simply storing the calcine waiting until concepts are finalized as how best to handle disposal of the HLW. The coordinator added that "pre-conceptual" ideas are being discussed that will be driven by pending negotiations with the applicable state on their Federal Facilities Compliance Agreement.

4.5.2 Assumptions

- This initial report will require updates as P2 HLW data become available to enable establishing volume/cost reduction estimates.

4.5.3 Rationale

No implemented HLW P2 projects were offered for analysis by either HLW generator site. No HLW P2 activities were reported as active at this time.

4.5.4 Actions

Future actions associated with this waste type are considered crosscutting to all generating processes and are found in the recommendations section at the end of Section 4.

4.6 Recommendations

General actions that the field can take to reduce all waste types:

- * Expand/implement site-wide recycling programs and reclaim valuable materials.
- * Write P2 into Waste Minimization Plans so that P2 becomes a normal day-to-day operation in waste management.
- * Incorporate P2 into ER project designs and procedures to promote WMin and P2 efforts.
- * Write P2 into contracts, requiring subcontractors' adherence to P2 requirements.
- * Provide positive incentives for individuals, get everyone involved in P2.
- * Advertise P2 successes, internal and external, that can be used as valuable lessons-learned.
- * Review facilities/areas that currently serve as a large collection point for rainwater that is subsequently disposed of as HAZ, LLW, MLLW, or TRU.
- * Control/lock waste containers to minimize repackaging or misclassifying waste.
- * Review/implement procedures for improved waste segregation techniques making waste more amenable to recycling, reuse, and/or reclamation.
- * Reduce contamination zones in order to reduce the amount of Personal Protective Equipment required.
- * Review/implement procedures that involve taking packaging materials on supplies/equipment into controlled areas. Plan usage—control volumes of materials.
- * Survey locations (square footage and/or entire facilities/structures) within existing radioactive controlled areas (RCAs) to assess "roll back"/"down posting"/ "contamination zone reduction" capabilities. Relocate equipment requiring routine maintenance outside high hazard areas. Plan traffic flow to minimize access to high hazard areas.
- * For glovebox operations, cut sleeves off plastic suits and dispose of the sleeves as non-compactible waste and dispose of remaining part of suit as compactible waste.

- Reduce inventory waste and waste generated by out-of-specification material. Establish an as-required chemical disbursement system.

- Development/expansion of site P2 Program, providing site priorities followed by completion of PPOAs to determine high return on investment projects.

- Control hazardous material purchases through the review and approval of the purchase requisitions.

- Review all hazardous material purchase requisitions to ascertain if the product is available elsewhere on site as surplus, if a less hazardous substitute is available, or if less of the product will suffice.

- Eliminate hazardous debris streams by utilizing the Debris rule in the Federal Register. This rule allows waste that is treated according to the BDAT listed in 40 CFR 268.45 to no longer be treated as hazardous waste.

- Develop a computer-driven, high-tech simulator that can provide waste operators the opportunity to make mistakes and learn without affecting the "real" process. This allows operators to learn without generating additional wastes associated with normal training runs.

- Implement an innovative small diameter (less than 5 cm PVC pipe generated from well maintenance activities) survey technique. Cutting a 50 cm section out of the center of 6-meter pipe sections can provide a necessary test sample. Radiological Control then determines if pipes are clean and can be released for sale as scrap metal.

- Review excess equipment/components to assess reuse capabilities onsite, at other DOE sites, or other government entities.

- Review procedures for handling acid solutions and determine which items can be neutralized and recharacterized.

- Incorporate P2 into the design of a liquid effluent treatment and disposal facility to provide methods to eliminate soil column discharge of untreated liquid effluent.

- Analyze storage limits for certain hazardous materials and miscellaneous items (such as cardboard, paper, etc.) within contamination zones.

- Change from field-fabricated, hut containment structures to prefabricated huts that will withstand the elements and can be decontaminated for reuse.

* "Action" items are ranked in priority order based on the value-added in meeting three metrics: 1) cost avoidance, 2) volume reduction, and 3) health and safety risk analysis. Items shown with an "*" are considered essential for field operations to assess their applicability, and wherever possible, implement across DOE to increased waste avoidance/reduction.

5. ENVIRONMENTAL RESTORATION REDUCTION OPPORTUNITIES

Mission: The planning, assessment, and implementation of ER and deactivation and stabilization activities which ensure that potential exposures to radionuclides and other contaminants present in environmental media and surplus facilities are eliminated or reduced to the prescribed levels deemed tolerable through formal agreements with regulators.

The following sections contain information on the potential waste reduction due to P2 and WMin. Sections 5.1, 5.2, 5.3, and 5.4 contain the potential range reduction and the assumptions used when the reduction was determined for HAZ, LLW, MLLW, and TRU wastes respectively. Section 5.5 contains the rationale behind the range of potential reductions. Section 5.6 lists recommended actions which can be applied across all of the waste types to help achieve the waste reduction range. High level waste was not included in any ER waste generating activities.

5.1 Hazardous Waste

5.1.1 Range

Low: 60%
High: 70%

5.1.2 Assumptions

- Approximately 90% of the primary waste streams are soils.
- Approximately 90% of the soils will be remediated or treated through best management practices and will not be disposed of as waste.
- The primary waste stream percentages assumed above were not included in the BEMR waste generation estimates and are not considered for the purposes of this study.
- Hazardous waste is defined by the Resource Conservation and Recovery Act (RCRA). It has no radioactive components and does not include waste that is defined as hazardous under the Toxic Substance Control Act (TSCA), states, or local regulations.
- Reductions are measured as the waste minimization impact in percentage decrease from total potential waste disposal volumes projected.
- Reduction actions include measures which reduce the waste stream's toxicity to the point of removing it from the hazardous category.
- Waste minimization does not include volume reduction treatments such as incineration, but does include decontamination and recycling.
- Actions identified as rationale for achieving these reductions are equally applicable across the DOE complex.

5.2 Low-Level Waste

5.2.1 Range

Low: 25%
High: 50%

5.2.2 Assumptions

- LLW is defined by the level of radioactive contamination and does not contain any RCRA hazardous constituents.
- Reduction actions include measures that reduce the waste stream's radioactivity to the point of removing it from the radioactive waste category.
- Approximately 90% of the primary waste streams are soils.
- Approximately 90% of the soils will be remediated or treated through best management practices and will not be disposed of as waste.
- The primary waste stream percentages assumed above were not included in the BEMR waste generation estimates and are not considered for the purposes of this study.
- The large variance in the potential reduction range is due to the huge impact of strategic decisions made at the HQ level (*de minimus* levels for release).
- Reductions are measured as the waste minimization impact in percentage decrease from total potential waste disposal volumes projected.
- Waste minimization does not include volume reduction treatments such as incineration, but does include decontamination and recycling.
- Actions identified as rationale for achieving these reductions are equally applicable across the DOE complex.

5.3 Mixed Low-Level Waste

5.3.1 Range

Low: 10%
High: 15%

5.3.2 Assumptions

- MLLW is low-level radioactive waste that is also defined as RCRA hazardous waste.
- The potential impacts to minimizing MLLW are much lower than LLW because of the absence of free release, decontamination, recycling, and treatment options applied to LLW.

- Approximately 90% of the primary waste streams are soils.

- Approximately 90% of the soils will be remediated or treated through best management practices and will not be disposed of as waste.

- The primary waste stream percentages assumed above were not included in the BEMR waste generation estimates and are not considered for the purposes of this study.

- Reductions are measured as the waste minimization impact in percentage decrease from total potential waste disposal volumes projected.

- Waste minimization does not include volume reduction treatments such as incineration.

- Actions identified as rationale for achieving these reductions are equally applicable across the DOE complex.

5.4 Transuranic Waste

5.4.1 Range

Low: 15%
High: 25%

5.4.2 Assumptions

- TRU waste is defined by the level of contamination and the radionuclides making up the contamination.

- Decontamination of TRU waste to low-level is considered a valid reduction technique since it lowers the toxicity of the resulting waste.

- Approximately 90% of the 40 primary waste streams are soils.

- Approximately 90% of the soils will be remediated or treated through best management practices and will not be disposed of as waste.

- The primary waste stream percentages assumed above were not included in the BEMR waste generation estimates and are not considered for the purposes of this study.

- Reductions are measured as the waste minimization impact in percentage decrease from total potential waste disposal volumes projected.

- Waste minimization does not include volume reduction treatments such as incineration, but does include decontamination and recycling.

- Actions identified as rationale for achieving these reductions are equally applicable across the DOE complex.

5.5 Rationale

The following information explains the rationale behind the potential reductions for each waste type.

The primary method used for developing the reduction estimates included here was the compilation of preliminary results from six case studies being conducted at five DOE sites. The studies are the results of the early efforts of the "Waste Minimization/Pollution Prevention in Environmental Restoration (WMin/P2 in ER) Project Team," as part of the task description document (TDD) titled, "DOE Complex Wide Pilot Test Addition of Waste Minimization/Pollution Prevention Personnel to Environmental Restoration Programs." This TDD proposes that WMin/P2 techniques can be (and have been) successfully applied throughout the ER process to provide waste reduction and waste management cost savings. One of the specific objectives of the project team was to conduct case studies of ongoing or completed ER activities that encompassed a variety of ER program areas (e.g., decommissioning, environmental assessment, and remedial action) The goal of the studies was to identify WMin/P2 techniques successfully used, or potential opportunities missed, and, where possible, quantify the waste reduction benefits. While the study results are preliminary, they have served as a good basis for identifying waste minimization actions and have provided some data for making the reduction estimates.

One site's successful implementation of waste minimization techniques at three completed deactivation activities was also studied. The after-action reporting on these projects included the calculation of recycle, reuse, and disposal indexes as part of the projects performance measures tracking. These indexes were very useful as a basis for establishing the waste minimization reduction potentials reported here, since they were calculated as volumes recycled, reused, or disposed, as a function of the total volume in-situ. In addition, the reports also provided actual waste generation and waste reduction amounts for each of the projects. The distribution of in-situ waste volumes by waste form (e.g., concrete, soils, and sludges) and the waste disposition post-remediation (e.g., disposal, recycling, and metal remelt) was also reported and very valuable in establishing reduction potentials. A listing of various waste minimization techniques applied was compiled and used in the actions section of this report.

Supplementing the results from the case studies and after-action reports are the results from a site's survey which asked for an accounting of waste minimization accomplishments during FY94–FY95. Responses from the management of eleven ER and deactivation and stabilization projects reported actual waste volume reductions and the techniques used to accomplish the reductions. Some of the responses also projected future volume reductions and descriptions of how they planned to accomplish these reductions. The methods described appear applicable across the complex. Actual volumes reduced were considered in calculating the reduction ranges for this study.

Because of the recognized success of one particular site's efforts in this area, a study was conducted on relevant site documents. These included: (a) Material Segregation and Packaging Criteria, (b) recycle contract/vendor listings, (c) Interim Remedial Action Waste Disposition Guidance Report, (d) a procedure and a position paper for the radiological control and release of materials, and (e) the sites' Waste Minimization Program Plan. These documents were gleaned for relevant waste minimization techniques for inclusion in this report.

Other existing tools and information were utilized in this effort. Helpful information was derived from: (a) PPOAs conducted at one site on activities common to most deactivation and ER projects and PPOAs on processes unique to particular projects, (b) a P2 facility design checklist, (c) meeting notes from the "WMin/P2 Tools Workshop, Performance and Tracking Parameters Working Group," held July 19 and 20, 1994, and (d) the "Draft Input for Development of Pollution Prevention and Waste Minimization Guidance for Environmental Restoration Activities. In addition, a literature search for any other relevant information was conducted. Resources and successes both within and outside the DOE complex were studied.

As a final check on the validity of the reduction estimates, an informal survey of personnel active in waste minimization, waste management, ER, and deactivation and stabilization was conducted. Also, interviews were held with individuals from three commercial waste treatment, decontamination, and recycling companies. Although there was not a complete consensus that the estimates were totally valid, there did seem to be a general feeling that the estimates were reasonable.

5.6 Recommendations

General Actions which the field can take to reduce all ER/deactivation and stabilization waste types:

- * During the Preliminary Assessment/Site Investigation, collect as much historical data as possible to preclude extensive sampling in later stages.

- * Negotiations with regulatory agencies should incorporate WMin in an effort to limit sampling waste, make reasonable future land use decisions, limit monitoring requirements, and set clean up standards based on reasonable risks.

- * Mandatory WMin considerations during the evaluation of alternatives in the Feasibility Study or Corrective Measures Study.

- Perform PPOAs during all phases of the planning and implementation

- Maximize efficient waste packaging of soils and debris destined for burial (bulk = 100% efficient, B25 boxes = 60%, 55 gallon drums = 38%).

- Optimize weight/volume limits of packages by including items such as bagged contaminated insulation and contaminated pallets to fill volume in heavy loads.

- The disciplined and approved application of field screening to prevent "clean" material from entering the contaminated wastestream.

- Use of existing, excess, on-site process equipment (pumps, data systems, air movers, scales, etc.).

- Implement P2 procurement programs which facilitate maximum reuse, recycle, and environmentally friendly treatment through correct purchasing.

- Establish and track WMin performance indicators, using both quantitative and qualitative metrics.

- Maximize uninterrupted work time in the contamination zone to minimize personal protective equipment and respirator usage (local break areas, 4 day work weeks).

- Sampling techniques which minimize waste should be given preferential use (micropurging, proper well placement, return of drill cuttings to drill holes).

- Minimize the personnel, equipment, and materials taken into contamination zones.

- WMin/P2 awareness training for all levels of involvement in the ER/Deactivation processes.

- Feed secondary waste streams back into the remediation process whenever possible (decontamination media, regenerated carbons, solvents, lubricants).

- Ensure proper boundary area designations and monitor WMin stations at entrance/egress points.

- Incorporate WMin language and performance criteria in subcontracts.

- Use physical separation techniques for segregating clean from contaminated. Insure that the physical barriers are reusable (launderable tarps vs. plastic sheeting).

- Establish a process for feedback of lessons learned.

- Use "Green is clean" waste segregation techniques.

- Reusable prefabricated containment structures whenever possible.

* "Action" items are ranked in priority order based on the value-added in meeting three metrics: 1) cost avoidance, 2) volume reduction, and 3) health and safety risk analysis. Items shown with an "*" are considered essential for field operations to assess their applicability, and wherever possible, implement across DOE to increased waste avoidance/reduction.

6. TRANSITION ACTIVITIES REDUCTION OPPORTUNITIES

Mission: Transition activities include planning, implementing, and managing the transition activities for the orderly transfer of facilities from the operating programs to Environmental Management, and the disposition of such facilities for alternate use or turnover for deactivation and stabilization. This mission also includes responsibilities for landlord operations.

The following sections contain information on the potential waste reduction due to P2 and WMin Sections 6.1, 6.2, 6.3, 6.4, and 6.5 contain the potential range reduction, the assumptions used when the reduction was determined, and the rationale behind the reduction percentages for HAZ, LLW, MLLW, TRU and HLW wastes respectively. Section 6.6 lists recommended actions which can be applied across all of the waste types to help achieve the waste reduction range.

6.1 Hazardous Waste

6.1.1 Range

Low: 10%
High: 25%

The ranges indicated could vary according to parameters agreed upon in the facility-specific MOA. However, many opportunities identified can be applied to this entire waste type.

6.1.2 Assumptions

- The projected waste volume numbers listed in BEMR are the waste volumes projected for transition activities only, and do not include waste generation volumes from landlord operations.

- All regulatory requirements specified for a particular material type can be applied throughout the DOE complex.

- For this section of this document, all previously generated waste (i.e., waste being stored in RCRA regulated temporary and satellite accumulation areas and spent nuclear fuel) has been removed from the facility prior to facility transition activities.

- Transition wastes are those wastes that are generated from the transition process and do not include facility structure materials.

- Opportunities will be identified for those wastes generated during facility transition.

- Opportunities will NOT be identified for landlord operations or processes housed in transition facilities.

6.1.3 Rationale

For the purposes of this report, and to eliminate duplication of effort, the facility transition phase includes removal of any bulk items and elevated levels of contamination. Landlord operations can look to the reduction opportunities listed in the waste operations section of this document for information on waste reduction/prevention.

The deactivation and stabilization process requires the setup and maintenance of radiation control zones and entry/exit of the zones. During this phase of facility transition, a characterization of the facility and equipment is required to determine the detailed radiological, chemical, and physical makeup. Associated activities primarily deal with radiological surveys and sampling.

Provided that all previously generated wastes have been removed, the hazardous waste generated during the facility transition phase is minimal, consisting of bulk RCRA metals (i.e., lead, mercury, and chromium), waste oil generated by the transport vehicles, solvents used for deactivation, and sampling materials which include personal protective equipment. Ballasts and other PCB contaminated items are regulated under TSCA; however, the avenue exists to recycle these materials once applicable quantities have been identified. Materials which were previously generated and left behind, are covered in the waste operations section of this document for waste reduction/prevention opportunities.

6.2 Low-Level Waste

6.2.1 Range

Low: 20%
High: 40%

The ranges indicated could vary according to parameters agreed upon in the facility-specific MOA. However, many opportunities identified can be applied to this entire waste type.

6.2.2 Assumptions

- The projected waste volume numbers listed in BEMR are the waste volumes projected for transition activities only, and do not include waste generation volumes from landlord operations.

- All regulatory requirements specified for a particular material type can be applied throughout the DOE complex.

- For this section of this document, all previously generated waste (i.e., waste being stored in RCRA regulated temporary and satellite accumulation areas and spent nuclear fuel) has been removed from the facility prior to facility transition activities.

- Transition wastes are only those wastes which are generated from the transition process and do not include facility structure materials.

- Opportunities will be identified for those wastes generated during facility characterization, hazards analysis activities, and initial decontamination.

- Opportunities will not be identified for landlord operations or processes housed in transition facilities.

6.2.3 Rationale

For the purposes of this section, the facility transition phase was limited to removal of any bulk items and elevated levels of contamination. The deactivation process requires the setup and maintenance of radiation control zones and entry/exit of the zones. Each time an individual enters and exits a contamination control zone, the clothing and materials taken into that zone are classified as LLW. With this type of activity representing the majority of the new waste generation, it would be feasible to achieve the reduction ranges based on information presented in the waste operations and environmental restoration sections of this document in addition to the recommendations in this section.

The existing contamination control zone entry practices utilize disposable anti-contamination clothing and associated materials used in setting up the contamination zone. By substituting the disposable materials with a launderable/reusable material, this LLW stream could be eliminated. Furthermore, if the materials presently classified as LLW (i.e., contaminated lead) can be evaluated for reuse in other contaminated areas, this portion of the LLW stream could be reduced as well. In staying with this method of reduction, cross-training personnel performing the decontamination work to complete multiple tasks would alleviate the need to conduct numerous entries into controlled areas by different individuals, thus, eliminating the redundant contamination of items used in decontamination.

6.3 Mixed Low-Level Waste

6.3.1 Range

Low: 10%
High: 20%

The ranges indicated could vary according to parameters agreed upon in the facility-specific MOA. However, many opportunities identified can be applied to this entire waste type.

6.3.2 Assumptions

- The projected waste volume numbers listed in BEMR are the waste volumes projected for transition activities only., and do not include waste generation volumes from landlord operations.
- All regulatory requirements specified for a particular material type can be applied throughout the DOE complex.
- For this section of this document, all previously generated waste (i.e., waste being stored in RCRA regulated temporary and satellite accumulation areas and spent nuclear fuel) was removed from the facility prior to facility transition activities.
- Transition wastes are those wastes that are generated from the transition process and do not include facility structure materials.
- Opportunities will be identified for those wastes generated during facility characterization.
- Opportunities will not be identified for landlord operations or processes housed in transition facilities. These waste generating processes are addressed in the waste operations section of this document.

6.3.3 Rationale

The facility transition phase includes removal of any bulk items and elevated levels of contamination. The decontamination process requires the setup and maintenance of radiation control zones and entry/exit of the zones. During this phase a characterization of the facility or equipment is required to determine the detailed radiological, chemical, and physical makeup. Associated activities primarily deal with radiological surveys and sampling.

Provided that proper steps are taken, new mixed waste generation as a result of cross contamination with radioactive sources is minimal. The hazardous waste generated during the facility transition phase is minimal, consisting of waste oil generated by the transport vehicles, solvents used for decontamination, and sampling materials which include personal protective equipment required to perform certain samples. Legacy bulk materials such as RCRA metals (i.e., lead, mercury, and chromium) fall under the responsibility of waste operations. Ballasts and other PCB contaminated items are regulated under TSCA; however, the avenue exists to recycle these materials once applicable quantities have been identified. If materials are kept separate or segregated properly, new mixed waste generation is kept to a minimum.

During the evaluation of the MLLW generating facilities, contact was made with both the Portsmouth and Paducah Gaseous Diffusion Plants. The waste characterization of the projected MLLW volumes was characterized as mainly Trichloroethane, Trichloroethylene, and heavy metal (cadmium, mercury, and lead) contaminated soils. These wastes were not generated during transition, but rather during operation of the plant.

6.4 Transuranic Waste

6.4.1 Range

*Low: 0%
*High: 0%

*See rationale

As defined in this document, facility transition does not carry a potential for transuranic waste generation. Therefore, responsibility for this waste type will remain with waste operations. Opportunities for reduction are covered in the waste operations section of this document.

6.4.2 Assumptions

- The projected waste volume numbers listed in BEMR are the waste volumes projected for transition activities only, and do not include waste generation volumes from landlord operations.

- All regulatory requirements specified for a particular material type can be applied throughout the DOE complex.

- For this section of this document, all previously generated waste (i.e., waste being stored in RCRA regulated temporary and satellite accumulation areas and spent nuclear fuel) has been removed from the facility prior to facility transition activities.

- Transition wastes are those wastes that are generated from the transition process and do not include facility structure materials.

- Opportunities will be identified for those wastes generated during facility characterization and hazards analysis activities.

- Opportunities will not be identified for landlord operations or processes housed in transition facilities.

6.4.3 Rationale

Transuranic waste is waste generated during nuclear weapons production, fuel reprocessing, and other activities involving long-lived transuranic elements. It contains plutonium, americium, and other elements with atomic numbers higher than that of uranium. Some of these isotopes have half-lives of tens of thousands of years requiring very long-term isolation.

The facility transition phase does not require the use of any transuranic materials to complete the intended actions. Waste prevention/reduction opportunities for this generating activity may be similar to those stated in the waste operations section of this document. Provided that proper control procedures are in place, no new TRU waste should be generated.

6.5 High Level Waste

6.5.1 Range

*Low: 0%
*High: 0%

* See rationale

As defined in this document, facility transition does not carry a potential for HLW generation. Therefore, responsibility for this waste type will remain with waste operations. Opportunities for reduction are covered in the waste operations and environmental restoration sections of this document.

6.5.2 Assumptions

- The projected waste volume numbers listed in BEMR are the waste volumes projected for transition activities only, and do not include waste generation volumes from landlord operations.

- All regulatory requirements specified for a particular material type can be applied throughout the DOE complex.

- For this section of this document, all previously generated waste (i.e., waste being stored in RCRA regulated temporary and satellite accumulation areas and spent nuclear fuel) has been removed from the facility prior to facility transition activities.

- Transition wastes are those wastes that are generated from the transition process and do not include facility structure materials.

- Opportunities will be identified for those wastes generated during facility transition activities.

- Opportunities will not be identified for landlord operations or processes housed in transition facilities.

6.5.3 Rationale

High-level waste is material generated by the reprocessing of spent fuel and irradiated targets. Most of the Department's HLW came from the production of plutonium. A smaller fraction is related to the recovery of enriched uranium from naval reactor fuel. This waste typically contains highly radioactive, short-lived isotopes, hazardous chemicals, and toxic heavy metals. It must be isolated from the environment for thousands of years.

The facility transition phase does not require the use of any high level materials to complete the intended actions. Waste prevention/reduction opportunities for this generating activity may be similar to those stated in the waste operations section of this document. No new HLW is anticipated to be generated in the transition process.

6.6 Recommendations

General Actions that the field can take to reduce all transition activities waste types:

- * Substitute chlorinated solvents with non-hazardous replacements.
- * Establish a material exchange system prior to initiating transition process and identify any unused chemicals for use or reuse on federal exchange.
- * Establish a comprehensive recycling program to allow for recycling of all non-radiological contaminated metal. Specialized contracts can be developed to allow for recycling RCRA regulated metals (i.e., lead, mercury).
- * Implement a program requiring the procurement of launderable anti-contamination clothing, to be used in the decontamination process.
- * Utilize reusable step-off pads in contamination control zones.
- * Implement a training program to cross-train labor, which would facilitate multiple task completion while conducting work in the control zone.
- * Utilize non-hazardous decontamination solutions when removing contamination from radioactive materials.
- * Establish clean-work areas within the radiological contamination control zone to reduce the potential for cross-contamination of hazardous materials with radioactive.
- * Contaminated materials such as lead can be reused as shielding in other nuclear applications.
- * Non-hazardous personal protective equipment can be substituted in place of hazardous.
- Establish sub-contracts with vendors to utilize waste oils and other ignitable liquid wastes as fuel in boilers and kilns. This practice is recognized as recycling for energy recovery.
- Establish strict controls over the maintenance program of the vehicles used in transport of transition wastes. These controls would include, but not be limited to:
(a) implementation of a solvent substitution program, (b) implementation of reusable oil

filters, (c) use of synthetic oil and oil additives to reduce emissions and the generation of possible hazardous bi-products.

- Recycle cooling water.

- Reuse/recycle acids used in precipitation processes.

- Implement stronger RADCON controls for material release.

- Aqueous solutions contaminated with both a RCRA characteristic waste and radioactive material, can be solidified to prevent leachate of hazardous component, thus, allowing for disposal of material as LLW.

- Solutions containing RCRA metals can be treated by precipitating the metals and neutralizing the solution. This results in final dispositioning as LLW.

* "Action" items are ranked in priority order based on the value-added in meeting three metrics: 1) cost avoidance, 2) volume reduction, and 3) health and safety risk analysis. Items shown with an "*" are considered essential for field operations to assess their applicability, and wherever possible, implement across DOE to increased waste avoidance/reduction.

Appendix A

Supporting Information for Hazardous Waste

Appendix A

Supporting Information for Hazardous Waste

Stockpile Support:

1) CHC and CFC Reductions: In order to achieve the reductions, line management through top management was informed with monthly progress reports (i.e., Top Users or Hit List) and a Precision Cleaning Laboratory was established to evaluate the latest in technological advances—including equipment, methodologies, and cleaning material chemistry. The largest impact came from the culture change - not doing it the same as was done for the last 30–40 years. The remaining breakthroughs came from the following:

- Solvent replacements with aqueous and semi-aqueous chemistries.
- Replacing spray cleaning and/or vapor degreasers with enclosed systems, ultrasonic equipment, plasma cleaning, supercritical CO_2, abrasive blasting, or dip tanks, etc.
- Use of aqueous machine coolants that are recycled and reused.
- Aqueous and no-clean flux soldering.
- Implementation of an R-11 recycle still, operator training, improved inspection for leak detection, and improved control of refrigerant purge and recharging unit to reduce CFC usage for the plant's cooling system.
- High volatile organic compound paint elimination, use of water-based coating alternatives, and powder coating technology development.
- Photolithography (soldermasks and photoresists) material replacements.

2) Water Conservation Practices in Plating Shops: The use of conductivity meters to determine when fresh water is needed has greatly reduced the volume of water expended and therefore, the hazardous waste. Conductivity meters operate to allow fresh water to be added only when the rinse water is contaminated and stop as soon as the rinse water reaches the desired level of purity for a specific chemical. Installation of these meters has decreased water usage by 75% and avoided 54,000,000 lbs per year in hazardous waste. Implementation costs are less than $5,000.

3) Inventory and Out-of Shelf-Life Waste Reductions: The U.S. Air Force takes a "pharmacy" approach to dispensing hazardous substances, distributing chemicals only as needed in specific amounts. As a result, an Air Force Logistics Center reduced its hazardous materials expenditures from 14 million to 4 million dollars in just two years, a 70% cost reduction.

4) Chemical Management: Effective control over the toxicity and amount of hazardous materials purchased is achieved by reviewing all purchase requisitions of a chemical nature. These requisitions are examined to ascertain if the product is available elsewhere on site as surplus, if a less hazardous substitute is available, or if less of the product will suffice. This initiative required $70,000 to implement and saves $15,000 annual in waste disposal costs.

Waste Management:

1) Waste Segregation and Reuse: The Thermal Emulsion Breaker is a process that uses heat to separate hazardous machining oils from water. The recovered, de-watered oil is then used for fuel in an off-site incinerator. The implementation of this action saves 668,000 lbs of water per year in hazardous waste disposal. In addition, an option is being implemented which uses chilled water instead of city water to condense and separate the water from the oil. The chilled water is recycled back to the cooling tower, instead of treating the city water. This action will decrease the usage and disposal of city water by 33,300,000 lbs/yr. Implementation costs will be approximately $4,000.

2) Hazardous Waste Reduction: The Debris Rinsing process makes use of a Debris rule in the Federal Register. This rule allows waste that is treated according to the BDAT listed in 40 CFR 268.45 to no longer be treated as hazardous waste. The waste streams of acid/chromate (2620 lbs) and alkaline/cyanide (2430 lbs) were totally eliminated after chemical extraction treatment and application of this rule. The first year implementation costs were approximately $14,000.

3) Volume Reduction: The Industrial Wastewater Pretreatment Facility treats/neutralizes aqueous wastes. Hazardous sludge is generated from this process. Sludge dryers were installed into the process to decrease the amount of water and volume of the sludge. Prior to the dryer installation, the sludge contained ~ 75% moisture. After the drying process, the sludge is ~ 40% moisture. The filling of the containers is easier and has decreased the volume of sludge waste by 67%. Implementation costs were approximately $320,000.

4) Hazardous Material Elimination: The current waste neutralization process in the Idaho Waste Processing Facility (IWPF) uses a sodium hydroxide at a pH of 11. By using an alternative precipitant, lime slurry, the precipitation can be completed at a pH of 9.5–10 which eliminates the necessity of lowering the pH to the required municipal level of 10. The alternate precipitant is projected to eliminate the majority of sulfuric acid (needed for pH adjustment) in the IWPF, approximately 100,000 lbs per year.

5) Expanding Recycling Programs: Major recycling programs include paper, scrap, precious metals, lumber, solvents, tires, and printed circuit boards. Additional programs include toner cartridges, lead batteries, carbon NiCad batteries, kitchen grease, and photographic film packaging. Those under investigation are corrugated fiberboard and office supplies. In total, 965 metric tons were recycled in 1993. This amounted to an annual savings of more than $227,000 (including operating costs).

6) Source Reduction: The concentration of an acid was decreased in a Frame Waste Recovery process. The acid concentration was reduced from 64% to 50% which resulted in a decrease of 237,000 lbs/yr of this acid at an implementation cost of $1,000–$10,000.

7) Reclamation: Unused sodium metal was excessed to an off-site customer. As a result, 16 cubic meters of potential hazardous waste was avoided and $448,000 was saved in disposal costs and $2,000 of revenue received.

8) Hazardous Waste Segregation: Through a Memorandum of Understanding between DOE and the Air Force, a research project has demonstrated a way to use high-pressure (supercritical/liquid) CO_2 to remove the oils, greases, and organic solvents from rags, wipes, swabs, coveralls, gloves, and other materials. Contaminants dissolved in high-pressure CO_2 are separated out by the expansion o f the fluid to a subcritical pressure, when the CO_2 again becomes a gas and the dissolved materials precipitate out, usually as liquids or solids. The gaseous CO_2 can then be recompressed and recycled as a solvent. The project results indicate that all of the solvents and most of the oils tested can be removed. Implementation costs are estimated at $250,000 to $350,000, depending on the waste streams involved.

Research and Development:

1) An analytical laboratory identified waste streams that might be non-hazardous and made an effort to separate those from hazardous streams. Testing was used to confirm its waste type. As a result, 1576 lbs of hazardous waste was avoided and that which could be reused was sent back to the laboratory. Implementation costs were estimated at $10,000–$50,000.

2) Laboratory procedures were revised to decrease the quantity of stock solutions prepared. A sample preparation technique of serial dilution was used to decrease sample size. This resulted in a combined decrease of 83% of the hazardous waste from this procedure.

Maintenance:

1) The Maintenance group donated all paints from their excess inventories for the annual Housekeeping Day. Normally, supplies for this special event would be ordered and purchased. As a result, 546 lbs of hazardous waste disposal was avoided.

2) An extensive evaluation was performed on maintenance supplies for janitorial support. This evaluation showed 168 different cleaning products with an estimated 99% of these being regulated. An initiative was implemented to reduce the number of cleaners used, replace aerosols with pump-type/non-hazardous cleaners, and to manage the surplus of regulated products that were being eliminated. Vendors were invited on site to demonstrate environmentally safe products for Custodial Service Staff. As a result, the use, generation, and disposal of hazardous waste cleaning products were eliminated saving 3.4 cubic meters of waste and $6344 in disposal costs.

Appendix B

Supporting Information for Low-Level Waste

Appendix B

Supporting Information for Low-Level Waste

LLW-1: Original planning for shutdown defueling of a test facility called for each component to be replaced as it was removed from the core with a simulated core assembly to maintain the necessary core configuration. This method would require the fabrication of new simulated core assemblies. Once removed, the 220 irradiated non-fuel components would require washing and transfer to dry casks prior to disposal. Thirty-seven new Disposable Solid Waste Casks and Core Component Containers would have been required, and an additional 1.5 years of the facility's operation. Approximately 1,900 liters of low-level radioactive liquid waste would be generated per assembly washed. The site initiated the following P2 action: During reactor defueling, the fuel in the reactor vessel was replaced with the existing irradiated non-fuel core components. This eliminated having to wash and dispose of these non-fuel components. Also, an ion exchange was installed in the fuel washing system that now allows the water to be reused instead of being single passed in the washing system. Depleted ion exchange resins generated by the fuel washing activity undergo further waste volume reduction through incineration and compaction by a commercial vendor. The results of this project denoted by the site were a one-time cost avoidance of $38,000,000 and generation of approximately 20,900 ft^3 of radioactive solid waste being eliminated by using the irradiated non-fuel core components. In addition, the ion exchange system saved an estimated $2,000,000 and reduced radioactive liquid waste (99.5% volume reduction) from 700,300 liters to less than 3,800 liters. The cost denoted by the site to implement these efforts was "none."

LLW-2: An automated surface-mapping system mapped the waste storage silos at a site allowing depositing the minimum amount of clay for a temporary cap. The data were used to measure cap thickness throughout the waste surface and verified that a regulatory milestone was met. The project was completed in 1991 at an estimated cost of $300,000 and saved an estimated $1,400,000 The project reduced approximately 37,400 ft^3 of LLW from the site, with a volume reduction stated by the site to be 61%. (Also refer to MLLW-1 in Appendix C for associated MLLW cost and volume reduction data.)

LLW-3: One DOE plant transferred approximately 4,000 tritium-filled glass radioluminescent (RL) light tubes to Saunders Roe Brandhurst Technologies processing facilities to recover and recycle the residual tritium (approximately 100,000 curies of tritium). The 100 shipping containers of RL lights were shipped to the company's processing facilities located in Canada. The project yielded a 100% LLW volume reduction with an estimated cost of $500,000 and an estimated cost savings of $1,200,000. The project was completed in April 1994. This P2 occurrence was considered to be a one-time activity.

LLW-4: To control proper use of B-25 boxes, one site implemented a B-25 control program that required that B-25s be locked when not in use. The site operators are now able to control materials that are placed in the boxes, ensuring that the materials meet requirements of the waste acceptance criteria and that the volume of space in each box is fully utilized. The P2 Project Activity Form for this activity also included the site's initiative to "roll-back" from RCAs to Radiation Buffer Areas (RBAs). The total P2 reduction for the B-25 boxes alone was calculated at 54%. These P2 activities were implemented in June 1994, with an estimated 23,800 ft^3 of LLW avoided at an estimated cost savings of $1,100,000. Implementation cost was shown as approximately $1,000. This P2 occurrence was stated to be a continual activity.

LLW-5: In August 1994, one site used the 5Q Manual, Procedure 488, to roll-back previously designated RCAs to RBAs. This eliminated disposal of waste inside this area from being classified as LLW. Instead, wastes are now disposed as sanitary waste. Of the 27,000 ft^3 generated from the old RCA, approximately 80% was non-compactible. Typical jobs and types of waste were as follows: (a) paving, grading, and construction activities generated pavement debris, soils, tools, etc.; (b) field maintenance activities on diesel generators, non-process equipment, compressors, etc., generated equipment and tool waste; (c) maintenance shops generated large quantities of scrap metal and broken equipment; and (d) wooden pallets comprised a large percentage of non-compactible waste. The pallets can now be reused or placed in the "wood only" dumpsters. The total non-compactible waste equaled 80% of 27,000 ft^3, or 21,600 ft^3. Approximately 29% is now compactible. Typical jobs and types of waste associated with this include: (a) housekeeping generated waste from the sweep down of roads; (b) office-type waste; and (c) storage facilities for general supplies that are no longer in an RBA that do not generate packaging material waste. The total compactible waste equaled 20% of 27,000 $ft^3/4$ (for compaction), or 1,400 ft^3. The total disposal reduction from the roll-back equaled 23,000 ft^3. No implementation cost was documented by the site. However, a calculated savings for this project would be approximately $881,000, based upon the estimated volume multiplied by the site's denoted per ft^3 cost to manage LLW. This P2 occurrence was stated to be a continual activity.

LLW-6: By using the 5Q Manual, Procedure 488, a site was able to avoid disposal of suspect soil and rubble in B-12 containers. The new method characterizes rad levels, thus reducing the B-12 usage and allowing suspect soils to be shipped via skid pans now. During the first 5 months of 1994, the site generated 190 B-12s of suspect soil, or approximately 38 B-12s/month. The last 7 months using the characterization method resulted in the generation of less than 10 B-12s. This provided a volume reduction of more than 98% in the usage of B-12s, with an estimated cost savings of $758,000. This P2 occurrence was stated to be a continual activity.

LLW-7: One site reported that their huts constructed for containment of contamination were field fabricated. The integrity of the huts to withstand elements of weather was poor; thus, huts became torn, requiring disposal of the huts and construction of new units. The site acquired new sturdier, prefabricated radiological containment huts which now withstand the weather. Additionally, the huts can be decontaminated, and stored for reuse. In 1994, none of the new huts had to be disposed. The site calculated the volume reduction as follows: on average, one hut generated approximately 0.7 of one B-25 box. Based on a requirement for 56 huts in the first quarter of 1994, the annual requirements equaled 224 huts. Therefore, 224 huts x 0.7 B-25s/hut equaled 156 x 90 ft^3/B-25 or 14,000 ft^3 in volume reduction. The site considered this calculation to be conservative. The calculated cost savings based on a 100% volume reduction was $539,000.

LLW-8: A new evaporator project was included as being within an RCA due to its close proximity. The site took the initiative to survey and determine that the project was actually outside the RCA boundary. Therefore, waste generated at the new project site could now be disposed of as nonradioactive waste. The site estimated 10,800 ft^3 of waste would not have to be classified as LLW due to this P2 action. Based on the site's per ft^3 cost for management of LLW, an estimated $415,000 was realized. The volume reduction was considered to be 100% and is a continual P2 occurrence. The site did not provide any estimated implementation cost data.

LLW-9: At one site, filter compartments were shipped to the burial grounds as complete units. This P2 implemented action involved the filters being cut in half, the internals being removed from each half, and the internals being placed in smaller containers. Subsequently, a top was fabricated for each half. The "gutted" halves were then palletized with waste and sent to the burial ground. Implementation cost was based on the cost to remove the internals from the filter compartments, which was shown to cost approximately $5,000 for the volume reported. This P2 effort (100% volume reduction) at this site was estimated to avoid 7,800 ft^3 of LLW based on the actual dimensions of the filter compartments involved, with an estimated one-time cost savings of $299,100.

LLW-10: Glovebox work required plastic suits to be worn by tritium operators. Arms and hands of plastic suits had tritium contamination levels above the site's compactor limits. Thus, entire suits were sent to Non-compactible Waste for disposal in B-25s. The site experimented with one shift for nine months during 1994, via cutting sleeves off plastic suits and disposing of sleeves as non-compactible waste and disposing of the remaining parts of the suit as compactible waste. The site's annualized estimate of the volume reduction of 7,700 ft^3 for this experiment resulted in an 80% reduction of LLW, with an estimated cost savings of approximately $296,800. This P2 occurrence was stated to be a continual activity.

LLW-11: At another site, compactible waste was defined as waste coming from offices within the RCA. Approximately 1,100 boxes per year were being generated at the site. A 5Q Manual roll-back survey allowed entrance to these areas without protective clothing such as gloves and shoe covers, which comprised the 1,100 boxes generated annually. Implementation of the roll-back procedures allowed a two-thirds reduction in compactible waste. An estimated 3,900 ft^3 of LLW is reduced annually. No implementation cost was provided by the site. The estimated annual cost savings for this continual activity was $151,000.

LLW-12: Changing regulations frequently require radiological warning signs to be redesigned, requiring a complete change-out of all the radiological warning signs on site. The radiological symbol (tri-foil) on outdated signs requires the entire sign to be destroyed or disposed of as radioactive waste. The site contacted a recycling company that would recycle the signs into useful items. The company accepted the signs and completely destroyed the signs (including the tri-foil symbol) in the process of recycling. The signs were reduced to 1/4" flakes and then made into underground piping. This P2 effort reduced approximately 1,000 ft^3 of radioactive waste at an implementation cost of $600, which resulted in an estimated cost savings of $150,000 for fiscal year 1994. Such an effort has potential for periodic application across DOE .

LLW-13: A reactor organization at one of the sites had been packaging all waste for burial ground disposal. The new P2 activity involved training personnel to segregate waste into three categories: Tritiated compactible, non-tritiated compactible, and non-compactibles. Tritiated waste is now shipped to a location on-site for compaction. The site estimates that this continual P2 activity will reduce the LLW waste stream approximately 83% or 3,900 ft^3 annually. The implementation cost associated with the effort was stated to be the shipping cost, which is estimated to be $1,000. The estimated cost savings are calculated to be $149,300, annually.

LLW-14: LLW was generated in certain RCAs at the site. Approximately 19 boxes of LLW were generated each week. This amount equated to 3,100 ft^3 annually, which could be reduced by implementing roll-back criteria. This P2 occurrence was considered a continual activity providing a 58% volume reduction in LLW. An estimated cost saving of $117,800 was calculated. The site did not provide any implementation cost data.

LLW-15: Normally, any irradiated metals or contaminated equipment must be sent to the solid waste burial grounds as LLW. A site had purchased a reactor several years ago for use in part of a neutron radiography program. The reactor was still stored in its original boxes. Upon the execution of a new contract, the facility where the reactor was housed was required to be prepared for transfer to the new contractor. Since the reactor program had been canceled, the normal procedure would have been to bury the irradiated equipment. An alternative to burial was found by locating an interested party with a need for the excess reactor. A grant proposal was prepared and accepted for the non-DOE receiving organization to pay all necessary shipping costs to acquire the reactor. The P2 action cost $1,900 to implement, which realized a one-time cost savings of $117,300, based on a volume of 865 ft^3. The volume reduction of LLW was 100%.

LLW-16: One site began processing on a four 12-hour shift basis beginning in the 2nd quarter of 1993. The increased activity at the facility increased generation of LLW. The site then used the roll-back criteria to reduce the LLW generation rate by 90%. The annualized volume reduced was calculated by the site to be 2,800 ft^3. This P2 continual occurrence activity saved the site an estimated $107,600 in 1994. The implementation costs are estimated at approximately $50,000 based on the following information provided on the site's P2 Activity Form: "Implementation of the RCA roll-back took many planning meetings (in excess of 10) with each meeting lasting approximately 2 hours with 15 exempt personnel in attendance. Implementation of the roll-back was accomplished in approximately 7 working days with 6 personnel involved."

LLW-17: Spent jumpers were removed from an evaporator and placed into a 12' × 12' × 20' carbon steel container for storage and permanent disposal as LLW. This steel box was made specifically for storage and permanent disposal of the spent jumpers. Their length prohibited the spent jumpers from being placed in standardized containers. The new P2 effort initiated a method for operations personnel to establish a staging and cutting area for the spent jumpers. A B-25 waste container was placed inside a windbreak to receive sections of the spent jumpers when cut. The cut length of the spent jumpers allowed placement inside the B-25 container instead of the larger sized containers previously constructed/used. The old method generated 2,900 ft^3 of LLW, whereas the new method only generates 90 ft^3, or a 97% volume reduction. This effort was stated to be a one-time P2 occurrence by the site. The estimated savings were calculated to be $107,100 based on the cost per ft^3 for managing LLW at the site.

Appendix C

Supporting Information for Mixed Low-Level Waste

Appendix C

Supporting Information for Mixed Low-Level Waste

MLLW-1: An automated surface-mapping system mapped the waste storage silos at a DOE site allowing depositing the minimum amount of clay for a temporary cap. The data were used to measure cap thickness throughout the waste surface and verified that an environmental regulatory milestone was met. The project was completed in 1991 at an estimated cost of $1,000,000 and saved an estimated $23,600,000. The project reduced approximately 1,600,000 liters of MLLW from the site and provided a 70% volume reduction in MLLW.

MLLW-2: Rather than dispose of potential contamination lead disks previously used as glovebox shielding, decontaminate the disks and use the lead for shielding in other areas, or ship as recycled scrap. The site stated the benefits of this effort to be reduction in requirements to package the disks as MLLW, reduced treatment costs, and provision of reusable materials for other facilities. The P2 action reduced the volume of MLLW by thirty 55-gallon drums, or 27,000 lbs based on a weight limit of 900 lbs/drum. The cost savings are estimated at $63,000 in avoided disposal cost, and $22,900,000 in avoided management cost for a total savings of $23,000,000. Implementation costs were stated to be nominal. This P2 occurrence is considered to be a continual activity.

MLLW-3: Due to facility improvements, two heavily shielded gamma counting chambers were discontinued from routine use. The rooms where the chambers are located were inside an RCA and were being modified for (transuranic) TRU waste management utilization. If these chambers were to be considered waste, approximately 8,000 lbs of mixed waste (lead and cadmium) metal waste would be generated. In addition, the iron housing structure for the chambers would generate 120 ft^3 of LLW. Instead, the site used the two shielded chambers to store the TRU waste assay source standards, when not in use. This P2 action eliminated the purchase and installation of an appropriate shielded source cabinet. This P2 innovative use conversely keeps gamma source emissions inside the chamber, reduces the dose rate to personnel, and reduces background radiation for the TRU waste assay system. The site took a hard dollar savings which amounted to $70,600 based on avoiding mixed waste disposal costs of $51,000, $4,600 for avoided LLW disposal, and $15,000 for the avoided cost of not purchasing a new source storage cabinet. The overall estimated savings based on these costs, and an estimated avoided management cost was calculated to be $6,800,000. The site stated this to be a one-time P2 activity occurrence.

MLLW-4: One of the reactor facilities had a problem with acid solutions originating from an RBA being disposed of as MLLW. The new P2 procedure involved zinc bromide from a reactor area viewing window being neutralized and disposed of as radioactive liquid waste. The site estimated that 300 gallons at 25 pounds per gallon was the volume reduction realized. The noted implementation costs included manpower and supplies for neutralization. The site estimated these costs at approximately $5,000. The estimated savings for the effort were approximately $6,300,000, based on the volume of waste avoided multiplied by the site's estimated per pound cost to manage MLLW. The site stated this to be a one-time P2 activity occurrence.

MLLW-5: This MLLW P2 project involved a staging pad identified as a collection point for rainwater, which ran off into a pit area and was subsequently pumped to a mixed waste tank system. Once in the tank system, the rainwater was considered MLLW and transferred to double-shelled tanks. The site's P2 initiative involved erecting a shelter over the concrete slab to shed the rain before it collected on the slab, thus preventing rainwater accumulation in the pit area. This action prevents approximately 41,300 liters of MLLW each year, based on an annual rainfall of 7 inches (18 cm). The site estimated that by avoiding MLLW costs, a cost savings of $132,000 is achieved annually. This project's projected pay-back period was 3.6 years based on an implementation (construction) cost of $480,000. This P2 occurrence is considered to be a continual activity.

Appendix D

Supporting Information for Transuranic Waste

Appendix D

Supporting Information for Transuranic Waste

TRU-1: A valve located over a 15-inch plastic port bag of a glove box leaked into the bag during process operations. This leakage created TRU and LLW. The site took the initiative to relocate the valve. This action eliminated the unnecessary generation of TRU waste. The site estimated the action saves four drums of waste per year at a disposal cost savings of $9,200 annually for the one valve. The one-time P2 occurrence activity could apply to other such valves/equipment components across DOE.

TRU-2: Solid radioactive wastes including glovebox equipment generated during maintenance outages and repairs, gloves on ports, and plastic wastes were generated during seal- outs. The site changed procedures to require horsetailing of seal-out bags, and changed the procedure to increase the mandatory life of glove bags and port gloves. The increase in glove life resulted in a 30% decrease in TRU wastes. The old procedure of increased frequency of changing the glove, whether worn or not, every 6 months or 18 months (depending on glove type) had caused three different facilities at the site to generate unnecessary wastes over the past 20-30 years. The estimated implementation cost at each of the three facilities was $130. No specific cost savings data were presented in any of the three duplicated projects submitted for multiple locations at the site.

TRU-3: Solid, potentially contaminated wastes were generated in process areas or surface contamination areas as a result of maintenance (not including gloveboxes or canyon areas), tours, housekeeping, and surveillance. The site initiated zone reduction procedures. This P2 action decreased the size of the areas allowing waste to be treated as LLW. Previous zone reductions helped decrease LLW by 25%. In addition, the Multi Energy Gamma Scan system put in place allowed the facility to treat previously classified TRU or suspect TRU waste as LLW, decreasing the TRU stream by 65% in one year. No specific costs for implementation or savings data were presented in either of the two duplicate projects submitted for multiple locations at the site.