LLNL Waste Minimization Program Plan

Lawrence Livermore National Laboratory

**Environmental Protection Department
Hazardous Waste Management Division
Waste Minimization Program**

**February 14, 1990
Revision 2**

MASTER

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- W Program
- Z-Division

ABBREVIATIONS

DOE	Department of Energy
DHS	Department of Health Services
DP	DOE Defense Programs
EPA	(United States) Environmental Protection Agency
HSWA	1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act
LLNL	Lawrence Livermore National Laboratory
OTA	Office of Technology Assessment
RCRA	Resource Conservation and Recovery Act
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
WRA	Waste Reduction Audit
WMSC	Waste Minimization Steering Committee (LLNL)
HWRMRA	Hazardous Waste Reduction and Management Review Act of 1989 (SB14 Roberti)

PREFACE

This document is the February 14, 1990 version of the LLNL Waste Minimization Program Plan (WMPP). The Waste Minimization Policy field has undergone continuous changes since its formal inception in the 1984 HSWA legislation. The first LLNL WMPP, Revision A, is dated March 16, 1985. A series of informal revision were made on approximately a semi-annual basis. This Revision 2 is the third formal issuance of the WMPP document.

Now legislation at the federal level is being introduced. Passage will result in new EPA regulations and also DOE orders. At the state level the Hazardous Waste Reduction and Management Review Act of 1989 was signed by the Governor. DHS is currently promulgating regulations to implement the new law.

EPA has issued a proposed new policy statement on source reduction and recycling. This policy reflects a preventative strategy to reduce or eliminate the generation of environmentally-harmful pollutants which may be released to the air, land surface, water, or ground water. In accordance with this new policy new guidance to hazardous waste generators on the elements of a Waste Minimization Program was issued. In response to these policies, DOE has revised and issued implementation guidance for DOE Order 5400.1, Waste Minimization Plan and Waste Reduction reporting of DOE Hazardous, Radioactive, and Radioactive Mixed Wastes, final draft January 1990.

This WMPP is formatted to meet the current DOE guidance outlines. The current WMPP will be revised to reflect all of these proposed changes when guidelines are established. Updates, changes and revisions to the overall LLNL WMPP will be made as appropriate to reflect ever-changing regulatory requirements.

WASTE MINIMIZATION PROGRAM PLAN

I. INTRODUCTION

The Lawrence Livermore National Laboratory has as its primary mission, the research and development of the nuclear weapons that make up the nation's deterrent force.

The design of the nuclear weapons has been called one of the most challenging enterprises ever undertaken. Specialists from many disciplines are called upon to predict, test, and analyze the results of an explosion. Astrophysics, plasma physics, atomic and nuclear physics, thermodynamics, hydrodynamics, computational physics, solid state physics, nuclear chemistry, and engineering are some of the disciplines involved. It's not surprising, then, that a multidisciplinary approach is required.

Since the founding of the Laboratory in 1952, the skills of scientists, engineers, technicians, and others have been blended into unique research teams using sophisticated technology to attack formidable problems.

This multidisciplinary approach is, in fact, the embodiment of "Big Physics" of science on the grand scale.

This research takes two forms at Livermore. One is basic research, in which our scientific people work at and beyond the frontiers of science. This "pure science" is typically found at universities. The other form is applied research, similar to that done at industrial laboratories. The use of both kinds of research gives Livermore the capability to move concepts from the fringes of basic research through the development of prototype hardware.

Although the exploration of nuclear weapons ideas remains the foundation stone of the Laboratory, we have assumed greater and more diverse responsibilities as our capabilities have developed. The result has been that, over the years, the expertise gained from the study of weapons has been transferred to other areas at the Laboratory.

Today, our work centers around six major programs. These are: weapons studies, magnetic fusion energy, laser isotope separation, laser fusion energy, energy and resources, and biomedical, environmental, and atmospheric sciences.

Moreover, many basic research disciplines - physics, mathematics, and computer science, chemistry, materials science, earth sciences, and

engineering - help advance the frontiers of knowledge as they support the major programs.

II. PROGRAM OBJECTIVES

There is a strong commitment by the Laboratory to minimize wastes - particularly hazardous and radioactive wastes. Its importance is reflected by the Director's Statement on Waste Minimization issued on February 27, 1989. "It is important that the Laboratory make a strong commitment to waste minimization - particularly to hazardous and radioactive waste minimization. Our goal is to reduce the Laboratory's hazardous/radioactive waste streams by a major factor in the next three to five years by reducing generation and increasing recycling. We will implement an incentive system where each Laboratory program will pay the costs associated with the handling and disposal of its waste. Each program will establish waste minimization goals and develop plans and assign responsibility for achieving these goals. Waste minimization will be incorporated in the design of new projects." It is consistent with the policy of LLNL to protect its employees, the public, and the environment against the adverse effects of hazardous and/or radioactive materials and their wastes. With the minimization program, LLNL assures another layer of protection through reduction in volume and toxicity of generated wastes.

By implementation of the Director's minimization policy, the overall Laboratory minimization effort will produce a reduction of 25% to 50% over a five-year period, in the generation of hazardous, radioactive, and mixed wastes. A range of expected reductions is given since some of the larger generators have existing minimization programs in place. Our previous studies show that minimization efforts produce early reductions which then reduce, in magnitude, with time.

III. DESCRIPTION OF PROGRAM

Three general methods, in decreasing order of priority, are available for reducing waste generation: source reduction; recycling; and treatment. The hazardous waste management hierarchy (Figure 1) provides a prioritized set of options that will be employed by LLNL facilities. Waste streams from the Lab have been identified. Reduction activities for each stream will continue or be undertaken as appropriate.

Each directorate has developed a minimization mini-plan for its own waste generation activities. The larger programmatic waste generators will in addition develop micro-plans for specific process operations. Thus a hierarchy of plans exists at LLNL: Overall Plan, Mini Plan, and Micro Plan.

Directorate

Program

Figure 1

Waste Minimization Strategy

Details are shown in the various directorate mini-plans (see appendix).

The Laboratory has studied a hazardous waste recharge system for all programmatic generators so as to fully allocate waste disposal costs to the generators. Originally the recharge plan was to be implemented at the start of FY90. Ambiguity in funding levels from the Department of Energy results from a more recent plan to fund waste management operations as a direct budget line item and has complicated plan to implement a cost incentive based allocation system. Alternatives to the initial recharge program are currently being studied. One of these alternatives will be implemented as final funding levels are determined.

A formal Quality Assurance (QA) Plan calling for an annual program audit of the minimization program plan will be issued. This QA Plan is required by DOE orders and will follow the DOE/SAN office QA Plan, which is yet to be issued. In the interim, a draft LLNL QA Plan was issued for internal guidance on August 4, 1989.

The results of the audit will be to verify annual progress on meeting reduction goals and also to identify potential areas for improvement.

Figure 2 shows the waste minimization organization responsibilities at LLNL. In order to meet the requirements of DOE orders and to implement the Director's statement on waste minimization, a Waste Minimization Steering Committee was formed. Each directorate at the Lab appointed a representative to serve on the Committee. The committee's charter included the review and evaluation of the proposed waste recharge system, and development of an auditable waste minimization plan including goals for all appropriate waste streams at the Lab.

Figure 2 shows the interaction/coordination between the Lab generators and DOE program staff by identifying the functional documentation and reporting responsibilities.

The FY90 budget for planning is \$815K and \$100K for implementation activities. The requested FY91 budget is \$1200K for planning and \$250K for implementation activities.

A waste accounting system is in place. The Hazardous Waste Management Division (HWM) develops and maintains a waste accounting system to track the types, amounts, composition, and generation dates of all hazardous wastes. The Facility Hazardous Waste Report is based on data extracted from the HWM database. The total costs of treating, storing, and disposing of waste were analyzed. These costs can also be extracted from the HWM database and reported for each waste stream.

Figure 2

LLNL Organization Responsibilities

Figure 3
DOE Order 5820.2A
Functional Documentation and Reporting Responsibilities

Identifies Organizational Interfaces Between the Office of Defense Programs, the Waste Reduction Program, and the Lawrence Livermore National Laboratory Waste Minimization Project

IV. DESCRIPTION OF WASTE MINIMIZATION ACTIVITIES TO DATE AND SCHEDULE OF PLANNED ACTIVITIES

As an important part of the "Good Housekeeping Practices" activities, employee involvement and training on Waste Minimization emphasizing updated source reduction techniques and methods, will continue (Figure 1).

Table 1 indicates the extent and nature of employee and management training in waste reduction. At this time an employee incentive program is being considered for waste minimization suggestions. Several companies have reported the importance of an incentive program to the success of their waste minimization programs. Other companies have reported successful programs without an incentive program; these companies believe that it is part of each employee's job to reduce or minimize waste.

The Waste Minimization Program will periodically rank waste streams by quantity, toxicity, or prevailing regulatory emphasis. Waste quantities and volumes will be gleaned from several sources including the waste generation data base. A waste stream may be selected as a candidate for study and possible implementation of waste minimization based on a combination of its ranking and the number of other drivers affecting it. A list of regulations and other minimization drivers affecting facilities/operations at LLNL is shown in Table 2. Each of the waste streams may be affected by land bans, disposal costs, new regulations, or SARA Title III Section 313 (which does not currently apply to LLNL). In addition, radioactive streams are affected by DOE Order 5820.2A.

In special cases, a waste stream may be selected for study and reduction despite its low ranking if a program has an urgent need to reduce its waste or if a commercially proven technology is readily available. This is a case of working smart by choosing the "low hanging fruit" which is ripe for the picking with little effort.

Cost savings are an important factor, but in some instances may not be the overriding reason for selecting waste streams for minimization. The published literature indicates that government support and incentives may be needed to offset costs. At the plant level, overhead monies may be required to assist programs in paying for waste minimization. Regulations appear to be a significant driver now and all indications are that they will continue to be so in the future. The literature reports that the main driver is fear of future liabilities.

Table 1
Training Efforts

**Extent and Nature of Employee and Management
Training in Waste Reduction**

<u>Programmatic Briefings</u>	<u>Dates</u>
B-141 Experimental Circuit Board	August 5, 1986
B-322 Plating Shop	June 18, 1986
B-325 Cooling Towers	July 11, 1986
B-151 Nuclear Chemistry	September 10, 1986
B-411 Supply and Distribution	March 2, 1987
B-321 Materials Fabrication Division	April 6, 1987
B-418 Paint Shops	April 21, 1987
B-4385 MFE	April 23, 1987
B-611 Motor Pool	May 4, 1987
All facilities using or handling lead Lead Integrated Management Program (LIMP) Steering Committee	June 17, 1987
Site 300 waste from firing tables	November 9, 1987
Waste from containers	February 9, 1989
B-482 LIS	March 2, 1989

Table 1
Training Efforts (cont.)

Extent and Nature of Employee and Management
Training in Waste Reduction

<u>Publications</u>	<u>Dates</u>
<u>Environmental Forum</u> "Minimizing Hazardous Waste" by R.A. Heckman	February 9, 1989
<u>The Quarterly</u> "Managing the Laboratory's Hazardous Waste"	December 1987
<u>Newsline</u>	
New panel formed to study reducing hazardous waste	April 19, 1989
Reducing hazardous waste becoming more vital to Lab	February 15, 1989
Hazardous waste minimization talk set for Thursday	February 8, 1989
Talk scheduled on hazardous waste	February 1, 1989
<u>Tuesday A.M. Update</u>	
Waste Minimization Committee forming	April 18, 1989
Waste minimization talk on tap this Thursday	February 7, 1989
Waste minimization talk slated for February 9	January 31, 1989

In the work to date for several facilities, several targets of opportunity have been identified for waste reduction, for these, capital costs have been estimated (Table 3). These changes are primarily for process modifications, the third of the sequential phases of source reduction. Some consideration has been given to providing a non-programmatic capital fund to provide these funds rather than facing the bureaucratic barriers and delays when programs directly pay for capital expenditure. This may be helpful, programs may be less reluctant to identify targets of opportunity for fear that they do not have the funds for implementation.

The data base for waste reduction is limited in so far as its use as a crystal ball for quantitatively predicting waste reduction for specific waste stream types or industries. Until far more information becomes available, one can only roughly predict that waste minimization for any waste stream will follow the general relationship curve for either hazardous or radioactive waste. Table 4 shows projected waste reductions for various waste streams for the next few years. These rates may be substantially modified as additional data becomes available, the list may be expanded as the waste minimization effort increases in scope.

V. DESCRIPTION OF TECHNOLOGY TRANSFER ACTIVITIES

Technology transfer is an integral part of the LLNL plan. DOE has a formal headquarters Waste Minimization Steering Committee which conducts Working Group meeting several times a year. New technology and applications are discussed at these technical meetings. A DOE electronic bulletin board and mail system, the WIN (Waste Information Network), has a waste minimization section to ensure speedy transfer of technical information. The Environmental Protection Agency has developed a computerized information network, EIES (The Electronics Information System) of the Pollution Prevention Information Clearinghouse (PPIC) also for waste minimization technology transfer. Site 300 has access to these networks through the overall Laboratory Waste Minimization Program Office.

In addition, the Waste Minimization Program office interacts with state, local, trade and academic organizations on waste minimization technologies and makes this information available to the site.

VI. DESCRIPTION OF PROGRAM PERFORMANCE EVALUATION

The site waste minimization effort will be reviewed on an annual basis to identify additional opportunities for source reduction and recycling. These annual reviews will emphasize the application of new technologies for waste reduction as they become known, keeping in mind the options for reducing wastes using the waste management hierarchy (Figure 1).

Table 2

**Waste Minimization Drivers Effecting
Facilities and Operations**

Waste Stream Number (1)	Land Ban	DOE Order 5820.2A	Disposal Costs	New Legislation	SARA Title III Section 313
1	x	—	x	x	x
2	x	—	x	x	x
3	x	—	x	x	x
4	x	—	x	x	x
5	x	—	x	x	x
6	x	—	x	x	x
7	x	—	x	x	x
8	x	—	x	x	x
9	x	x	x	x	x
10	x	—	x	x	x
11	x	—	x	x	x
12	x	—	x	x	x
13	x	—	x	x	x
14	x	—	x	x	x
15	x	—	x	x	x
16	x	—	x	x	x
17	x	—	x	x	x
18	x	—	x	x	x
19	—	x	x	x	x
20	—	—	x	x	x
21	x	—	x	x	x
22	—	x	x	x	x

Table 3

Identified Targets of Opportunity

Fiscal Years [\$1M = \$1,000,000]

	Building	Waste Stream No.	1993	1994	1995	1996	1997	1998
Radioactive wastes (DOE Order 5820.2A)								
Solids	Site 300 gravel	228	—	—	\$1.5M		\$0.25M	\$0.25M
Scintillation vials	151, 253, 292, 331, 361, 377, 412	8, 10, 11, 16, 17	—	\$0.2M	\$0.2M			
Hazardous wastes (RCRA & HSWA regulations)								
Electroplating wastes	322, 141	3, 4	\$1.7M	\$2.0M	\$4.0M		—	—
Solvent wastes	LLNL & Site 300	Nearly all	\$0.07M	\$2.4M	—		—	—
Waste waters	221, 325	1	\$0.14M	\$0.25M	\$1.25M			
Machine coolants	321	2	\$0.10M					
Paint shops	418	1	\$0.02M	\$0.02M				
Antifreeze wastes	519, 611	1	\$0.02M					
Laser operations	482	13	\$0.10M	\$0.10M				
Total			\$2.15M	\$4.97M	\$6.95M	\$9.0M	\$0.25M	\$0.25M

Table 4

Project Waste Reductions

Gallons (unless otherwise specified)

	1991	1995	1996	1997	1998
Radioactive wastes					
Solids					
Scintillation vials		220Kg	220Kg		1,000 cu yd
Hazardous wastes					
(RCRA & HSWA regulations)					
Electroplating wastes		42,000	42,000		
Solvent wastes	40,000	49,000	57,000		
Waste waters		100,000	50,000	50,000	
Machine coolants	14,700	15,600			
Paint shop aqueous wastes		24,000			
Antifreeze wastes					

APPENDIX

DIRECTORATE MINI PLANS

DIRECTORATE MINI PLAN

for

ADMINISTRATION AND OPERATIONS

Administration & Operations Directorate Waste Minimization Plan

April 1990

**Administration & Operations Directorate
Waste Minimization Plan**

April 1990

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I. Introduction

The Lawrence Livermore National Laboratory was established with the primary mission of research and development of nuclear weapons. However, the multidisciplinary approach taken in this work has led to the assumption of more diverse responsibilities. Today, our work centers around six major programs. These are: weapons studies, energy and resources, laser isotope separation, laser fusion energy, biomedical and atmospheric sciences, and environmental sciences. To support the diversity of such research operations, Livermore has established the Administration and Operations (A&O) Directorate. The A&O Directorate encompasses a wide variety of activities in support of the Laboratory. In fact, the A&O activities could best be compared to a medium sized industrial park with a diversity of independent facilities/operations.

II. Program Objectives

A&O has placed a high priority in establishing and implementing a waste minimization program plan. The A&O Directorate has adopted the Director's Statement On Waste Minimization (Attachment 1), issued in February, 1989. In the process of implementing the policy, A&O has formed the A&O Waste Minimization Committee (Fig. 1) and assigned the associated responsibilities to top management personnel. A&O also prepared a Waste Minimization Miniplan.

To meet the goals of our policy, the informal waste minimization activities already in place have been reviewed and updated where necessary. These early waste minimization efforts were driven primarily by ever increasing off-site disposal costs. Administrative controls, modified operating procedures and installation of new equipment will provide the necessary source reduction achievements. As regulatory and DOE criteria for waste reduction success demonstration become final, these criteria will be addressed and a revised mini-plan will be issued.

Further implementation of minimization efforts will produce a reduction of 25% to 30% over a five year period (see Fig. 2). This is relatively low in magnitude because many of our minimization activities started as early as 1986, and have already produced significant reductions. Greater reductions may be attained if process modifications and new technologies can be applied to our support efforts.

III. Description of Program

Three general methods, in decreasing order of priority are available for reducing waste generation: source reduction; recycling; and treatment. The hazardous waste management hierarchy (Fig.4) provides a prioritized set of options that will be analyzed by LLNL facilities. Waste streams from the A&O Directorate have

been identified. Reduction activities for each stream will continue or be undertaken as appropriate.

Employee awareness and training has been addressed through mandatory formal training sessions. These were given in the summer and fall of 1989. Training activities will continue and will be reviewed on an annual basis.

Waste minimization incentives, such as employee-oriented incentive and award programs can not be implemented without Laboratory-wide approval, and will probably be managed at that level.

The A&O Directorate encompasses a wide variety of activities in support of the Laboratory. These activities and the organizational structure of the A&O Waste Minimization Program are shown in Fig.3. Many of these activities generate wastes and are of such diversity that they must be reviewed independently. A summary of the waste generating activities follows. In all minimization activities, the options for reducing wastes are considered based on the waste management hierarchy depicted in Figure 4.

✓ The Hazardous Waste Management (HWM) Division operations generate hazardous, radioactive and mixed wastes in the Decontamination facilities at Building 419, and as a result of chemical analysis activities in the Environmental Analytical Science Laboratory in Buildings 222 and 226. HWM also operates the Laboratory's silver recovery process located in Building 411. The total volumes of waste generated are small.

✓ The Hazard Control Laboratories generate small waste streams from bio-assay analysis and some low level radioactive waste streams.

✓ The Medical Department laboratories generate small volumes of wastes, including "sharps", in performing routine physical examinations for current and prospective employees. The total volumes of infectious waste generated are small.

✓ The Automotive Fleet Division vehicle maintenance operations generate the usual garage type waste streams. Due to State of California regulations, an extensive network of off-site recyclers can provide commercial recycling services. For several years the maintenance operations have taken advantage of these services. Waste motor oils are recycled. "Safety Kleen" provides a solvent recycle service including equipment for small parts cleaning which significantly reduces waste solvent wastes. Off-site recycling of anti-freeze wastes is being implemented.

✓ The Technical Information Department photo labs generate modest size waste streams in support of Laboratory wide activities. The principal waste streams are film rinse waters.

✓ The Plant Engineering Department is responding to the impact of the Montreal Protocol on the reduction and eventual elimination of chlorofluorocarbons (CFCs), e.g. the Freons, for use in refrigerants and air conditioning. The

Department is also responsible for operation of the Laboratory wide Low Conductivity Water Cooling System. In 1986, significant changes in operating procedures produced large reductions in wastes associated with operation and maintenance of this system.

The Plant Engineering Department also has two small photo processing units in Buildings 551 and 3778. Waste silver solutions are sent to HWM for silver recovery. Additionally, a Diazo printing operation (see Attachment 2) produces about one ton of wastes per year.

The Space and Site Planning Group of Plant Engineering also runs a photoprocessing operation. Attachment 3 details their waste quantity and composition.

The Plant Engineering Craft Shops currently generates large volumes of rinse waters in the spray booths and other cleaning and maintenance operations. Attachment 4 contains flowsheets describing these operations and wastes generated.

Plant Engineering also generates classified waste paper and asbestos contaminated wastes. These waste streams are detailed in Attachment 5.

Safeguards and Security generates a very small waste stream from their equipment cleaning operations. They have already substituted the use of chlorinated solvents with a water based cleanser.

IV. Description of Waste Minimization Activities To-Date and Schedule of Planned Activities.

Informal waste minimization activities already in place have been reviewed and where necessary updated. Additionally, administrative controls, modified operating procedures and installation of new equipment will provide the necessary source reduction achievements.

Waste minimization activities exist for each of the waste streams identified in Section III, above.

Source substitution is the principal reduction tool for the Hazardous Waste Management (HWM) Division operations. Work on substitution of water and proprietary commercial compounds for acid and/or organic solvent decontamination fluids continues and provide a promising technique for reduction by substitution of non-hazardous solvent to eliminate generation of a mixed waste stream.

Administrative control will be the principal source reduction method for the Hazard Control Laboratories. This also applies to the Automotive Fleet Division's vehicle maintenance operations.

To significantly reduce the waste from the Technical Information Department photo labs there are plans to install a low temperature vacuum evaporation process unit in order to recycle the rinse water feed. Concentrated silver solutions are sent to HWM's 411 silver recycling facility. Installation of the vacuum water recycling units should allow achievement of significant reduction in waste generation.

Installation of a centrifuge to separate paint sludge and solvents from the rinse water thereby allowing recycle of the water back to the spray booths will significantly reduce the generation of this waste stream.

Engineers in Plant Engineering's Design Division are choosing different Freon mixtures for air conditioning design for new and proposed buildings. A detailed engineering study is underway of existing air conditioning systems to study retrofit problems for existing systems. Future impacts on capital funds for system replacement and retrofit costs will be large. Operating costs for these systems will also be large. Projected costs for the Freon replacements show a factor of up to 30 times greater costs for the replacements. As more information becomes available this section of the mini-plan will be updated.

Waste minimization is also being implemented through changes in operating procedures and through purchasing policies. The Supply and Distribution Department has initiated two very useful changes in procedures that reduced use of hazardous materials by the Laboratory overall. In 1986, S & D started issuing organic and chlorinated solvents in 5 gallon containers instead of 55 gallon drums. The use of solvents decreased nearly a factor of 10 by this new procedure. S & D is changing its chemical stocking procedures so that laboratory chemicals will be delivered directly from the wholesale distributor rather than being carried in the main storeroom. This procedure will minimize the generation of out-of-date/over-age waste chemical reagents that must be packed for off-site disposal, an expensive disposal method. As the Hazardous Chemical Tracking System matures, additional procedural modifications may produce other source reduction achievements by the S & D Department.

Work on integrating possible procedural changes in the handling of purchase requests by the Purchasing Department to minimize the purchase of both the quantity and type of hazardous materials is starting. How to achieve the objective of minimizing the purchase and use of hazardous materials or perhaps substituting non-hazardous materials with the shortest of administrative procedures to reduce programmatic impacts is the goal.

The reduction of the amount of waste paper sent to the local sanitary landfill by recycling waste office paper is one of our goals. A Recycling Working Group, reporting to the overall WMSC, has been organized and is currently evaluating commercial recycling alternatives.

We will also be investigating the substitution of non-plastic containers by the cafeteria contractor for the various types of food containers currently used. Elimination of styrofoam would be one objective. An initial meeting with the Cafeteria contractor has occurred. Alternatives are under study.

V. Description of Technology Transfer Activities

The A&O Waste Minimization Plan includes numerous technology transfer activities. These activities are based throughout different divisions and at different management levels. High level management personnel are involved in the LLNL Waste Minimization Steering Committee, and are members of the Program Recharge, Program Planning, and Recycling Working Groups. Also, A&O personnel have attended professional meetings on subjects such as environmental law and waste management.

A&O personnel keep informed of technical advances via membership in bulletin boards such as DOE's Waste Information Network, EPA's EIES (Electronic Information Exchange System) and, the Superfund/Solid Waste Technology Transfer Electronic Bulletin Board. In addition, personnel throughout the Directorate interact heavily with state, local, trade, and academic organizations on waste management and minimization.

VI. Description of Program Performance Evaluation

The A&O waste minimization effort will be reviewed on an annual basis to identify additional opportunities for source reduction and recycling. These annual reviews will emphasize the application of new technologies for waste reduction as they become known, keeping in mind the options for reducing wastes using the waste management hierarchy (see Fig. 4).

A&O Waste Minimization Program Functional Responsibilities

Figure 1

A&O Waste Minimization Program Projected Waste Reduction

JCD W&EP H&M 6/90

Figure 2

A&O Waste Minimization Program

Hierarchy of Waste Minimization Plans

Figure 3

Figure 4

Options for Reducing Wastes Using the
Hazardous Waste Management Hierarchy

**Attachment 1. Director's Statement on
Waste Minimization**

DIRECTOR'S STATEMENT ON WASTE MINIMIZATION

It is important that the Laboratory make a strong commitment to waste minimization -- to substantially reduce waste generation and increase recycling. Our goal is to achieve a significant overall reduction in the next few years. We plan to implement an incentive system where each Laboratory program will pay the costs associated with its wastes. Each program will also establish waste minimization goals and to develop plans and assign responsibility for achieving these goals.

John H. Nuckolls

Director

Attachment 2. Plant Engineering Print Room

Plant Engineering Print Room

Attachment 2

Attachment 3. Space and Site Planning Graphics Group

The Space and Site Planning Group uses Kodak Itek Fixer, Kodak Itek Universal Developer, and Agfa-Gaevert Itek Instacolor Activator in photoprocessing cameras. This use leads to the generation of 876 lbs. of waste (of these spent chemicals). The attached sheets detail material balances and composition of these chemicals.

Kodak Itek Fixer

IN

COMPONENT(S):	Percent	TLV*	Accession No.	CAS Reg. No.
Water	65-70	---	035290	7732-18-5
Ammonium thiosulfate	15-20	---	909586	7783-18-8
Ammonium thiocyanate	10-15	---	900433	1762-95-4
Acetic acid	1-5	10 ppm	900763	64-19-7

SPENT

ammonium thiosulfate	15	10	%
ammonium thiocyanate	10	5	%
acetic acid	3	0	%
water	balance		
silver	600	200	ppm
nickel	3	0	ppm
pH	6.5	5.5	

Agfa-Gaevert Itek Instacolor Activator

IN

<u>Ingredients/Synonyms</u>	<u>CAS No.</u>	<u>PERCENTAGE</u>	<u>TLV (Units)</u>
Methylpropylpanediol	78-26-2	1 - 5%	---
Cyclohexanedimethanol	105-08-8	1 - 5%	---
Trisodium Phosphate	7601-54-9	1 - 5%	---
Sodium Hydroxide	1310-73-2	1 - 5%	2mg/m ³ Ceiling

SPENT

<u>methylpropanediol</u>	<u>5</u>	<u>1</u>	<u>%</u>
<u>cyclohexanedimethanol</u>	<u>5</u>	<u>1</u>	<u>%</u>
<u>trisodium phosphate</u>	<u>5</u>	<u>1</u>	<u>%</u>
<u>sodium hydroxide</u>	<u>5</u>	<u>1</u>	<u>%</u>
<u>alkaline strength</u>	<u>1.2</u>	<u>0.6</u>	<u>N</u>
<u>silver</u>	<u>10</u>	<u>5</u>	<u>ppm</u>
<u>chromium</u>	<u>0.1</u>	<u>0</u>	<u>ppm</u>

Kodak Itek Universal Developer

IN

SECTION II - HAZARDOUS INGREDIENTS (TYPICAL VALUES-NOT SPECIFICATIONS)

<u>Ingredients/Synonyms</u>	<u>CAS No.</u>	<u>PERCENTAGE</u>	<u>TLV (Units)</u>
Sodium Hydroxide	1310-73-2	Less than 1%	2mg/m ³ Ceiling
Trisodium Phosphate	7601-54-9	1 - 5%	---
Sodium Sulfite	7757-83-7	1 - 5%	---
Hydroquinone	123-31-9	1 - 5%	2mg/m ³
Methylphenidone	2654-57-1	Less than 1%	---
Methylaminoethanol	109-83-1	1 - 5%	---
Glycerine	56-81-5	1 - 5%	10mg/m ³ (inst)

SPENT

<u>sodium hydroxide</u>	<u>1</u>	<u>0</u>	<u>2</u>
<u>trisodium phosphate</u>	<u>5</u>	<u>1</u>	<u>2</u>
<u>sodium sulfite</u>	<u>5</u>	<u>1</u>	<u>2</u>
<u>hydroquinone</u>	<u>5</u>	<u>1</u>	<u>2</u>
<u>methyl aminoethanol</u>	<u>5</u>	<u>1</u>	<u>2</u>
<u>glycerine</u>	<u>5</u>	<u>1</u>	<u>2</u>
<u>water</u>	<u>balance</u>		
<u>silver</u>	<u>1</u>	<u>0</u>	<u>ppm</u>
<u>chromium</u>	<u>.55</u>	<u>0</u>	<u>ppm</u>
<u>pH</u>	<u>11.3</u>	<u>10.8</u>	

**Attachment 4. Plant Engineering Craft
Shops Flowsheets**

OILS, SOURCE - BUILDINGS 511 & 519

Waste oil streams are a by-product of normal routine maintenance performed on various plant equipment, i.e. chillers, compressors, heavy equipment. Other oil waste streams that are generated by the Programs are normally vacuum pump oil and in the high voltage area, the change out of transformer oil.

Total pounds per year - 52,000

RINSE WATER, SOURCE - BUILDING 418

Rinse water waste stream is a by-product of the spray booth operation in Building 418. Water is used to trap the paint spray mist and is pumped out into holding tanks.

Total pounds per year - 20,000

SLUDGE, SOURCE - BUILDING 519 STEAM CLEANING AREA

Heavy equipment, tools and pumps require periodic steam cleaning. The result of this activity is an oil, dirt sludge that is collected in the sump of the steam cleaning area. The sump is cleaned out on a regular basis, the sludge is put into drums and processed as hazardous waste.

Total pounds per year - 4,500

FREON, SOURCE - BUILDING 511

Freon waste streams are primarily a by-product of various cleaning activities. Those types of activities are high pressure regulators and vacuum pump overhauls.

Total pounds per year - 3,200

PAINT, SOURCE - BUILDING 418

General use is primarily in refurbishment of facilities and structures. Other uses as in the paint coating of programmatic items and experimental as well as normal aesthetics use. This waste stream provided by this activity is leftover paint that cannot be re-used due to special mixing of colors as well as unique properties of some products like epoxy base.

Process

Total pounds per year - 18,600

PAINT THINNER (LACQUER & SOLVENT)
SOURCE - 30% LABOR ONLY, 70% BUILDING 418

Primary use of this product is for thinning paint and other coating products. Cleaning of coating equipment such as sprayers, brushes and rollers is the primary use of the solvent based thinner. Waste streams that are produced in the use of these products are mixed coating and thinner residues and dirty solvent thinner after cleaning equipment.

Total pounds per year - 7,700

**Attachment 5. Plant Engineering Classified
Waste Paper and Asbestos Abatement
Flowsheets**

CLASSIFIED WASTE PAPER, SOURCE - HAMMERMILL

Classified waste paper is picked up throughout the Laboratory on a daily basis. This waste is transported to the central hammermill where it is shredded, compressed and bagged. The bales are then sold to outside vendors for recycling.

Total pounds per year - 500,000

ASBESTOS, SOURCE - LABORATORY WIDE

Plant Engineering has been involved in incidental asbestos abatement for many years. The material removed from damaged pipe lagging and other asbestos containing items are bagged at the worksite and transported to a WAA.

Total pounds per year - 2,750

DIRECTORATE MINI PLAN

for

BEAM RESEARCH AND MFE

HAZARDOUS WASTE MINIMIZATION MINIPLAN

**Beam Research Program
Magnetic Fusion Energy Program**

**Prepared by
Stephen M. Hibbs
Samuel F. Eccles**

January, 1990

HAZARDOUS WASTE MINIMIZATION MINIPLAN

Beam Research and Magnetic Fusion Energy Programs

I. INTRODUCTION

The Beam Research (BR) and Magnetic Fusion Energy (MFE) Programs are engaged in research leading to applications of charged-particle beams and of magnetically-confined fusion reactions. They comprise a single Programmatic directorate and are historically connected, the Beam Research Program originating as an offshoot of MFE. They continue to share many buildings and support resources.

Both conventional and technical facilities vary greatly in age. Most office buildings and light laboratory spaces are 10 years old or less, while most of the major technical buildings are 30 to 40 years old, and include the oldest laboratory building at the Livermore site. The experimental machines and support equipment are from 1 to 15 years old. The Programs' electrical energy capacity requirements are larger than those of the rest of the Laboratory combined, so we have a very large collection of heavy electrical equipment that ranges from 10 to more than 30 years old.

Research in the BR and MFE Programs is characteristically performed using a few very large experimental machines with relatively long service lives. Two generic kinds of hazardous waste streams result. Operation and support of these machines generate small but continuous hazardous waste streams. Decommissioning an experiment at the end of its life happens infrequently, but may generate a large amount of hazardous waste in a relatively short time.

The BR and MFE Programs are treated in this Miniplan as a single waste source because their hazardous waste streams are generated in common support facilities and are collected at a single waste accumulation area.

This Miniplan is confined in its geographic scope to the BR/MFE complex outlined in Figure 1 (Site Map) and to the Advanced Test Accelerator (ATA) facility at Site 300, Figure 2.

When the ATA operated at its full electron beam energy of 50 MeV, radioactive nuclides were created. The bulk of the resulting radioactive waste is in the form of activated aluminum. This radioactive waste has been safely stored in controlled areas set aside for this purpose at Site 300. After a few years, it will decay to non-hazardous levels and will be disposed of as ordinary waste. We do not project further radioactive waste production at ATA in the foreseeable future, and neither the BR nor the MFE Program currently generate any other radioactive waste streams. This Miniplan therefore confines itself to discussion of hazardous waste, and does not address radioactive waste or non-hazardous waste.

II. MANAGEMENT BY THE PROGRAM

The Director of LLNL has committed the Laboratory to a policy of hazardous waste minimization. In this Miniplan, the BR and MFE Programs commit to a real reduction in their flow of hazardous waste. The Associate Director (AD) for Beam Research and Magnetic Fusion Energy is responsible for this reduction of waste generation by the Programs. The AD has appointed a representative to serve on the LLNL Waste Minimization Steering Committee, and the position of Waste Reduction Coordinator for the Programs has been created.

Responsibility for hazardous waste minimization is delegated from the AD to supervisors and to people responsible for the experiments. Each experimental program's Lead Experimenter is responsible for assessing the hazardous waste products of his or her experiment, and for adopting alternatives, consistent with scientific objectives, that will reduce them. The supervisors of machine shops and assembly areas that support experimental programs have the responsibility for assessing their waste streams and, with appropriate management people, determine which alternate processes will reduce the hazardous waste products. These managers are responsible for motivating their employees to implement the measures selected.

A waste reduction oversight group will be formed to oversee the Programs' waste streams, consider and propose alternatives that will reduce waste, and help motivate employees to implement waste minimization measures selected and approved

by Programmatic managers. The members will include the Programs' Waste Reduction Coordinator, the AD's representative to the LLNL Waste Reduction Steering Committee, and one representative each from the BR and MFE Programs, from the matrixed engineering disciplines, and from the local Hazards Control team.

Personnel affected by newly adopted waste minimization processes will be trained in their implementation. This training will be in the form of classes given either by the Programs themselves or by the Hazards Control and Environmental Protection departments.

Once trained, all personnel will be accountable to the AD for implementation of the LLNL Waste Minimization Program Plan.

III. CHARACTERIZATION OF BR/MFE WASTE STREAMS

These Programs generate two characteristic kinds of hazardous waste streams:

1. A more-or-less continuous flow of waste results from operating their experimental machines and from support operations. Of the support areas, the local area machine shop is the dominant contributor. Its waste output varies greatly and depends on whether the experimental machines are operating (small output) or are shut down for modification (larger output). These waste streams lend themselves to minimization, and will be identified hereafter simply as "operational" hazardous waste.

2. Infrequent but massive amounts of waste may be created when a major experimental machine and/or conventional facility is demolished or undergoes a major reconfiguration. These waste loads are not subject to minimization, and will be identified hereafter as "one-time" hazardous waste. These machines and facilities were built long before there was concern with waste minimization and before some materials used in their construction were known to be hazardous. Also, we are uncertain when they will be decommissioned. As these facilities are dismantled or modified, we will deal immediately with all the waste material we encounter regardless of kind or amount.

Contents of the operational waste streams:

The LLNL Hazardous Waste Management (HWM) Waste Disposal database shows that the MFE and BR operational waste streams have historically consisted of:

- Oils - cutting oils from machine shop operations (declining usage) and hydrocarbon vacuum pump oils (synthetic oils are very expensive and have always been recycled)
- Solvents used for degreasing and incidental cleaning
- Fluorocarbon dielectric coolant from operation of induction linear accelerators
- Copper sulfate from accelerator load resistors
- Oil-filled capacitors and transformers (sometimes with PCB's , but most of these have been disposed of)
- Chips and dust from machining structural laminates made of reinforced resins - fiberglass/epoxy is most prevalent
- Miscellaneous chemicals (unused paint, mercury, etc.)
- Miscellaneous solids (lead, beryllium, fiberglass, etc.)

(The average output of operational hazardous waste disposed of by the BR and MFE Programs in 1989 was on the order of 4 barrels plus 800 pounds of miscellaneous items per month. These averages represent a relatively small operational waste stream.)

The following MFE/BR experimental facilities are currently in operation. They and their support facilities are currently the sources of the Programs' operational waste streams:

- ETA-II (BR linear induction accelerator)
- MTX (MFE tokamak, sometimes operated in conjunction with ETA-II)
- High Field Test Facility (superconducting magnet research)
- ARC (research in advanced accelerator concepts)
- High Power Test Stand (research in advanced pulsed power sources)
- RACE (Ring ACcelerator Experiment)
- DDT (Davis Diverted Tokamak)

Future changes in research missions will eventually cause these facilities to be modified. This may change the character of their operational hazardous waste streams.

Expected contents of one-time waste loads

It is not possible to predict all the hazardous waste that might be discovered when an old experimental machine is disassembled or an old facility decommissioned. A survey of the expected contributions would be prepared shortly before starting such work. At least the following might be expected in sizable quantities:

- Oil-filled electrical switchgear, capacitors, and transformers, some of which might contain dilute PCB's.
- Dielectric cooling systems employing fluorocarbon coolants
- Mercury diffusion vacuum pumps
- Oil-filled and mercury-contaminated mechanical vacuum pumps and piping
- Components coated with loosely-bound titanium
- Reinforced resin structural laminates
- Plastic foam insulation of various types
- Asbestos pipe lagging, structural fireproofing, and building siding panels

(A one-time waste load is illustrated by the removal, packaging, and disposal by the MFE Program in December, 1989 of 5,500 PCB-filled capacitors (330,000 pounds) at a cost of \$410k.)

MFE/BR facilities that may eventually become sources of large one-time hazardous waste contributions include:

Experimental machines already out of service:

- MFTF-B (demolition)
- MFTF-B ADCPS electrical switchyard (demolition)
- TMX-Upgrade (demolition)
- High Voltage Test Stand (demolition)

Experimental machines still in service:

- MTX (major reconfiguration)
- ATA (Site 300) (major reconfiguration)
- ETA-II (major reconfiguration)
- ARC (major reconfiguration)
- High Power Test Stand (major reconfiguration)
- High Field Test Facility (major reconfiguration)
- RACE (major reconfiguration)
- DDT (demolition or major reconfiguration)

IV. THE BR/MFE PROGRAMS' WASTE REDUCTION GOALS

The Programs' main objectives are to achieve real reductions, to the extent feasible, in the amount of operational hazardous waste, and to minimize the costs of managing it. To reduce operational waste, we will institute the following plan.

In the first year:

The goal of the Programs for the first year this Hazardous Waste Miniplan is in effect will be to determine accurately the volumes, masses, categories, and costs of operational hazardous waste generated, and compute their generation rates as a function of our "Unit of Production". This computation is described in detail in Section VI. These will be the baselines against which future generation rates and costs will be compared.

In succeeding years:

The goal will be to reduce the operational waste generation rates per "Unit of Production" at the end of the fifth year by 25% to 30% of the baseline rates determined in the first year. Expressing this goal in terms of generation rates instead of absolute quantities will allow us to demonstrate the effectiveness of our waste reduction efforts even as our waste-generating workload fluctuates. Adoption of this goal instead of a more ambitious one is supported by operational waste output that is already relatively small, and by the fact that gains are harder to achieve in older facilities like ours. Only our office spaces and a few small technical spaces are less than thirty years old. The major technical buildings are thirty to forty years old, and MFE's Building 431 is the oldest dedicated laboratory building at the Livermore site. Our experimental machines, some of which are not currently operating, range in age from 2 to 15 years.

The measuring system described in Section VI will be used to determine how effectively this goal is being met.

An additional goal in the succeeding years will be to reduce the cost recharges due to hazardous waste disposal compared to recharges incurred in the first year, and to avoid offsetting the savings with associated Programmatic administration costs.

One-time hazardous wastes resulting from demolishing or reconfiguring our old facilities may temporarily overshadow the Programs' operational waste streams. Their timing depends on the Programs' scientific objectives and funding levels, and cannot be predicted today.

If the main objectives of true waste minimization and of cost reduction are met, then additional benefits should follow, namely, improved compliance with laws and regulations, reduced occupational health and accident risks, improved operating efficiency, and improved relations with the community outside the Laboratory.

V. METHODS OF MINIMIZING WASTE

✓ Generally, the principal avenue open to us for operational waste minimization is to seek non-hazardous alternatives to the oils, chemicals, silicon compounds, Freon, and other fluorocarbon compounds presently used in significant quantities. These wastes can be measured with respect to the "Unit of Production" as outlined in Section VI below.

Improvements in housekeeping practices and disposal of unused equipment should also give us substantial early gains. This activity has already begun in earnest in both Programs.

A recurring contribution to the waste stream is the scheduled replacement of oil in mechanical and turbomolecular vacuum pumps. Synthetic oils have always been recycled. It should be possible to recycle hydrocarbon oils, too, to avoid wasting them. The vendors we buy from are willing to do this on either a purchase order or contract basis.

✓ In these Programs' experimental machines, materials are often used far beyond their rated capacities and must often be replaced much sooner than they would be in applications for which they are rated. For example, an electrical breakdown through the fluorocarbon dielectric fluid in an induction linear accelerator contaminates the fluid with byproducts that make it impossible to continue operating the accelerator. Waste minimization cannot be a factor in the decision to replace the fluid. The replaced fluid is likely to momentarily dominate the

Programs' operational waste stream and, like one-time waste, it is irreducible.

It is recognized that the awareness and motivation of individual employees are the ultimate keys to the success of the LLNL Waste Minimization Plan. Therefore, all personnel working within the BR and MFE Programs will be provided with current copies of this Miniplan, and other methods will be devised and implemented to foster a "minimum-waste culture"

VI. MONITORING WASTE MINIMIZATION

QUANTIFYING THE OPERATIONAL WASTE STREAMS

Our method of quantifying the Programs' existing operational waste streams, both initially and when assessing our reduction efforts, is designed to reflect real gains or losses in our rate of operational hazardous waste production, even as our waste-producing workload fluctuates. It will work as follows:

When this Miniplan goes into effect: We will divide our operational hazardous waste output, as reported by the Hazardous Waste Management Waste Disposal database, into no more than ten categories, much as they are categorized in Section III. This categorization, while subject to review, will not ordinarily change over time.

On a monthly basis thereafter:

1. Every line item in the database will be assigned to one of the categories described in the preceding paragraph.
2. An Adjusted Total Cost will be computed for the month. It will serve as the Programs' mandated "Unit of Production". It will consist of the sum of all wage expenses except those for computations and scientists from other programs, plus S & E charges for procurements, stores, contract labor, ME fabrication recharge, administration, and electricity. The intent is to include the costs of activities in the Unit of Production that truly affect the rate of hazardous waste generation and to exclude those that clearly do not. These assignments are slightly arbitrary, because some activities certainly will fall into gray areas, yet the arbitrariness is necessary to keep the computational workload reasonable.

3. The quantity of each category of operational waste, in pounds or gallons, will be divided by the Programs' Adjusted Total Cost (Unit of Production) for that month. If, for example, our ("Unit of Production") for a month is \$1.0 M and we generate 50 pounds within a given hazardous waste category in that month, the basis for that waste category, B, for comparison with past and future months is

$$B = \frac{50 \text{ pounds}}{\$1.0M} = 5.00 \times 10^{-5} \quad \begin{array}{l} \text{(units omitted to avoid} \\ \text{confusion with costs of} \\ \text{disposal)} \end{array}$$

Quantifying the one-time waste loads

Records of the one-time hazardous wastes generated by the demolition or major modification of our facilities, when it occurs, will be kept separate from the monthly computation of operational waste streams. They will be documented, but since they will be irreducible, no statistical analysis or comparison with other waste streams is contemplated.

The Waste Reduction Coordinator will be responsible for collecting the data, performing the calculations described above, and maintaining the data files needed to evaluate and report on the Programs' waste minimization efforts.

The Programmatic oversight group will, over time, target specific major contributors to the Programs' operational waste stream. Intensive efforts will be made to reduce their rate of generation. Opportunities will be sought to minimize these waste products and their costs through materials substitution, changes in the processes that create them, and input to the design of new processes and experimental machines where possible. The waste minimization goals outlined above will form the criteria for selecting targeted materials and processes. The Oversight Group may institute source controls for these materials so that they can be traced through the processes that consume them and so that the fraction that becomes hazardous waste can be identified.

VII. COSTS OF WASTE HANDLING

The Laboratory has studied a hazardous waste recharge system for all programmatic generators so as to fully allocate waste disposal costs to the generators. Ambiguity in Department of Energy funding levels for waste management operations has complicated the Laboratory's plan to implement a cost incentive-based allocation system. Alternatives to the initial recharge program are currently being studied. One of these alternatives will be implemented at the LLNL after final funding levels are determined, and the BR and MFE Programs will then conform.

VIII. INFORMATION EXCHANGE

Sources of ideas for new waste reduction strategies will come from employees, from data bases and informational publications at LLNL, from other DOE laboratories, and from industry. These sources will be monitored by the Programmatic oversight group for new processes and procedures. (Example: investigating ongoing research seeking replacements for chlorofluorocarbons by LLNL's Atmospheric and Geophysical Sciences Division, reported in *The Daily Clips*.) Any new process we devise will be available to LLNL databases. Conferences and workshops will be a major forum for exchange and we would plan to attend these where appropriate to the Programs.

IX. AUDITS AND EVALUATIONS

The Programmatic oversight group will review and prepare annual written reports on the effectiveness of the Programs' waste minimization effort. The reviews will address, as a minimum, progress toward the Programs' waste minimization goal as stated in this Miniplan, compliance with current laws and regulations, the impact of waste minimization procedures on the Programs' scientific and support work, the cost/savings attributable to the waste minimization effort, changes needed in the Miniplan, and recommendations for changes in the LLNL Waste Minimization Plan.

The reports will be distributed to everyone in the Programs who has accountability for execution for a part of this Miniplan, and to the LLNL Waste Minimization Steering Committee. The first report will be dated one year after formal implementation of this Miniplan. One additional informal review will take place six

months after formal implementation of this Miniplan, and the report will be distributed only to Programmatic management.

In addition, the oversight group will be responsible for coordinating audits and responding to inquiries on waste minimization from outside the Programs.

Figure 1. The Beam Research and Magnetic Fusion Energy complex at the LLNL Livermore site

Figure 2. The Advanced Test Accelerator (ATA) facility at Site 300

DIRECTORATE MINI PLAN

for

BIOMEDICAL AND ENVIRONMENTAL RESEARCH

Waste Minimization Plan for the Biomedical and Environmental Sciences Research Program

September, 1989

The Biomedical and Environmental Sciences Research (BER) Program at Lawrence Livermore National Laboratory, has reviewed its research goals and operations and formulated a plan of action that will allow its staff to contribute to the minimization of wastes produced at LLNL. This plan is in keeping with the national priority to reduce the amount of hazardous waste produced by our nation and to reduce the impact on the environment of the disposal of wastes that are produced. The approach primarily utilizes procedures established within the BER Program but also relies upon the waste requisition data resources of the Hazardous Waste Management Group. The primary components of the plan, education and administrative controls, will ensure that careful review of the nature and volume of wastes generated in our ongoing research operations occurs on a regular basis, that new operations are carefully scrutinized for waste minimization options, and that successful approaches to waste minimization are shared with all staff to maximize their impact. It is expected that these actions will have the additional benefit of helping to control the costs of waste disposal.

It is intrinsic to our research missions in genetic toxicology, monitoring of environmental exposures, and molecular genetics to work with hazardous chemicals and radioisotopes. Our operations include many research groups with widely diverse and independent goals. Generation of wastes containing toxic materials, radioactive materials, biohazardous materials, and mixtures of these is inevitable. We will work, however, to identify and adopt new practices and new technologies that permit reduction of the amount of waste generated wherever it is safe to do so. Many of the elements of this program are already in place.

It will continue to be BER Program policy to make conservative judgements about the hazardous nature of waste generated in our research. For example, unless it is directly determined that no toxic materials are present, culture fluids or other materials exposed to toxic materials will be disposed of with the assumption that the toxic materials are present. Mutagens, carcinogens, and presumptive carcinogens at any concentration will continue to be disposed of as hazardous waste; there is no method to determine the risk of their disposal by other means.

The plan outlined below identifies both administrative controls and educational programs that will help ensure that minimization of waste occurs when possible and that these efforts are documented.

THE PLAN

Administrative Controls

Guidance Documents: The operations of the BER Program are performed under Facilities Safety Procedures (FSPs) and Operational Safety Procedures (OSPs) developed by the Program with the guidance of the Hazards Control and Environmental Protection Departments. When each of the FSPs comes due for revision, sections explaining the rationale for minimization of waste production and examples of activities that minimize waste or reduce its toxicity, will be incorporated. Approval of new OSPs, and renewal of old OSPs, will require that the amount and types of waste generated have been reviewed for minimization and that substitutes for processes or materials have been considered and adopted where possible.

med expansion *Ordering:* Where possible, redundancy, waste and toxicity of chemicals will be reduced. (1) Orders of carcinogens, chemicals whose handling and disposal require special care, will require confirmation that the requested items are not currently available in satisfactory form in our carcinogen handling facility. These orders currently are funnelled through one office, so no major revision of procedures is required. The log of carcinogens held by the BER Program will be made available to this office. (2) During inventories of the BER storeroom, it will be determined if there are items that are being discarded due to expiration of useful shelf life. If so, the amount of these items ordered will be reduced. (3) Whenever possible, when less toxic substitutes of stock items become available, they will be substituted, even if these are not available through the Central Supply Department.

Recycling: New users will be sought for surplus chemicals that would otherwise become waste. Scientists will be urged to segregate materials that the Laboratory has determined can be recycled.

Audits: Summaries of the wastes produced by each working group, made possible by recovery of data from the Waste Requisition Forms by the Hazardous Waste Management Group, will be shared with them to alert them to the types and volumes of materials generated. Successful methods of reducing either the volume or the toxicity of waste will be shared with each generator so that each may determine the relevance of these approaches to his/her research program.

Education

Individual scientists can have the greatest effect on the amount of waste generated if they are aware of the impact of their actions. It is necessary that they understand the value of reduction of the toxicity of waste generated, of segregation of wastes, as well as the overall reduction of volume of waste. The costs of disposal or treatment of different types of waste will be distributed to all waste generators. When known, changes in disposal practices that affect the cost of waste disposal will also be shared with BER staff.

There are currently several formal training conduits for explaining and encouraging waste minimization practices: our BER Program Safety Orientation course (HS92B), offered for scientific staff twice a year, and the Environmental Protection Department courses for waste generators.

In addition, periodic memos are distributed to all our staff that draw attention to new technologies or products whose adoption can lead to reduction of waste.

Summary

This plan for minimization of waste generation in the Biomedical and Environmental Sciences Research Program will permit the staff and administration of this Program to continue its research on the impact of hazardous agents on man and the environment in a responsible manner.

DIRECTORATE MINI PLAN

for

CHEMISTRY AND MATERIALS SCIENCE

CHEMISTRY AND MATERIALS SCIENCE DEPARTMENT WASTE MINIMIZATION PLAN

INTRODUCTION

The "Hazardous and Solid Waste Amendments of 1984" have increased the difficulty and expense of disposal of hazardous wastes. Some wastes, such as liquids and extremely toxic substances are now banned from land disposal, the conventional method of disposal used by industries for hazardous waste disposal. Inadequate containment of wastes after disposal has resulted in contamination of air, water, and land resources. In response to a number of highly publicized incidents (e.g., Love Canal and Times Beach), Congress has passed new laws resulting in the closure of many disposal sites. California previously had eleven disposal sites; now it has one.

Congress has mandated that waste production be minimized and that whatever waste cannot be eliminated be disposed of in a safe manner. Waste minimization has long been a goal of congressional action. The "Federal Water Pollution Control Act of 1972" set a goal of zero discharge of wastes to the nation's waters by 1985. The title of the original hazardous waste legislation, "Resource Conservation and Recovery Act of 1976" [RCRA] was cast in terms of reducing wastes rather than disposal of wastes. In the "Hazardous and Solid Waste Amendments [HSWA]" to RCRA in 1984, Congress stated it's policy clearly:

"The Congress hereby declares that it is the policy of the United States that, where feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste nonetheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment. And that the proposed method of treatment, storage, or disposal will minimize the present and future threat to human health and the environment." [RCRA section 1003(b) as amended by HSWA PL 98-616, Nov. 1984]

It is required by legislation that waste generators certify that they have in place a plan to minimize waste generation. Until the publication in the Federal Register [June 12, 1989, vol 54, no. 111] by the Environmental Protection Agency of "Draft Guidance to Hazardous Waste Generators on the Elements of a Waste Minimization Program", there was no clear indication of what level of program would be considered to satisfy the intent of the legislation. Prior to the publication of the EPA draft guidance, the Department of Energy had defined waste minimization as any "action that minimizes the volume or toxicity of waste by: (1) avoiding its generation, or (2) recycling". Waste reduction was defined as "waste minimization plus any waste treatment that reduces volume or toxicity of waste requiring disposal". (DOE memo from T. E. Wade, acting assistant secretary for Defense Programs dated Oct. 20, 1988, and presentation materials used by J. Mathur, DP-12, in June, 1989).

Cost reduction provides a strong additional incentive to minimize wastes. Over the past several years, prices for disposal of liquid wastes have increased by nearly an order of magnitude; current costs average \$20 to \$25 per gallon, depending on the exact

DRA

type of waste. In the future, all liquid wastes will have to be treated and rendered into solid form prior to disposal. The costs of waste treatment and disposal now need to be factored into any experimental plan. Another cost that needs to be considered in the generation of waste is the time commitments required for waste disposal. The person generating the waste must provide a waste requisition form describing the nature of the waste prior to shipment for disposal. In the Chemistry and Materials Science Department, the waste generator is also responsible for packaging of the waste.

WASTE MINIMIZATION PLAN FOR CHEMISTRY & MATERIALS SCIENCE DEPARTMENT

DRAFT

There are several key elements that need to be included in a waste minimization plan. These elements are

1. Establishing the inventory of wastes generated.
2. Establishing methods of control for unintentional waste generation, e.g., by control of chemical stocks.
3. Factoring waste minimization into experiment and process design.
4. Ensuring proper segregation of wastes and recycling wastes where appropriate.
5. Training of personnel to ensure that waste minimization concepts are understood.

In the Chemistry and Materials Science Department, the majority of activities that generate wastes involve the use of chemical reagents and solvents in individual research and analytical laboratories. Consequently, our waste minimization plan will focus on control of chemical inventory and usage.

The first stage of our program will be an inventory of waste generation by each laboratory and an inventory of chemicals held by each laboratory. The information gathered by this inventory will be entered into a computer data base for use in tracking future chemical purchases and waste generation.

A central control system will be established for purchase of hazardous or toxic chemicals. Data related to purchase and subsequent disposal of wastes resulting from usage of these chemicals will be entered into the central data base. When a request to purchase a hazardous or toxic chemical is received, the inventory control clerk will determine whether a source of the substance already exists in the Department stocks. If such a source exists, the requestor will first be directed to the existing stock prior to authorization of purchase of new stock. The central data base will also track disposal cost for wastes from each laboratory.

Wastes generated in the laboratory will be placed in prelabelled containers. Every effort will be made to segregate non-hazardous wastes from hazardous wastes, and to avoid the

generation of mixed radioactive/hazardous wastes caused by improper disposal procedures.

Periodic inspections will be conducted to ensure that waste minimization and waste disposal requirements are being followed.

Laboratory personnel will receive training in the principles of waste minimization and the requirements for handling and disposal of hazardous and toxic wastes, and of radioactive wastes, where appropriate.

All bench top and pilot-scale experimental simulations that represent new procedures and involve chemical usage will require a formal experimental plan that lists reagent usage and expected waste generation. For those experiments expected to generate more than ten (10) gallons of liquid waste or twenty (20) pounds of solid waste, or ten (10) pounds of solid or one (1) gallon of liquid extremely (accutely) hazardous waste, or which have the potential for exceeding allowable air emission standards, the plan will establish whether

- a. the specified volumes and types of reagents are necessary;
- b. the waste by-products are amenable to reduction in volume and/or toxicity;
- c. the design has been optimized so that unnecessary waste generation is avoided;
- d. all ancillary systems are considered with respect to pollution abatement, equipment contamination, and energy and water conservation;
- e. in cases involving radioactive material, each low level waste generator has established methods to separate non-radioactive waste from low-level radioactive waste to facilitate cost-effective treatment and disposal.

We believe that the plan outlined above, when implemented, will lead to minimization of waste generation in the Chemistry and Materials Science Department. The plan involves commitment by management to inventory controls and to oversight, while retaining a high level of awareness and responsibility for waste minimization at the level of the laboratory scientist.

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DIRECTORATE MINI PLAN

for

COMPUTATIONS

The E-6 process is a color reversal process. It is also a semi-automated process. This process requires seven different chemicals to produce color slides and motion pictures. Of these seven chemicals, three are de-silvered and along with the other four flushed to the Lab sewage system. During the making of this minimization survey, we discovered a way to generate less waste and still produce a quality product. We made adjustments to our processing equipment and chemicals replenishment. We found that the E-6 process was highly adaptable to changes in the process. It lends itself well to waste reduction with minimum deficiency in the hue, contrast and overall color rendition of the film product. We were able to reduce our waste by one half. We accomplished this by mixing only the amount of chemicals that can be used in a two week period. Two weeks is the life span of most of the chemicals in this process. We replenish the solutions only when replenishment is necessary. This process is plotted on a graphic display chart and is controlled and monitored by a computer.

The hard copy negative (conventional) process is also a semi-automated process. This process contains two chemicals (developer and fixer). The fixer is de-silvered and along with the developer flushed to the Lab sewage system. This process is a low volume replenisher. Because of the nature of the process (two step), very little replenishment is required. This is also a very low volume user. However, we have made a one third reduction in replenishment rates. Due to the low volume of use, any lesser amount of replenishment will cause the chemicals to die off and increase our total usage.

Options. To further reduce chemical usage and waste.

1. Dry process (no Chemicals) Laser print.
2. Negative process (uses only two chemicals).
3. Negative process with Vesicular reversal.
4. Trade in com units XC's for XL's eliminates five (5) chemicals
5. Black and White reversal process. Five (5) chemicals.
6. Close down Com-units, use only FR80s, eliminate five (5) chemicals.

EVALUATION AND FEASIBILITY OF OPTIONS

1. The dry process can be used for alpha-numeric com, provided quality and storage for less than six months to one year is acceptable in the end product. The dry process is not acceptable for graphics or archival quality for the following reasons: To obtain the required tones and shades of gray in a graphic reproduction, a film must be able to record a minimum of 150 line pairs per inch. The very best a dry process can do is 50-60 line pairs per inch. To achieve archival quality, a product must be prepared and processed to last 50-100 years. The maximum life span of the laser dry process is six months to one year, depending on how it is stored. Given the lack of precise definition, and the short storage life time of this product, we believe our users would find it unacceptable.
2. The negative process has its advantages and disadvantages. The advantages are: We can totally eliminate ten chemical and use only two. It is totally acceptable for alpha-numeric and graphic output. It will record the required 150 line pairs per inch. It will record the required tones and shades of gray. It meets the required archival quality and storage period of 50-100 years.

The disadvantages are: Black letters or objects on a white background. This will cause eye strain on the user, because there is nothing to block the bright back ground light. (This is why the reversal process is used). The three XC Com units will have to be replaced with three XL Com-units. The photo lab will have to either re-model, or replace two film processors. The

diazo Fiche duplicator will have to be replaced with a Vesicular model. This type of output is intended for Hardcopy output, making prints from the original Negative, not for direct viewing for long periods of time. This option is very costly and would produce a lengthy perturbation in our ability to process output. There's some question about the products' acceptability.

3. The negative process with vesicular duplication reversal is the mating of the dry and negative process. This process creates the illusion of a reversal process. It uses the negative master to reproduce a seemingly reversal product. It brings with it all of the disadvantage of the dry process, and none of the advantages of the negative process. There is a built in twenty percent image degradation. This product is not suited for microfilming, if the end product is used for research and archival qualities.
4. Replace Com units XCs for XLs. The XC Com unit has a built in film processor that uses five chemicals (AutoPos 2000 process) to process the microfilm output. The XL Com unit comes with a Camera, take-up, and supply magazines, using the same configuration as the FR80s. The film from the XLs can then be processed in the Photo Lab using the microfilm reversal process. This will totally eliminate five chemicals from the inventory. This is, and probably will be, the most expensive way to eliminate five chemicals from the inventory. We currently have three XC Com units on hand. This option would increase the amount of waste from the Photo Lab Black and White processors.
5. Continue with Black and White Reversal Process. It is the ideal process for a microfilm end product. It has the advantages of a silver base image, very good resolving power, good resolution, the inherent ability to record fine details in tones, and shades of gray. It can correctly record 150-300 line pairs per inch. It is very good for long term viewing. It meets or surpasses archive requirements for quality, and long term storage. This process has one disadvantage; one of the chemicals used in the process is Sodium Dichromate. We must collect this chemical and send it off site for treatment. We are currently using approximately fifty gallons per month.

Close down the XC Com units, and use only the FR80s. The work load over the past year has not out paced the ability of the FR80s to handle the load. This has not always been the situation in the past, but it has been the situation for the past year. Closing down the Com units will have no effect on the user community in receiving their output in a timely manner. The advantage to this move, will be the total elimination of five chemicals from the inventory. The disadvantage is the inability of the FR80s to handle the workload should it return to previous levels.

DB

Don Birds
Photo Lab Supervisor
Network Operation Division

cc: P. Du Bois
C. Klutts
S. Mendicino

MICROFILM DEV. PROCESS

NOD PHOTOGRAPHIC LABORATORY

Waste Survey Table

For the period of August 1, 1988 thru August 31, 1989

STREAM ID NO.	PROCESS SOURCE	WASTE CHARACTERISTICS	HAZARD CLASS	RATE GENERATION	WASTE MANAGEMENT ON SITE	OFF SITE
6750 65123	Film Proc.	Water 50-55%	1B	249 Gal/Mo.	Sewage	
Microfilm Dev.		Potassium Sulfite 20-25%				
		Diethylene Glycol 5-10%				
		Hydroquinone 5-10%				
		Potassium Hydroxide 1-5%				
6750 65124	Film Proc.	Water 75-80%	2B	99 G /Mo.	Collected	Treatment
Microfilm Wash		Sulfamic Acid 15-20%				
		Potassium Dichromate 1-20 10%				
6750 45125	Film Proc.	Water 75-80%	1B	92 Gal/Mo.	Flushed to sewage	
Microfilm Clear		Potassium Sulfite 15-20%				
6750 59265	Film Proc.	Water 40-50%	1B	101 Gal/Mo.	Fiber Silver	Flush to sewage
Fixer		Ammonium Thiosulfate 40-45%				
		Sodium Acetate 5-15%				
		Acetic Acid 5%				
		Sodium Bisulfite 1-5%

AUTOPOS 2000 Chemicals		NOD PHOTOGRAPHIC LABORATORY				
		Waste Survey Table				
		For the period of August 1, 1988 thru August 31, 1988				
STREAM ID NO.	PROCESS SOURCE	WASTE CHARECTERICES	HAZARD CLASS	RATE GENERATION	WASTE MANAGEMENT ON SITE	OFF SITE
MX-1330	Film/Proc	Water > 80%	2G	16 Gal/Mo.		Treatment
1st Dev		Sodium Sulfite < 10%				
		2-Methylaminoethanol < 3%				
		Hydroquinone < 5%				
		P-Methylaminophenol sulfate < 1%				
MX-1330	Film/Proc.	Water > 80%	2G	16 Gal/Mo.		Treatment
2nd Dev		Sodium Sulfite < 10%				Treatment
		Hydroquinone < 5%				
MFPX-979-2/3M651						
Film	Film/Proc	Water > 90%	1B	16 Gal/Mo.	Filter Silver	Flush to sewage
		Ammonium Thioisulfate < 8%				
		Alkali Metal Sulfite < 2%				
		Acetic Acid < 2%				
		Alkali Metal Acetate < 1%				
DAR-776-Inc-51P	Film/Proc.	Water > 98%	1B	16 Gal/Mo.	Filter Silver	Flush to sewage
Film Wash		Alkali Metal Sulfite < 2%				
		Acetic Acid < 1%				
DAR-2-10630	Film/Proc.	Alkali Metal Sulfite < 1%	1B	16 Gal/Mo.	Filter Silver	Flush to sewage
Film Wash		Water > 99%				

E-6 COLOR PROCESS TREATMENT & DISPOSAL

HARDCOPY CHEMICALS NEGATIVE PROCESS			NOD PHOTOGRAPHIC LABORATORY			
Waste Survey Table						
For the period of August 1, 1988 thru August 31, 1989						
STREAM ID NO.	PROCESS SOURCE	WASTE CHARECTERICES	HAZARD CLASS	GENERATION RATE	WASTE MANAGEMENT ON-SITE	OFF-SITE
149-3956 RA2000 Dry.	Film/Proc.	Water 55-60% Sodium Potassium Sulfate 15-20% Diethylene Glycol 5-10% Hydroquinone 5-10% Potassium Hydroxide 1-5% Potassium Carbonate 1-5%	2-B	33 Gal/Mo.	Flush to Sewage	
197-3201 Rapid Fixer-B	Film Proc.	Water 65-75% Aluminum sulfate 10-20% Sulfuric acid 10-15%	1-B	12.5 Gal/Mo.	De Silver	Flush to sewage
186-6342 Rapid Fixer-A	Film/Proc.	Water 40-50% Ammonium Thiosulfate 40-50% Sodium acetate 5-10% Boric acid < 5%	1-B	12.5 Gal/Mo.	De Silver	Flush to sewage

HCV CHEMICALS NEGATIVE PROCESS DEVELOPER FINISH

DIRECTORATE MINI PLAN

for

ENERGY PROGRAM/EARTH SCIENCES

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WASTE MINIMIZATION PLAN FOR THE ENERGY PROGRAM/EARTH SCIENCES DEPARTMENT

The Energy Program/Earth Sciences Department has identified three locations within their area where waste is generated - Building 243 (the machine shop areas, the laboratories, and the High-Pressure Testing Facilities), Trailer 1402 (Rm. 1003 Dark Room); and Building 410.

CHEMICALS USED:

Building 243 - Chemicals used are acetone, alcohol (methanol, ethanol, isopropyl), toluene, methyl ethyl ketone, trichloroethylene, trichloroethane, carbon tetrachloride, and kerosene. There are numerous reagent grade chemicals used and stored in the building. Presently they are - hydrofluoric, hydrochloric, and nitric acids, acetic acid, sodium hydroxide, iodine, bromine, and salts. Cutting fluids/oils used are sulfur based cutting oil, A-9 aluminum cutting fluid, Cool Tool cutting fluid, and Trimsol water soluble oil in a 40:1 mix. Isopar-H, hydraulic fluid, and mechanical pump oils are also used.

Trailer 1402 Dark Room - Photographic chemicals (activators/developers).

Building 410 - Solvents are used to clean and recover product material from equipment used in retorting at the oil shale retort facility.

WASTE GENERATED:

Building 243 - Chlorinated and non-chlorinated solvents, non PCB oils, analytical reagent chemicals, paper wipes and cloth rags contaminated with oils, solvents and chemicals. Also, photographic developer, fixer solutions and waste paper are periodically generated from a darkroom (Rm. 2004A) in this building.

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T1402 Dark Room - photographic developer, fixer solutions and waste paper accumulated from the photographic work.

Building 410 - waste solvent, cloth rags and paper wipes, filtering materials that is contaminated with the product oil and/or other material.

WASTE HANDLING AND MINIMIZATION:

All storage of chlorinated and non-chlorinated solvents, cutting fluids and oils, and all waste products from them, are kept to a maximum of 5 gallons and are stored in an approved safety dispenser or container in an approved containment structure. All waste products have their own individual containers to eliminate waste mixing. All waste contaminated with a chemical, solvent or any substance that is considered to be hazardous to the environment is handled as hazardous waste and is disposed of as hazardous waste.

We will be moving the dark room in T1403 into Building 243's dark room. Combining these two areas into one location will reduce chemical usage, storage and waste.

Of the twenty-one machine tools in the machine shop areas, seven machines have coolant recovery systems, seven machines are not equipped with recovery systems, and seven do not require such systems. The seven machine tools that have coolant recovery systems use a water soluble oil solution for cutting. The fluid is recovered and used again - creating little or no waste. The seven machine tools not equipped with recovery systems are specialized milling machines or small lathes where small amounts or no cutting fluid is used. These machines will be fitted with coolant recovery systems in future upgrades to minimize some cloth and paper waste. All other machines do not require coolant for their operation or require special coolant applications (grinders, band saws, drill presses, sanders).

Installing coolant recovery systems on all machines will reduce the need for different types of cutting fluids, thereby reducing our generation of waste. This will be addressed in future upgrades.

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In the High-Pressure Testing area the largest waste is hydraulic oil (used in the presses and vessels during testing) and cloth and paper wipes (used to clean equipment and spills). Plans for waste reduction are to send the oil for reclamation, and use launderable cloth rags to eliminate the usage of paper and cloth wipes.

SUMMARY:

The waste generated in Building 243 is small and poses minor problems. Personnel in Energy Programs and Earth Sciences Department will be made aware of the proper handling for all types of wastes. They will be responsible for all waste generated from their job assignments and will be responsible for prompt, correct handling and disposal procedures. This will be achieved through employee education and awareness.

DIRECTORATE MINI PLAN

for

ENGINEERING

WMP 343
January 1990

WASTE

MINIMIZATION

PLAN

High Pressure Laboratory
Building 343

DRAFT

LAWRENCE LIVERMORE NATIONAL LABORATORY
University of California/Livermore, California

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Objective:

This plan has been prepared and will be actively pursued to minimize the generation and disposal of waste by products and, in particular, hazardous or potentially hazardous waste in and around the High Pressure Laboratory. The objective is to abide by all policies, rules and regulations applicable to the Laboratory and to environmental, health and safety policy statements issued by the Laboratory Director and the Associate Director of Engineering.

General Description of Facility Activities

The High Pressure Laboratory at the Lawrence Livermore National Laboratory is primarily an experimental facility for the design, assembly and testing of gas and/or liquid systems at pressures up to 120,000 psi. The 22,000 square foot building has twenty reinforced concrete test cells for use in proof, burst and leak testing of vessels and high pressure assemblies. In support of these activities, the lab has a machine shop, two high bay assembly areas, welding and brazing facilities, and a gas mixing/analysis laboratory. Several compressors and hydraulically operated pressure systems contain approximately 500 gallons of hydraulic oil. A small acid etching and rinse tank operation is located in room 1220D. In addition, small quantities of solvents have been used at this laboratory for general cleaning purposes.

Applicable Documents:

The following documents and references form the basis for this plan. These documents are not necessarily all encompassing and reference to them is not to be construed to mean that they are the only guidelines used to develop and implement this plan.

1. FSP 343, Facility Safety Procedure for Building 343, latest issue in effect.
2. LLNL Health and Safety Manual, latest issue in effect.
3. "Hazardous Waste Handling Practices, Mechanical Engineering Department", notes by Brad Thomson, Dec. 1989.
4. "Guidelines for Waste Accumulation Areas", by J. M. Hirabayashi, LLNL, March 1989.
5. "Guidelines for Discharges to the Sanitary-Sewer System", by C. H. Grandfield, LLNL, August 1989.
6. "Preparation Guide for Generators of Hazardous Chemicals and Radioactive Waste at LLNL", by J. Huss, LLNL, March 1987.

Training and Awareness:

It is the firm belief of the Building Management that an effective program in waste minimization has to rely on the full cooperation of the employees and visitors to the building and that training and an awareness program of issues pertaining to waste management has to be formulated, monitored and adhered to. As stated in the FSP 343, attendance in various classes dealing with Environmental, Health and Safety policies is required for the building employees. In particular, EP-0006 "Hazardous Waste Handling Practices at LLNL" is required annually.

Each employee has at his disposal and referral copies of the references and documents listed above. In addition, the building management holds a one hour meeting twice a month with all the building employees to discuss new management issues, safety and health items as well as noteworthy comments related to waste generation and disposal procedures. The building has been segregated in such a manner that every employee is responsible for the housekeeping, maintenance and waste handling practices for a specific area, cells or storage space. Thus the individuals are not only responsible for being aware of proper procedures but they have to actually put them into effect.

Waste Generation Identification:

The High Pressure Laboratory, compared with other facilities at LLNL, generates relatively little waste and very little hazardous waste. Nevertheless this plan intends to clearly identify those areas and material types which have in the past been generated into waste, what materials are currently stored in the building, and plans to minimize future procurement of materials which would subsequently be turned into possible hazardous waste products.

1. Documentation of past waste disposal will be reviewed. Hazardous waste identification as to type, quantity and periodicity will be tabulated as a starting point. An analysis will be made to determine if any up or downward trends in quantities can be associated with work load and type of activities ongoing at that time.
2. Further identification will be made of materials and waste which previously might not have been considered to result in hazardous waste.
3. Past practices will be discussed with all employees and a plan will be formulated to have everyone provide a list of materials they consider essential, useful, and not necessary. An estimate will be made of the quantities used and what inventory levels need to be maintained.
4. Current inventories of these materials will be collected and tabulated.
5. In addition, a review will be made of quantities of waste not normally considered hazardous. This will be used in subsequent analysis and plans to minimize non-hazardous waste.

Current Waste Minimization Practices:

The following practices have been initiated during the last twelve months in an effort to reduce waste generation and the need for waste disposal:

1. The cooling liquid mixture of Trim Sol and water (which is used in all cutting and machining operations in the machine shop areas) are treated by the MFD Division on a monthly basis to centrifuge and separate any hydrocarbons and contaminants from the cooling solution. This extends the usefulness of this solution and eliminates having to dispose of it as hazardous waste.
2. A solvent cleaner/washer cabinet which used petroleum naphthas and other volatile solvents has been eliminated. A water based cleaning system has been adopted for cleaning machined components.
3. The hydro test cells previously used a water soluble oil as the pressurizing media. This has been converted to a 50:50 water and antifreeze (ethylene glycol) solution. Furthermore, test articles to be hydro tested are now pre-filled with distilled or tap water which allows the tested components to be drained into the sewer system. The quantity of polyglycol used in this system is being monitored.
4. One set of rinsing tanks and a refolding station has been removed from the building. This eliminated the use of chromic and nitric acid. The one remaining station now uses two dip rinsing tanks for the small amount of nitric acid used in the cleaning operation. A log of these tanks is maintained and the concentrated rinse solutions are handled as hazardous waste when appropriate.
5. The hydraulic oil used in the isostatic bonders and compressors is now filtered and purified on a regular maintenance schedule. This will extend the time interval for oil changes in this equipment.
6. Several old compressors which showed wear and tear and small amounts of leakage have been replaced with new, state-of-the-art equipment which has substantially reduced the amount of clean up and soiled rag disposal.
7. The building janitorial service has instituted a project to collect and recycle all aluminum cans normally disposed of as waste.

Future Waste Minimization Practices

Additional action items have been identified to reduce the waste generated at this facility. They are listed below. New items and procedures, which may be forthcoming from noteworthy practices at other facilities or as they are identified by the employees at the High Pressure Lab, will be added to this plan.

1. Reduce the use of aerosol cans of fluids such as WD40, glass cleaner, spray paint, etc.
2. Recycle the ink cartridges for copy machines and printers.
3. Minimize the amount of hydraulic oil leakage and clean up by eliminating and/or replacing old compressors and pumps which require frequent overhauls and maintenance with more up to date and new equipment.
4. Make everyone aware of the need for reducing the use of solvents for cleaning, degreasing, etc.

Tracking, Reporting and Review:

The original of this WMP343 will be kept with the Facility Engineer, room 1C18A of building 343. This document will include the records of hazardous waste which was generated and disposed of during the last one to two year period. It will also include any documentation which has been generated on inventory levels of solvents, oils, acids and other hazardous materials. These documents will be reviewed and updated monthly. A summary report will be prepared and sent to the N.E.E.D. Division Office, the HC Safety Team Leader and Hazardous Waste Management.

PRE-PRINT

LER89-1012-01

**Waste Minimization Plan
Bldg. 141 Special Processing Facility
Electronics Manufacturing Group**

**Cal Sato and Ralph Hersey
February 5, 1990**

**Lawrence Livermore
National Laboratory**
Electronics Engineering

LER89-1012-01
WASTE MINIMIZATION PLAN
BLDG. 141 SPECIAL PROCESSING FACILITY
ELECTRONIC MANUFACTURING GROUP

Cal Sato and Ralph Hersey

SUMMARY OF CURRENT AND PLANNED ACTIONS

The Electronic Manufacturing Group is eliminating sources of hazardous waste generation in its Special Processing Facility in Building 141 by using alternative processing chemistries and technologies. Materials and chemicals such as cyanide, chromic acid, butox ethanol, mercury, lead, and solvents are listed as banned from land disposal (The Land Ban Act, 1984 amendments to the Resource Conservation Recovery Act - RCRA), and are used in the process to manufacture printed wiring boards, chemically machined products and metal finishing. Cyanide has been eliminated from metal finishing, and hazardous solvents are being replaced by non-hazardous aqueous agents. The chromic acid etch system will be replaced with less toxic sulfuric acid etch system during the 2nd quarter of FY '90. Special Processing is searching for substitute processes, chemicals and materials to maximize compliance with regulations.

Special Processing and Material Fabrication Divisions, Electroplating and Metal Finishing Facility, joined efforts to evaluate, procure, and install a vacuum distillation system that will allow recovery and recycling of their process rinse water. This acquisition should occur in FY '90. More than 90% of the waste discharged from these facilities is water. The vacuum distillation system will reduce the discharge volume by 90%, which has a direct impact on disposal costs.

Special Processing's upcoming March 1990, installation of its new sulfuric-peroxide etcher will replace the existing chromic-sulfuric acid etcher, which will include recovery and recycling of copper sulfates. The re-

placement metal finishing line, planned for installation in May 1990, will replace the trichloroethane degreaser with a soap-soak cleaner.

Alternative processing chemistries and technologies are being evaluated to minimize waste. In mid FY '89, a plasma etch system was installed for surface conditioning of plastic and other surfaces for subsequent metal coatings. This eliminated the need for several hazardous concentrated chemicals. The outlet vapors from the plasma etcher are passed through a flume scrubber that neutralizes the vapors in a significantly less hazardous sodium bicarbonate solution. Alternative processing chemistries coupled with alternative rinsing technologies can significantly reduce waste water generation. Special Processing is continuing its search for cost-effective methods to minimize the amount of waste discharged from the facility.

Other facility improvements are in process to reduce the danger of contaminating the environment with hazardous materials. Special Processing's aging and non-complying underground piping and sump system is being replaced with above ground complying systems. The acid waste stream plumbing and sump was replaced in FY '89. Equipment and installation plans to replace the Solvent and Chromic waste stream system are in process and should be complete by May 1990. Improvements to our Waste Accumulation Area will be evaluated in January and February 1990. Facility improvements will continue towards our goal to minimize our hazardous waste discharge and to approach zero hazardous waste if at all possible.

Figure 1. Building 141 Special Processing Area

INTRODUCTION

Purpose

The Special Processing Facility, along with the rest of LLNL, has a responsibility to minimize the generation and discharge of hazardous waste. There are several federal and state regulations that control pollution through restrictions and inspections of our facilities. Special Processing will minimize their hazardous waste through: 1) source reduction and substitution; 2) recycling and recovery; and 3) waste treatment. This document will provide facility personnel and management a resource to identify, plan, take action, and document waste control and minimization issues. The plan is titled "CLEEN", defined as Clean Livermore Engineering's Effluents Now.

Facility Overview

Special Processing is a facility within the Electronic Manufacturing Group of Electronic Engineering's Engineering Services Division. The facility is located in Building 141, Bay 1 (see Fig. 1). The facility provides concurrent on-site service for experimentation, one-of-a-kind, and prototype products for all LLNL Programs. The processes of this facility that generate hazardous wastes are: printed wiring board fabrication, chemical milling, and metal finishing.

Background

The Special Processing Facility in Building 141 commenced operation on January 5, 1980. The facility was designed and constructed to meet the state and federal regulations imposed on a facility of this type at that time. All of the rinse waters and concentrated waste is captured in retention systems separate from the LLNL Sanitary sewer system. The rinse waters were separated into three waste streams, the acid, chromate and

solvent streams. Each of the waste streams accumulate in separate underground sump systems and are then pumped into their respective primary, above ground, retention tank. During the early years of operation, each of the retained waste types were analyzed and discharged to either the sewer system (when appropriate to do so) or to an approved hazardous waste dump through LLNL's Hazardous Waste Management system. As of 1987 all of the waste generated by the Special Processing Facility is being analyzed and transferred to LLNL's Hazardous Waste Management system for disposal.

New Hazardous Waste Control Regulations

Environmental concerns have since resulted in even more stringent hazardous waste control regulations that affect the operation of the Special Processing facility. Major issues include limitations to underground piping, sumps, and tanks; limitations on the use of or elimination of certain hazardous toxic materials; closures of many disposal sites; and (most recently) the Land Disposal Regulation of certain materials. The effect of the new regulations is not necessarily negative: new production methods necessitated by the regulations can often result in actual improvement in the quality of the products. The suppliers of materials, supplies, and equipment used to produce printed wiring boards have developed many new processes and products to help clean the environment and simultaneously improve the quality of our printed wiring boards. The Special Processing Facility will continue to minimize waste with a long range goal of zero waste discharge.

Metal Finishing Process Flow

Chemical Milling Process Flow

Figure 2. Building 141 Special Processing Area - Process Flow Diagrams

SPECIAL PROCESSING FACILITY PROCESS FLOW CHARTS

There are three major processes in the Special Processing Facility (see Fig. 2) that generate wastes. These processes are printed boards (primarily double-sided and multilayer plated-through hole printed boards), metal finishing and chemical milling.

The metal finishing process is used to treat aluminum metal parts for electronic assemblies for corrosion resistance and primarily to enhance the surface electrical properties of aluminum to ensure good electrical grounding.

The printed board process consists of about 200 to 300 individual process steps. These process steps have been simplified in the Printed Wiring Board Process Flow chart in Fig. 2 to 29 process blocks. All the waste rinse water streams have been coded in the chart as ALW for acid/alkaline lab waste, CLW for chromic lab waste or SLW for solvent lab waste.

The chemical milling is used to form two-dimensional metal parts that cannot be manufactured using traditional metal machining operations.

CURRENT RINSE CONFIGURATION

Special Processing's current rinse configuration is shown in Fig. 3

Acid Underground Plumbing and Sump Bypassed by Aboveground Pump/Sump System

- Allows HWM to evaluate acid underground sump leak
- Aboveground system meets existing regulations whereas, the underground systems now in use do not meet current regulations for secondary containment.

General Rinse Process Technology for the Special Processing Facility

In general, with few exceptions, all rinsing processes are based on a two-stage stagnant rinse after each chemical processing step. When the stagnant rinse waters become contaminated to the process limits, the tank rinse waters are pumped into the appropriate waste stream to the waste retention system. Due to rinse-tank size restrictions and space limitations, most two stage stagnant rinse tanks serve two processing chemical solutions. The general processing steps are as follows:

- When completed, lift the part out of the chemical processing solution and allow the solution on the part to complete solution runoff until the drip rate is very low.
- Submerge the part with vigorous agitation in the first stage rinse tank.
- When completed, lift the part out of the first rinse tank and allow the rinse water on the part to complete solution runoff until the drip rate is very low.
- Submerge the part with vigorous agitation in the second stage rinse tank.
- When completed, lift the part out of the second rinse tank and allow the rinse water on the part to complete solution runoff until the drip rate is very low.

Rinse Process Sequence

This process sequence is used many times in the Special Processing Facility, but a few of the exceptions need some explanation.

The electroless copper process rinse waters are not allowed to be contaminated with other solutions, and

- Submerge the part being treated in the processing solution.

Figure 3. Building 141 Special Processing Area - Current Rinse Configuration

there is a three-stage rinse tank as the last rinse in the electroless copper process line.

The rinse module on the chemical machining etcher (ferric chloride) is a two-stage spray rinse. This rinse module is an inefficient rinse system and will be replaced by about April 1990 with the four-stage counter-flow rinse module currently on the printed board etcher.

The rinse module on the existing printed board etcher (chromic/sulfuric acid) is a very efficient four-stage counter-flow rinse system with a recirculating spray rinse for each counter-flow stage. Clean rinse water enters the four-stage counter-flow rinse at the exit (last) rinse tank and exits the rinse system at the first rinse tank. The output waste water exits the first rinse tank and flows to an aboveground sump from which it is pumped into an aboveground storage tank. The flow of clean water is controlled into the last module by a conductivity controller. The basic operation is as follows:

- When the rinse water solution in one of the rinse module tanks becomes sufficiently contaminated, a conductivity controller turns the clean inlet water solenoid valve on.
- Water flows at a controlled rate from the exit stage to the entrance stage (counter flow) until the conductivity controller senses the rinse water in the monitored tank has reduced in contamination to an established lower limit.
- When the contamination in the monitored rinse tank is below the established limit, the conductivity controller turns the clean inlet water solenoid valve off.

A multistage cascade rinse combined with vigorous agitation and conductivity controlled rinse water flow is a very efficient and effective rinse system. When the new printed board etcher is installed, this multistage rinse system will replace the existing, less-efficient single-pass spray etch module on the chemical machining etcher.

General Design and Operation of the Rinse Water Waste Retention System for the Special Processing Facility

The Special Processing Facility in Bldg. 141 was designed for adding the capability to recycle most of the rinse water used in the facility. The capability to reclaim and recycling rinse water was one of the major design requirements for the new Special Processing Facility. This was because the new facility was designed in the late 1970s - the last year of a drought in California. Water was being rationed and limited for both residential and industrial use. At that time, the best available technology for processing rinse water for recycling in plating shop like operations was to segregate waste water according to general content.

Types of Rinse Waters

The Special Processing Facility generated three types of general rinse waters.

One rinse water waste stream consisted of acid/alkaline waste water. The plan was to neutralize the rinse water by adjusting the pH, precipitating out the salt, which would be removed from the water with a filter.

The solvent rinse water waste stream contained a small amount of solvents and other organic materials, and pumice and metallic copper from mechanical scrubbing operations. These materials could be removed from the rinse water by two stages of filtration, one particle filter to remove pumice and copper, and carbon filters to remove the solvents.

The third rinse water waste stream contained chromic acid, copper in solution, and chelates from the electroless copper plating line. The plan was to react the chromic acid to a more stable chemical state, then adjust the pH to precipitate out the salts, which would be removed from the water with a filter. All the treated water would then be passed through a "polishing" operation to improve the quality of the recycled water to meet the rinse water quality requirements. All the salts, sludges, and other materials would be appropriately disposed of as a solid waste or sludge. The water recycling capability was not installed, except for the scrubber/rinse/dryer where the rinse water is recycled through a sand filter to remove metallic copper and abrasive materials from the rinse water.

Figure 4. Building 141 Special Processing Area - Planned Rinse Configuration with Aboveground Plumbing

The rinse water waste streams have separate sumps, transfer pumps, control systems and storage tanks. The planned operation of the waste retention system was to allow the rinse water waste to accumulate to a predetermined level in the underground sumps. At a preset level a pump transfers the contents of the sumps to one of a pair of above ground storage tanks. When one

storage tank is filled, an alarm is sounded (which has to be manually reset) to alert Special Processing Facility personnel, and the transfer pump's output is switched by solenoid valves to the second storage tank. When a storage tank was filled, Hazards Control would arrange for waste disposal in one week.

PLANNED RINSE CONFIGURATION (Above-Ground Plumbing)

Special Processing's rinse configuration requires certain upgrades to conform to existing regulations. Plans to upgrade the rinse configuration coincides appropriately with plans to minimize the volume and hazardous types of waste. The planned rinse configuration is shown in Fig. 4.

Abandoning Underground Sumps and Plumbing

A major issue of nonconformance to regulations involves the continued use of the underground sump system, which is not secondarily contained, in the chromic and solvent rinse discharge system. We will combine each of our waste rinse streams (acid, chromic, and solvent) into one stream and concurrently abandon the use of the underground sump. Note: this is not mixing of chemicals as much as mixing different rinses that are basically comprised of water (98%) with trace amounts of acid. Aboveground sumps and plumbing will be installed, similar to the acid rinse discharge system previously installed. This new system will upgrade the balance of our wet-processes, which includes; the metal finishing line (chromic), screen-printing (solvent), dry-film developing (solvent), scrub sink, copper etcher, and chemical milling etcher. The existing retention tanks, except the chromic tanks, will continue to be part of this rinse discharge system. The solvent retention tanks will be the primary tanks and the acid tanks secondary. The chromic tanks will be removed and the area prepared for a vacuum distillation system described below (see Fig. 4). This upgrade is part of the initial steps to minimize our waste volume through distillation. Each of the underground sumps will be used as additional volume for the bermed area surrounding the retention tanks. We estimate completion of this system to be in April 1990.

Substituting Processes and Chemicals

Concurrent to a abandonment of the underground sumps, we are actively substituting processes and chemicals to reduce the hazardous materials used to manufacture our products. The replacement chemicals are not included as "Land Ban" materials. These include:

- Metal finishing process: Complete tank replacement to include replacing the Trichlorethane Degreaser with a sodium-hydroxide soak cleaner and replace the chromic acid panel cleaner (desmutting) with non-chromic desmutting chemistry. The existing tanks have temporary fixes for leaking seams. Estimated completion is June 1990. This finishing process continues to include chrome in the conversion coating. We are continuing our search for coatings that do not include chrome and meet product quality and performance specifications.
- Copper etching process: Replace the contaminated, leaking and obsolete etcher. Replace the chromic-sulfuric etchant with hydrogen peroxide-sulfuric etchant. Install an etchant rejuvenation system in-line with the etcher. Estimated completion is March 1990. The Environmental Protection Department will assist us to determine whether or not a permit is required to operate this etcher rejuvenation system.
- Screen-printing process: Replace the hazardous cleaning solvents with environmentally safe cleaning agents. We are currently in the final stages of approval and replacement of our stock with an aqueous cleaner as the replacement. Estimated completion is February 1990. We are continuing

Figure 5. Building 141 Special Processing Area - Rinse Configuration Vacuum Distillation Proposal

our search for water based screen-printing inks that will meet product quality and performance specifications.

- Imaging process: Locate and convert from semi-aqueous imaging film to fully aqueous film. This

conversion will allow replacement of solvents used for the imaging process. We are aware of existing fully aqueous systems that will require evaluation. No estimate of completion date at this time.

PLANNED RINSE CONFIGURATION (Vacuum Distillation Proposal)

Special Processing's aboveground waste retention system will be modified, as shown in Fig. 5, to minimize rinse water discharges. Rinse water discharges will be significantly reduced by vacuum distillation of the rinse water discharge streams and recycling the distilled water. Further waste minimization will be obtained by vacuum distillation of our concentrated liquid waste prior to releasing it to HWM. The combined waste minimization of both rinse water and concentrated waste will result in a total waste minimization of as much as 80% of our current liquid waste volumes. The estimated cost for the vacuum distillation equipment and installation is \$150,000, and is planned to be installed in FY90. The vacuum distillation unit may need environmental permits in order to process our rinse water for recycling the rinse water within the Special Processing Facility.

Modified Rinse Water Processing

Current plans are to install the vacuum distillation equipment in the center section of what has been called the Chromic Waste Retention Area. All rinse water waste streams will be collected in what is now the Solvent Waste Retention Area (Tanks TLW-5 and TLW-6). The rinse water will be processed through the vacuum distillation unit. The vacuum distilled water will be transferred to Reclaimed Water Storage tanks, which are now the tanks in the Acid Waste Retention

Area (TLW-1 and TLW-2). The water in the rinse water storage tanks will be pumped into the Special Processing Facility for recycling the rinse water. The concentrated waste from the vacuum distillation unit will be discharged into drums for suitable disposal by HWM. The vacuum distilled water from the vacuum distillation unit may need some secondary processing, or "polishing," in order to meet the rinse water quality requirements. The rinse water retention tanks (TLW-5 and TLW-6) and the Reclaimed Water Storage tanks will need to be cleaned up and/or replaced. Depending on the condition of tanks TLW-1, -2, -5 and -6, they may need to be replaced due to mechanical/chemical deterioration or seismic considerations.

Vacuum Distillation of Rinse Water

Vacuum distillation of our rinse water wastes can reduce our rinse water discharges by about 90%. The reclaimed rinse water from the vacuum distillation unit will be recycled through the Special Processing Facility as new rinse water. There are two benefits to recycling the rinse waters: First, by increasing the flow of water in our current rinse tanks, we will improve our product quality. Second, by recycling our rinse waters, we will reduce our consumption of high-quality water from LLNL sources by a proportional amount. Tables 1 and 2 show our approximate current rinse water discharge volumes and the anticipated waste discharge volumes:

Table 1. Waste Discharge

Waste Discharge Stream	Waste Discharge Volume (gal/yr)	
	Current	Future
Chromic Waste Stream	9,000	900
Solvent Waste Stream	15,000	1,500
Acid Waste Stream	<u>17,000</u>	<u>1,700</u>
Total Waste Discharge	41,000	4,100

Figure 6. Building 141 Special Processing Area - Future Rinse Configuration

Vacuum Distillation of Concentrated Waste.

Vacuum distillation is planned to reduce the volume of concentrated lab waste from the Special Processing Facilities process chemical tanks and equipment. Concentrated lab waste can be processed through the

vacuum distillation unit and can be further concentrated into a solid, sludge or more concentrated solution.

Table 2. Concentrated Waste Discharge

Waste Discharge	Waste Discharge Volume (gal/yr)	
	Current	Future
Concentrated Lab Waste	4,800	<2,500

FUTURE WASTE RINSE CONFIGURATION

Additional post-processing for the Special Processing Facility is being considered, as shown in Fig. 5, to achieve a "Zero Discharge" liquid waste goal. Current plans include the installation of vacuum distillation and some other post processing equipment to recycle most of the rinse water within the Special Processing

Facility. Further waste reductions of water may be obtained by using liquid ion exchange (LIX) post-processing of the vacuum distillation concentrated waste discharge stream. Ion exchange columns will remove metals, chlorides, sulfates, and other chemicals from the waste in a more concentrated form.

CONSIDERATIONS FOR APPROACHING MASS BALANCE

One of our goals is to develop a mass balance analysis for the Special Processing Facility. Simply stated, mass balance for the Special Processing Facility is the ratio of the mass of all the material that enter the facility to the mass of the output products that leave the facility.

Ideal Mass Balance

There are two ideal mass balances: The first case is when all of the input products are consumed in proc-

essing or manufacture of the output product with no waste or recycled materials. The other ideal mass balance is when all of the input materials are consumed as final product or recyclable materials, in other words there is no waste (or scrap). In general, there are few processes that do not generate some form of a waste product. The mass balance for the Special Processing Facility can be a simple flow diagram as shown in Fig. 7.

Figure 7. Generalized mass flow diagram for the Special Processing Facility

An Analytical Tool

Mass balance is a new analytical tool being applied to the Special Processing Facility. Initial efforts identified the need to accumulate the necessary data to perform a mass balance analysis. The first mass balance analysis was based on the relationship of the square footage of

metal-clad base material laminate purchased and the volume of waste rinse water and concentrated liquid wastes for the year 1989. The mass balance for 1989 was determined to be 14.3 gal/sq.ft. We will continue to use this ratio until better relationships are developed.

$$\frac{45,800 \text{ gal (Concentrated and rinse water waste)}}{3,400 \text{ sq ft (Copper laminate)}} = 14.3 \text{ gal/sq ft}$$

This mass balance ratio is not a accurate number because the square footage of metal-clad base material laminate is not an accurate representation of the amount of laminate processed in the facility. Until recently, the Special Processing Facility did not maintain an inventory or use record of laminate materials. We have now instituted a log to record the use of laminate materials. Therefore, with time, we will be able to obtain more accurate mass balance numbers. As planned, we will be determining which data will be needed to provide a more meaningful mass balance ration in the future.

Mass Balance Example

Mass balance can be applied to individual processing operations. As an example, we will analyze the copper

electroplating operation that consists of a heated copper pyrophosphate plating tank followed by a rinsing operation. The heated copper plating tank requires the daily addition of water and ammonium hydroxide to make-up for evaporation losses. Currently, the rinse tanks following copper plating are also used for rinsing other materials and the rinse water effluent is accumulated in the waste rinse water retention system. The current copper plating and rinsing process flow chart is shown in Figure 8. Let us focus on the utilization of water. Note that water enters the plating tank to compensate for evaporation loss, and that water enters the rinse tank and leaves as an effluent (to the waste rinse water retention system).

Figure 8. Current copper plating and rinse process flow chart

Modifying the Copper Plating Process

Consideration is being given to modifying the copper plating process by adding a multistage counter-flow rinse system after the copper plating operation. We plan to use the effluent from the counter-flow rinse system as the water source to make-up for evaporation losses from the copper plating tank. This accomplishes two key goals: First, it keeps the ammonia out of the rinse water effluent collected in the waste rinse water

retention system. Second, copper and other constituents of the copper plating bath are recycled back into the plating tank and out of the waste rinse water retention system. This modified copper plating process flow chart is shown in Figure 9. Note that this is almost a zero-discharge, mass balanced process except for the water evaporation and ammonia vapor losses.

Figure 9. Modified copper plating process using recycled rinse water effluent

Additional Studies

We will conduct additional studies to achieve zero-discharge and mass balance processing on both a process and system level scale.

MATERIALS FABRICATION DIVISION WASTE MINIMIZATION PLAN

J. W. Dini

February 14, 1990

Introduction

The Materials Fabrication Division (MFD) is a specialized division within the Mechanical Engineering Department. It supports LLNL by providing many of the components needed for the Laboratory's diverse programs.

Because of the research and development nature of LLNL, MFD often is called upon to develop new equipment and methods. It must maintain a repertoire of capabilities which makes almost any manufacturing job possible. This requires sustaining a high level of technological expertise as well as a comprehensive inventory of up-to-date machinery. Almost 400 people and approximately \$20 million worth of equipment are channeled into this effort.

MFD fabricates parts from a variety of materials, including ferrous and nonferrous metals, plastics and ceramics. The division also works with materials associated with nuclear technology, such as beryllium and uranium, as well as high explosives. MFD is equipped to produce parts which range in size from miniature, such as one millimeter diameter laser targets, to very large, such as five-foot diameter canisters. Fabrication and inspection requirements in the one ten thousandth-inch region are commonplace, with many components specified in the low microinch domain.

The main fabrication complex occupies about 150,000 square feet. In addition, 23 area shops are located throughout the Laboratory. Site 300, where high explosive devices are machined and assembled and used in test, is located about 15 miles from Livermore.

MFD is committed to an active program on waste minimization (see Appendix A) and the purpose of this document is to outline the plan of action.

Waste Minimization Assessments and Strategies

Waste minimization assessments within MFD will include four major steps: 1) information gathering; 2) identification and screening of potential waste minimization options; 3) evaluation of technical and economic aspects of potential options, and 4) implementation. Within MFD, the waste minimization assessment process will be an on-going program and not a one-time effort. Reviews will be conducted every six months, emphasizing the application of new technologies for waste reduction and recycling over treatment or disposal of wastes as illustrated by the example shown in Figure 1.

Information Gathering

A. Identification of Waste Streams

We are presently gathering information identifying the waste streams which are generated. These consist of waste associated with machining operations (e.g., machining coolants, chips, solvents, rags, etc.), waste associated with plastics operations (e.g., plastics resins, catalysts and solvents), and wastes associated with plating operations (solutions containing dissolved metals, acids, bases, etc.). A preliminary waste minimization plan has already been developed for plating wastes since they are a large part of the wastes generated and this plan is included as Appendix B.

Figure 2 lists the waste minimization functional responsibilities and identifies key personnel from each area in which waste is generated. Areas not included are Site 300 and MFD area shops. A separate waste minimization plan has been developed for Site 300 ("LLNL Site 300 Facility Waste Minimization Plan", by M. A. Gonzalez and R. A. Heckman, Feb. 1990). Area shops are not formally covered in this plan since we rely on the respective program supporting the individual shop to do this. However, we will keep the shop personnel in these areas up-to-date on waste minimization education via training and technology transfer.

Goals

Our principle goal is to obtain a significant reduction of waste; quantitatively we would like to reduce waste by 75% within the next two years (by Jan 1992). Ideally, we want to drive toward zero

Figure 1

Waste Minimization Strategy

discharge, but this will not be possible with some operations such as machining of toxic and/or radioactive materials. Both source reduction options and recycling options will be included in the program. Source reductions include such items as good operating practices, technology changes, material changes or product changes. Recycling techniques include use/reuse techniques and resource recovery techniques.

Status and Accomplishments

A waste minimization program team has been established. (see Figure 2) and will continue working the issues discussed in this report.

A number of waste minimization issues have already been addressed and these involve items that are the heaviest waste generators in the division

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- An evaporation unit has been ordered for the metal finishing operation and this will reduce waste that has to be hauled off-site by 80-90% (for more details, see Appendix B).
- We are now recycling machine tool coolant in the Main Bay machining facility in 321, and this is resulting in a reduction of 85% of material that has to be either treated on-site or hauled off-site. Specifically, between January and July 1988, we sent 33 each, 55 gallon drums of coolant waste to Hazardous Waste Management. During the same period in 1989, when we were recycling, we sent 5 each, 55 gallon drums (see Appendix C for details).
- A similar unit has been ordered for our NC Machining area, also in the 321 complex. We anticipate this unit being on-line and operational by April 1990. We average 100 each, 55 gallon drums of coolant sent to Hazardous Waste Management from this facility per year. With the recycling unit in place, we expect approximately the same reduction that we experienced in the Main Bay (approximately 85%), which means we will generate only 15 each, 55 gallon drums per year.

FIGURE 2

APPENDIX A

OBJECTIVES SUPPORTING ENVIRONMENT, SAFETY AND HEALTH

- INCORPORATE AN INDIVIDUALS PERFORMANCE IN MEETING ES&H GUIDELINES INTO HIS/HER PERFORMANCE EVALUATION
- ESTABLISH A QUANTITATIVE GUIDE TO ALL OF MFD'S WASTE STREAMS
- DEVELOP A SPECIFIC AND QUANTITATIVE PLAN FOR WASTE MINIMIZATION
- DEVELOP A FORMAL ES&H INDUSTRIAL MATERIALS HANDLING PLAN
- ESTABLISH A PLAN THAT WILL ASSURE THAT ALL EMPLOYEES ARE KNOWLEDGEABLE IN THE ES&H AREAS PERTINENT TO THEIR JOBS THROUGH TRAINING (FORMAL AND OJT), TESTING AND PERFORMANCE MEASUREMENT. THE PLAN WILL PROVIDE A MEASURE OF TRAINING EFFECTIVENESS.
- REACH ZERO WALK THROUGH ERRORS IN ES&H AREAS, INCLUDING HOUSEKEEPING

This is from a talk titled "MFD Division Briefing" given by Steve Patterson, Division Leader MFD, on January 31, 1990 to MFD employees.

Introduction

The Plating Shop (Building 322), which is part of the Materials Fabrication Division, provides a viable, one-of-a-kind, on-site service to all LLNL programs. The facility provides processes such as electroplating, electroless plating, anodizing, cleaning, etching, electroforming and chemical milling. The only other facility at LLNL that provides electroplating and surface finishing services is the Electronic Engineering ESD Printed Circuit Facility (Building 141). This operation concentrates on plating operations required in the fabrication of printed circuit boards; therefore, does not provide the extensive range of metal finishing processes that are available in the Building 322 Plating Shop.

The MFD Plating Shop is important to all LLNL programs for two reasons: 1) it offers quick turnaround on many processes, and 2) it offers highly specialized technology that is difficult and sometimes impossible to find elsewhere.

We in MFD are committed to an active program on waste minimization, and the purpose of this document is to outline the plan of action.

Overview of Minimization Plan

In this section, we will review the plan including accomplishments, the current situation, short range goals, intermediate goals and long range goals. The plan is detailed in Table 1.

Accomplishments

Elimination of chromic acid plating tanks - Two chromic acid plating tanks (about 300 gallons each) have been used for LLNL programmatic work. The largest part of our chromic acid waste stream was generated because of these two tanks (another minor contributor is a dichromate treating solution for aluminum). As part of our minimization program, the two chromium plating tanks were decommissioned in January 1989 and this service is no longer provided in our shop. Customers with requirements for chromium plating are now referred to shops in the Bay area.

Current Situation

In our present operation, we can identify one major waste stream and one rinse water stream. The waste stream generates liquid (about 1250 gallons/week) which is transported off-site for treatment. The rinse water stream generates approximately 10,000 gallons of water per day and this is monitored for pH and total dissolved solids and, if within proper limits, is discharged to the sanitary sewer. If outside proper limits, it is transferred off-site for disposal.

$1250 \text{ gal} \times 10^3 \text{ gal} = 12,500 \text{ gal}$
 $\approx 6.25 \text{ days}$

Short Range Goals

Our short range minimization goals are threefold:

1. Reduce our major waste stream by 90%,
2. Minimize discharge of rinse water to sewer system, and
3. Eliminate vapor degreasing in the shop.

Reduction of the major waste stream by 90%:

Our minimization plan includes purchase of a freeze vaporization unit which will allow us to reclaim and recycle water from this waste thereby reducing the volume of material which will have to be hauled off-site. The cost of the distillation unit is \$78,000 and the order has been placed. We've been told by personnel in EPD that we will have to obtain a variance to operate this unit. Our plan is to have the unit operational before June 1990.

Minimize discharge of rinse water to the sewer system:

Although we've had no problem with the issue of monitoring and then discharging our rinse water to the sanitary sewer system, our goal is to recycle this water and minimize discharge to the sewer system. The distillation system discussed above will be used to recycle this rinse water and this coupled with procedural changes in shop operations should allow us to noticeably minimize discharge to the sanitary sewer system.

Elimination of vapor degreasing:

Our vapor degreaser utilizes about 700 gallons of perchloroethylene per year and also creates waste solvent that has to be disposed of in some manner. We plan on eliminating this operation from the shop and replacing it with a water pressure cleaning system. This new system recycles the water so waste is kept to a minimum. The cost of the new unit including installation will be about \$15,000. The unit has been purchased.

Intermediate Goals

The intermediate goals consist of characterizing the waste streams and evaluating recovery processes. To do this, we first need to have the distillation unit operational and time to determine its effectiveness. If it proves to be as effective as we anticipate, we will perhaps purchase a second unit. Regardless, the streams that we can identify include: nickel, copper, rinses, acids, alkalies, electropolish and miscellaneous. Our goal is to utilize electrolytic processes to recover metals such as nickel and copper and

processes such as ion exchange for some of the other streams. We intend to evaluate the full gamut of recycling processes available for these streams. We anticipate completing this phase of the minimization program by January 1993.

Long Range Goal

The long range goal is zero discharge or since this could prove extremely difficult, development of processes that will allow us to produce a sludge cake that could be handled by our Hazardous Waste Management Group.

Table 1

Waste Minimization Plan - Building 322 Plating Shop

<u>Accomplished</u>	<u>Current Situation</u>	<u>Short Range Goals</u>	<u>Intermediate Goals</u>	<u>Long Range Goals</u>
Elimination of chromium plating line	Waste generated (1250 gallons/week) Rinse water to sewer (40,000 gallons/week)	Waste generated (125 gallons/week) Minimize rinse water to sewer (recycle) Eliminate vapor degreaser	Characterize individual waste streams and evaluate recovery processes: nickel copper rinses acids alkalies misc electropolish	Zero discharge or sludge cake Hazardous Waste Management Group
January 1989	December 1989	June 1990	January 1993	January 1995

Waste Minimization Organization

The Waste Minimization Policy Statement of March 8, 1989 (Attachment 1), issued by the LLNL Laboratory Director, reflects the strong commitment by top management to implement waste minimization efforts at LLNL. To reinforce the need for inclusion of the Director's policy in daily operations, Nuclear Design Program management has also developed a more specific policy statement applicable to waste minimization at Site 300 (Attachment 2).

As illustrated in Figure 1, several LLNL organizations have roles and responsibilities in carrying out the Site 300 Waste Minimization Program. The Nuclear Design Program Deputy Associate Director (DAD) for Assurances has the responsibility for management of Site 300 safety and environmental programs, as delegated by the Associate Director for Nuclear Design (ND). The Site 300 Resident Manager has the responsibility for daily oversight of Site 300 safety and environmental programs. Knowledge of environmental compliance and operational safety requirements and implementation of these requirements is the responsibility of the programs and support organizations operating each facility or complex. Work is performed at these facilities in accordance with established Operational Safety Procedures and in compliance with environmental regulations. The DAD/ND, Site 300 Resident Manager, and program and operational support managers receive guidance and assistance in implementation from safety and environmental specialists assigned to Site 300.

With respect to waste minimization, the DAD/ND provides the system for reviewing and auditing programmatic and support activities to ensure that waste minimization goals are being addressed. The Site 300 Resident Manager provides the oversight to ensure that routine operations receive the proper review to ensure that both LLNL and Site 300 waste minimization policies are being incorporated into activities. The Nuclear Design Waste Minimization Coordinator coordinates assessment and implementation activities of all Nuclear Design operations and ensures that Site 300 waste minimization information is communicated between Site 300 personnel and LLNL/DOE Waste Minimization Program personnel.

Figure 1. Functional Organization Chart – Site 300 Waste Minimization Program

Solid lines denote lines of responsibility. Broken lines denote support organizations.

APPENDIX C

COOLANT RECYCLING AT LAWRENCE LIVERMORE NATIONAL LABORATORY

This paper is presented by Dick Fasholz, a Senior Supervisor of the Main Bay Machining Facility within Materials Fabrication Division at Lawrence Livermore National Laboratory. The topic of this discussion is one aspect of waste minimization: the recycling of machine tool coolant within the 321 Complex of Materials Fabrication Division. This paper will chronicle some of the events which moved us into the recycling business, summarize in detail the equipment and procedures we use when recycling, and discuss our future recycling objectives.

The motivation for our entry into a recycling effort stems from the need to comply with the laws, ordinances, codes, restrictions and procedures of a number of government agencies, and also to minimize the resources associated with the handling and disposal of spent machine tool coolant which is classified as a hazardous organic waste.

In May of 1982, a memo from Calvin Ozaki, of the Lab's Toxic Waste Control Group, to Don Brazil, a superintendent in Materials Fabrication Division, defined the procedures to be used when handling liquid wastes out of the 321 Complex. This put us on notice that there would now be considerable costs and effort connected with handling of liquid waste. This would be a combined effort among MFD personnel, Hazards Control and Toxic Waste Control Group.

In the next few years we operated according to the 1982 guidelines. During this time coolant and disposal studies were performed by George Sutton of MFD which culminated in a 1987 funding proposal for two coolant recycling systems and a building to house liquid waste handling equipment.

While this proposal worked its way through the system, we contacted people at Lawrence Berkeley Lab who had purchased a XYBEX coolant recycling system, and they invited us to see the operation. Two visits to Berkeley were made. The first, in early 1987, produced an agreement whereby Berkeley would process our uncontaminated spent coolant through their system. Subsequently, we had to obtain a variance from the California Department of Health Services in order to transfer drums of coolant from Livermore to Berkeley and also allow Berkeley to perform the processing. In August, 1987, I became personally involved in our coolant recycling efforts. I visited Berkeley to get a first hand look at their operation. Larry Calais, the Berkeley supervisor of the operation spoke highly of it. At this time, we also went over some fine points of the coolant transfer scenario.

Back at Livermore, the consensus was that with the resources we would have to expend transferring drums, manifesting, transporting, storing, plus the administrative costs and the safety impacts, there would be little gain with the Berkeley strategy. It was at this time that we decided to aggressively pursue the purchase of our own equipment.

We went through the normal Lab competitive bid process. Our bid solicitation, began in early 1988, was based on Master Chemical's XYBEX 1000 because of favorable reviews from observations at machine tool shows, and because we had become familiar with the equipment through our Berkeley communications. We did research various recycling processes including centrifuge, evaporation, cyclonic, and coalescing plate systems. Our research pointed to the centrifuge as the best technology to use in a recycling system. In early September, 1988 Bob Accardo, a member of our organization and part of our recycling team, visited a southern California firm to assess their experience with recycling equipment manufactured by Clinton Centrifuge. He also contacted another southern California Clinton user by phone. In both cases only centrifuge components were used on in-house built systems, and we couldn't verify the performance of a stand alone unit. On September 16, 1988 we awarded the purchase to Master Chemical for their XYBEX 1000 recycling system at \$40,687.00 which included a machine sump cleaner. Master Chemical was chosen the successful bidder because they met all the specifications and their unit was compatible with products we already use. Other bidders never successfully demonstrated they had a unit which would meet the specifications. We took delivery in December and accomplished installation and training in January, 1989. The system became operational on January 18, 1989.

The system we purchased consisted of a skid-mounted unit containing dirty and clean coolant reservoirs, an automatic coolant proportioning pump, an oil belt 'mmer, a high speed centrifuge, electrical controls and PVC plumbing. The PVC is used with deionized water because this water is so pure it reacts with metallic pipe or tubing, leeching out minerals. The heart of the system is the centrifuge. This is a Westfalia high speed centrifuge operating at 9000 RPM. It can remove tramp oil to less than .5% concentration and solid matter to 5 microns or less. This centrifuge can process 90 gallons/hr. It requires a dedicated cleaning every 8 hours of operation. To augment the XYBEX we also purchased a sump cleaning vacuum called the Yellow-bellied Sump Sucker. This is a twin compartment unit holding 100 gallons of fresh coolant and room for 100 gallons of used coolant. It is propane operated making it truly portable and has hoses and hookups making the unit compatible with the XYBEX. As part of the regular maintenance, we send a monthly sample of fresh coolant to Master Chemical for analysis. They fax the laboratory report to us showing the concentration, Ph level, bacteria count, fungal count, and tramp oil percentage. We are especially concerned with the bacteria count because a high bacteria population can ruin the coolant we have stored in the system and that in the machines. We do occasionally use a bactericide as a control measure.

As a first step in the formal recycling program I envisioned, I sent a memo to all potential users of our system, discussing the equipment, procedures and some of their responsibilities. We then proceeded to thoroughly clean all the machine tools in the shop. The Main Bay Machining Facility is approximately 21000 square feet containing 33 major machine tools with 1100 gallons of coolant which required recycling. The schedule I generated grouped close proximity machines together. The cleaning effort took about seven weeks. This was accomplished on a part time basis by 2 employees. The procedure started with the pump out of all the coolant in the machine. This spent coolant was placed in 55 gallon drums and processed through Hazardous Waste Mgmt. There was no attempt to process this initial coolant through the recycler as we had no knowledge of contaminants or bacteria that might be present. Next, all solid material such as chips and sludge was removed from the reservoirs, recesses and cavities of the machine. The machine coolant reservoir was filled with a machine cleaner provided by Master Chemical and allowed to circulate for 3-4 hours. During this time the entire machine was thoroughly cleaned. The machine cleaner was pumped out and also processed through HWM. Next a clear rinse of deionized water was flushed through the machine and also pumped out. In the future, we plan to add a germicide to this cycle. Finally the machine was filled with fresh coolant and was ready for scheduled coolant changes and processing through the XYBEX. The machine cleaning effort took 160 hours/\$8000.00 which should be considered a start-up cost.

started regularly scheduled recycling in March and have continued it on a monthly basis. The recycling takes about 20 hours over a monthly period. In July we added the MFD Precision Shop to the recycling program. This shop is located adjacent to the Main Bay and has 200 gallons of coolant for recycling. We have had inquiries from the MFD Optic Lab but their coolant is not compatible with Trim-Sol. As an additional benefit, our machinists have commented about the excellent quality coolant we have due to regular recycling.

An analysis of the economic issues and payback associated with this effort proved interesting. Our start-up costs included: XYBEX purchase: \$40,687.00; training: \$3600.00; security guard during installation: \$1200.00; machine cleaning: \$8000.00; total costs: \$53,487.00. On the payback side, HWM costs to process (1) 55 gallon drum of coolant: \$14.60/gal or \$803/drum. MFD costs for sampling: \$50.00 per drum. Between January and July 1988 we sent (33) 55 gallon drums of coolant waste to Hazardous Waste Management. During the same period in 1989 we sent 5 drums, a reduction of 85%.

We are about to incorporate our first area shop into the recycling program. Building 343 High Pressure Lab would like us to service a Hurco Milling machine and two smaller machines for a total of 70 gallons. I can see the time when we can no longer service all the machines we are requested because of our limited personnel. I believe at that time, coolant recycling could become a separate entity. As a final note, I feel that Materials Fabrication Division deserves credit for recognizing a problem and implementing a workable solution.

DIRECTORATE MINI PLAN

for

LASERS (LIS AND ICF)

Laser Programs Waste Minimization Plan

February 1990

Laser Programs Waste Minimization Plan

February 1990

Approved by:

V. Alan Mode

Deputy Associate Director
Laser Programs Assurances

LAWRENCE LIVERMORE NATIONAL LABORATORY
University of California • Livermore, California • 94550

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administrative **MEMO**

Policy and Procedure

Vol. 19, No. 6

March 8, 1989

DIRECTOR'S STATEMENT ON WASTE MINIMIZATION

It is important that the Laboratory make a strong commitment to waste minimization--particularly to hazardous and radioactive waste minimization. Our goal is to reduce the Laboratory's hazardous/radioactive waste streams by a major factor in the next three to five years by reducing generation and increasing recycling. We will implement an incentive system where each Laboratory program will pay the costs associated with the handling and disposal of its waste. Each program will establish waste minimization goals and develop plans and assign responsibility for achieving these goals. Waste minimization will be incorporated in the design of new projects.

John H. Nuckolls
Director

Attachment 2

Site 300 Resident Manager's
Policy Statement on Waste Minimization
February 1, 1990

In accordance with the Director's Policy Statement on Waste Minimization (LLNL Administrative Memo, Volume 19, Number 6) issued on March 8, 1989, and the Nuclear Design Program Waste Minimization Plan currently undergoing final review, Site 300 employees shall incorporate waste minimization in the design and implementation of programmatic and support activities. This policy is consistent with the current Site 300 philosophy of including methods for (1) eliminating or reducing sources of hazardous waste by material, process, or housekeeping controls, (2) recycling wastes through reclamation or reuse, and (3) treating waste to reduce its toxicity and/or volume in all Site 300 experiments and operations. It is our goal to reduce the volume of hazardous and mixed wastestreams generated at Site 300 by at least 25% over volumes generated in 1988 in the next three to five years. We intend to accomplish this goal by favoring source reduction and recycling over treatment in existing and future operations.

Each Site 300 program and support organization manager or representative shall establish individual waste minimization goals and plans. The manager or representative shall also appoint a waste reduction coordinator to direct waste minimization efforts in their programmatic or support organization area, ensure that personnel are made aware of waste source reduction requirements, and interact with the Nuclear Design Program Waste Minimization Coordinator. Waste minimization recordkeeping functions shall continue to be the responsibility of EPD's Hazardous Waste Management Division.

The Nuclear Design Program Deputy Associate Director for Assurances Office will provide the system for reviewing and auditing programmatic and support activities to ensure that waste minimization goals are being addressed.

M. L. Grissom

Site 300 Resident Manager

Attachment 3

Waste Minimization Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Donnis K. Fisher
Laboratory Associate Director
Administration and Operations
Lawrence Livermore National Laboratory

Attachment 4

Waste Minimization Certification

I hereby certify under penalty of law that, personnel under my direction and supervision, at this facility are undertaking specific steps in accordance with a program in place, to minimize the amount and toxicity of hazardous waste generated at this facility to a degree economically practicable and that the method utilized for the treatment, storage, or disposal of hazardous wastes is the practicable method currently available to this facility which minimizes the present and future threat to human health and the environment. I am aware that there are significant penalties for false certification, including the possibility of fine and imprisonment for flagrant falsifications.

Dennis K. Fisher
Laboratory Associate Director
Administration and Operations
Lawrence Livermore National Laboratory

DIRECTORATE MINI PLAN

for

NUCLEAR TEST

Waste Minimization Plan for Nuclear Test-Experimental Science Program

January, 1990

Introduction

In response to the HAZARDOUS and SOLID WASTE AMENDMENTS (HSWA) to the RESOURCE CONSERVATION and RECOVERY ACT (RCRA)¹ and to a greater concern for the environment, the Nuclear Test-Experimental Science (NTES) Program has reviewed its programmatic and research goals and its operation, and has formulated a plan that will accomplish the mission and minimize waste at the same time. This is in keeping with DOE and LLNL policy to reduce the amount of hazardous waste and to lessen the impact on the environment. This plan relies upon procedures established within L- and Nuclear Chemistry Divisions. The primary components of the plan are education and administrative controls. The nature and volume of wastes generated by the Divisions' operations will be reviewed on a regular basis. New operations will be screened for waste minimization options, and successful methods will be shared with all staff.

The Nuclear Test-Experimental Science Program consists of three divisions: Nuclear Chemistry Division (NCD); L-Division; and Nuclear Test Operations Division (NTOD). Waste minimization responsibilities rest within each division, and matrixed personnel are expected to be familiar with the policies of the division they support, as well as the policy of their parent organization. This document contains the individual plans only for NCD and L-Division. NTOD is located at Mercury, Nevada, at the Nevada Test Site, and is primarily a scientific administrative organization that supports the other two NTES divisions and provides liaison with the other contractors. The amount of hazardous waste generated by NTOD is very small and is handled by the principal NTS contractor, Reynolds Electrical Engineering Company (REECo), whose overall plan is approved by the DOE Nevada Operations Office.

Waste Minimization Plans

1. L-Division

L-Division is under the jurisdiction of the Associate Director for Nuclear Test-Experimental Science. The Division chiefly supports the programmatic mission of obtaining experimental data important to understanding the physics of nuclear weapons. We design, assemble, and calibrate instruments for application on nuclear tests at the Nevada Test Site (NTS). We also maintain physics laboratories wherein nuclear weapons conditions may be simulated and studied, and where advanced diagnostic development may be accomplished. The Division's physical plant includes electronic and mechanical assembly and calibration laboratories, machine shops, small accelerators, x-ray generating equipment, laser laboratories, and photo labs. They are located in Building 121 and portions of Buildings 174, 212, 255, and, at Site 300, Building 812B.

In order to minimize the generation of waste, L-Division will:

- 1) Establish an inventory of wastes generated.
- 2) Establish methods to minimize unintentional waste generation.
- 3) Factor waste minimization into experiment processes and plans.
- 4) Separate wastes where appropriate.
- 5) Train personnel to assure that waste minimization concepts are understood.

Effectively all of the routine operations generating hazardous wastes in L-Division laboratories are found in many other facilities at the Laboratory. They involve the use of solvents, laser dyes, photo chemicals, oils, adhesives, etc. No radioactive or mixed wastes are generated in routine operations. L-Division will emphasize identification of waste-generating materials and processes; evaluating the use of substitute non-hazardous materials; monitoring and minimizing the inventory of waste-generating materials on hand in the facilities; and waste separation to enhance recycling and to minimize disposal costs. In these routine operations we will coordinate our waste minimization efforts with Laboratory policy established through the Environment, Safety, and Health Council.

Non-routine operations involving hazardous materials require formal Operational Safety Procedures (OSP) for their execution. The author will be required to address hazardous waste generation and minimization as part of the description of his operation. The OSP's are reviewed and signed by the Division Leader.

Records of hazardous waste-generating materials and their locations will be maintained on a room-by-room basis and updated periodically. This will allow coordination across the facilities in minimizing inputs to the waste stream from overstocking of such materials. Records of hazardous waste disposal as maintained by the Laboratory's HAZARDOUS WASTE MANAGEMENT GROUP will be used to monitor generation and to demonstrate trends.

The waste minimization plan will be communicated to the L-Division staff and its effectiveness will be monitored.

The plan described above, when implemented, will lead to minimization of hazardous wastes generated by L-Division. The plan involves commitment by management to inventory controls and to oversight, while maintaining a high level of awareness and responsibility for waste management at the level of the Laboratory scientist, engineer, and technician.

2. Nuclear Chemistry Division

The NUCLEAR CHEMISTRY DIVISION (NCD) is under the jurisdiction of the Associate Director for Nuclear Test-Experimental Science. We have a diverse mission: The quantification of radionuclides produced in nuclear tests, the quantification of radionuclides in the environment, and research into nuclear properties and processes. The use of both radioactive and hazardous materials is inherent in our work. The generation of hazardous waste, radioactive waste, and

mixtures of these is inevitable. We will work to identify and adopt new technologies that permit reduction of the amount of waste generated wherever it is both safe and feasible to do so.

In order to minimize the generation of waste, Nuclear Chemistry Division will:

- 1) Establish an inventory of wastes generated.
- 2) Establish methods to minimize unintentional waste generation, e.g., by sharing chemical stocks.
- 3) Factor waste minimization into experiment and process design.
- 4) Separate wastes where appropriate.
- 5) Train personnel to ensure that waste minimization concepts are understood.

In the NCD, the majority of activities that generate wastes involve the use of radioactive materials, chemical reagents, and solvents. Consequently, our waste minimization plan will focus on control of chemical inventory and usage and on segregation of radioactive and non-radioactive waste. At the present we have an inventory of chemicals in each laboratory. By reviewing this inventory we can determine if there is excessive duplication and work to correct it. We also have established a data base of waste generated by the Division. With this we can compare the amount of waste generated by the Division on a monthly basis. We will also work closely with our stores people in order to maintain control of chemical stocks used. A key ingredient for successful implementation of a plan such as this is training. NCD will provide necessary training. It is NCD policy that wastes generated in the laboratory will be placed in labeled containers. Efforts will be made to segregate non-hazardous wastes from hazardous wastes, and to avoid the generation of mixed-waste. However, it has been and will be the practice of NCD to avoid the inadvertent addition of radioactive waste to non-radioactive waste even if this results in more than minimum amounts of low level radioactive waste. In other words, if there is any question about radioactive content, NCD will consider it to be radioactive waste. Periodic inspections will be conducted to ensure that minimization techniques and waste disposal requirements are being followed. All bench top experiments and pilot-scale experimental simulations requiring an OSP will be reviewed to determine if it meets waste minimization standards set by NCD. Any experiment that will generate more than ten (10) gallons or ten (10) pounds of extremely hazardous waste will be reviewed by the Division. A data base of waste generated the last two years has been established. With this and the information available from LLNL's Hazardous Waste Management Group we will be able to compare our present waste generation with previous times.

	<u>HAZARDOUS</u>		<u>RADIOACTIVE</u>	
	<u>Liq. (kg).</u>	<u>solid (kg).</u>	<u>Liq. (kg).</u>	<u>solid (kg).</u>
1988	727	1215	1256	3083
1989	2180	1229	1021	7287

We believe that the greater amounts shown in 1989 are due to better record keeping and to the greater number of samples processed.

The Associate Division Leader for Operations through the section leaders will communicate to the NCD staff the proper elements of the waste minimization plan, and will monitor its effectiveness.

We believe that the plan described above, when implemented, will lead to minimization of waste generated by NCD. The plan involves commitment by management to inventory controls and to oversight, while maintaining a high level of awareness and responsibility for waste minimization at the level of the laboratory scientist. The 1990 NCD HAZARDOUS WASTE MINIMIZATION GOAL is to reduce the amount of hazardous waste by 5% based on 1989 records.

¹RCRA section 1003(b) as amended by HSQA PL 98-616

DIRECTORATE MINI PLAN

for

PHYSICS

Date: December 3, 1989

TO: Richard Heckman

FROM: Edward English

SUBJECT: Waste Minimization Within Physics

Physics supports the Laboratory's concern to assure that processes generate the minimum level of managed wastes. Essentially, this affects our operations in two areas: program supported engineering area shops and semi-conductor fabrication.

We have asked Engineering to assure that the practices and procedure improvements which they put into effect in their directly managed shops (e.g. MFD) be incorporated within our program sponsored shops. This will affect shops in Buildings 194, 212, and 292.

Within the semi-conductor fabrication area, we have worked with Hazards Control to assure that our processes employ the lowest possible volume amounts of hazardous materials in the fabrication process in order to maximize our protection of employee health and safety. Further, we have incorporated the most efficient research fabrication processes which we could suitable for our purposes. Finally, these actions were all undertaken within the past two years and thus the technology and processes are current. The result is that we do not see how we could improve our process at this time to reduce the volume of wastes. We will keep abreast of technology improvements and make changes as they become cost effective in the future. For further information on the specifics of these operations, please contact Joe Simpson within "O".

Physics is also in the process of establishing two permanent waste accumulation areas, one to support operations in Building 212 and the other for Building 197.

cc: Jim Doggett
Roger O'Brien
Joe Simpson
Bruce Tarter
Roger Werne

DIRECTORATE MINI PLAN

for

W PROGRAM

Weaponization Program

Waste Minimization Plan

The Weaponization Program at Lawrence Livermore National Laboratory operates facilities in Livermore and at Site 300. The personnel in these facilities support a wide variety of engineering activities for the development of weapons systems.

The Program is actively identifying its waste stream, reviewing methods for reducing the inventory of hazardous and radioactive material, providing employee awareness through training/orientation, funding equipment upgrades, and incorporating administrative controls to ensure the Program's efforts are consistent with the Director's Waste Minimization policy statement. Many of the features outlined in the plan are in place already; some will be modified as we find new ways to improve them.

In general, the Program's activities require a small inventory of hazardous materials such as oils, solvents and hazardous chemicals for machining, cleaning, and assembly operations that take place in our facilities. In recent years, the inventory of these materials, including waste products, has been reduced because of an improvement in housekeeping and some changes in methodology to match the Program's and Environmental Protection Department's changing requirements.

Education

Educating our employees to the benefits of prudent hazardous materials' minimization and waste product removal is an extremely important feature in our plan. The group leaders are responsible for assuring that their employees receive training consistent with recommendations from the Environmental Protection and Hazards Control Departments. The group leaders are also responsible for documenting training activities and maintaining the training files. The group leaders will utilize current Environmental Protection Department training courses, distribute related literature and informational films to their employees for review, and discuss the subject in group meetings to expand the employees' awareness and encourage their active participation. It is particularly important that the employees understand and appreciate the cost implications and difficulties associated with waste removal.

Administrative

Weaponization Program activities involving hazardous materials are limited in scope by the facilities' safety procedures and special operating safety procedures. It is the group leader's responsibility to review each of these documents as they are drafted, or when they require renewal to ensure that the minimization and hazardous material handling issues are addressed and conform to the Laboratory's goals. Changes in process methodology, or choosing substitute materials are to be considered at this time to further reduce the waste stream.

It is the group leader's responsibility to ensure that minimal hazardous materials are proposed during all aspects of a systems development. Cost considerations for the disposal of the waste products, consistent with Environmental Protection Department requirements, are to be discussed to determine the best choice of materials to meet the minimization goals and to more accurately project the Program's budget. The group leader will also encourage the utilization of alternate system evaluation and assembly methods to achieve the same goals.

Centralizing the procurement of hazardous chemicals/materials and oils has merit; however, because the project teams work independently with different requirements and schedules, the coordination efforts may be too cumbersome to be practical. Further review is in order to evaluate this option.

Accomplishments

We have incorporated several changes in our operations to reduce hazardous materials and improve waste product handling practices in our facilities in recent years. For example, all of our 55 gallon storage racks containing our supply of oils and solvents were removed approximately 4 years ago to reduce the inventory and to avoid the possibility of a large spill. A new system was incorporated wherein our stock of these materials is limited to only that necessary to accomplish the task at hand, wherever possible. The materials, in unbreakable containers, are stored in fire safety cabinets in the work areas and limited to small quantities, typically less than 1 gallon.

Waste products such as contaminated Kimwipes, rags, commercial absorbant materials, and spent liquids are appropriately packaged, tagged and stored in the facilities' waste accumulation area until processed by Hazardous Waste Management personnel.

In the past 3 years, we have upgraded two closed-loop systems containing hazardous fluids that had the potential to produce large amounts of waste as a result of leaks, or catastrophic failure. Following design reviews, we established guidelines for improving the equipment's maintenance practices, and funded extensive mechanical upgrades to reduce the risk of a sizable release.

We improved our waste product handling and removal system at both sites by installing waste accumulation areas conforming to the Environmental Protection Department guidelines. Frequent documented inspections are required to record the facilities' status and activity. Upgrades to the Livermore waste accumulation areas are currently under review to meet the buildings' changing requirements.

Summary

We believe our plan is a very workable method for assisting us to meet the Laboratory's commitment to reduce the hazardous materials waste stream. Thus far, a great deal of progress has been shown because many of its features have been in place for some time. Modifications of this plan are anticipated to address future situations.

DWH:nm/q0019

DIRECTORATE MINI PLAN

for

Z DIVISION

Z Division Waste Minimization Plan

There are two types of waste generators in Z Division - the Applied Technology Program and the Technical Information Department assigned to Z Division.

The Applied Technology Program works on a variety of reimbursable projects which utilize the expertise available at LLNL. Some of the work is done within the B261 complex, and some is done by matrixed personnel in laboratories, on site (including Site 300), but outside the B261 complex. Both of these areas will be addressed with regards to waste minimization.

There is a small machine shop in B261 which uses solvents and cutting oils. We will be doing a number of things to minimize waste in this area. We will look at the list of land ban chemicals and determine if any of the solvents or cutting oils are on the list. If they are, we will find substitutes which are not on this list. We will work closely with the main shops in the B327 complex to learn how they are minimizing machine shop waste. Where possible, we will incorporate these practices into the B261 machine shop.

Cleaning solvents are used both in the electro-optic/laser and electronic research projects. Again, the land ban list will be consulted and substitutes for solvents on the list will be found and used. We will work closely with Y Division laser personnel and the Electronics Engineering Department to learn how they are implementing solvent waste minimization, and will use those techniques in Z Division. In situations where solvent substitutes cannot be found, as may be the case with laser dyes, we will ensure that the waste is properly labeled, segregated from other waste, and recycled, if possible.

For Applied Technology Program experiments which are performed on site but outside the B261 complex, we will work closely with the matrixed organization to ensure compliance with their waste minimization plans.

The environmental impact of new projects undertaken by the Applied Technology Program will be assessed before the project is started. Although we do not have control over what materials Supply and Distribution stock, we do have control over what

materials are purchased through Z Division's technical coordinators. Material requests will be screened for possible toxic waste to be dealt with later. Quantities of materials will be limited to just that needed to complete the project without stockpiling for some future project.

The photographic processing and phototypesetting activities within Z Division primarily produce as waste spent developer and fixer. The phototypesetting chemicals are purchased in cartridge form, and are disposed of in cartridge form according to Laboratory procedures. Chemicals used in both color and black and white photographic processing are collected in 5 gallon carboys, labelled, and then put in labelled lard cans for disposal. The empty developer and fixer containers are compacted and put into labelled lard cans and disposed of as the chemical itself. Cotton swabs, Kimwipes, Kaydrys, ... which are used in conjunction with any of the land ban chemicals are collected in labelled lard cans and disposed of according to Laboratory procedures. Since most of the phototypesetting and photographic processing equipment used in Z Division is not the same as that used by the Technical Information Department in Core 1, we will not be able to utilize their learnings on how to minimize these types of waste. We will, however, work with the equipment manufacturers to see if non hazardous waste generating chemicals could be used with their equipment.

Waste minimization starts with educating the employees about good waste minimization practices. Both Z Division employees and those matrixed to Z Division from other parts of the Laboratory will be informed of this waste minimization plan and any further changes to it.

Wastes generated by any particular experiment and/or photographic or printing process will be placed in prelabeled containers and disposed of according to approved Laboratory procedures. Periodic inspections will be conducted in order to ensure that waste minimization and waste disposal practices are followed.

1. Introduction

The Laser Programs Waste Minimization Plan establishes the policy and assigns responsibility for minimizing wastes from Laser Programs operations at the Lawrence Livermore National Laboratory (LLNL). The policy is consistent with the intent of Environmental Protection Agency (EPA) policy, Department of Energy (DOE) requirements, overall LLNL policy, and good waste management practices. The policy applies to research, technology development, engineering demonstration, and technology deployment activities of the Laser Programs. In particular, it applies to the five Programmatic elements under the direction of the Associate Director for Lasers: Special Isotope Separation (SIS); Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS); Laser Technology; Inertial Confinement Fusion (ICF), and Advanced Applications (AA). It also applies to the Operations function of the Laser Programs. These activities cover a broad range of scientific disciplines, and generate various forms and amounts of hazardous, radioactive, and mixed wastes.

This Plan supplements and provides implementation guidance for the Laser Programs Waste Minimization Policy Statement issued by the Associate Director for Lasers.¹ The Plan is responsive to the Waste Minimization Policy Statement of the LLNL Director dated March 8, 1989,² and has been written to conform to both LLNL guidance and EPA guidelines for waste minimization plans contained in the Federal Register.³

1.1 Need for Plan

Waste minimization is becoming an increasingly important national consideration in many activities, and this concern applies to research and development activities at LLNL. Legislation [e.g., the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA)] has made it increasingly difficult and expensive to dispose of hazardous wastes. Some wastes (e.g., liquid wastes) have been or will be banned from land disposal entirely. Restrictions on waste disposal have resulted in a reduction in the availability of sites that can accept waste. Overall waste disposal costs have gone up significantly and are expected to continue to increase in the coming years.

In parallel with the growing constraints on waste disposal, there is increasing official pressure from governments (federal, state, and local) and from regulatory agencies (EPA, state, etc.) on waste generators to

reduce the quantities of waste generated. In the 1984 Hazardous and Solid Waste Amendments to RCRA, Congress established the following policy:

"The Congress hereby declares that it is to be a national policy of the United States that, where feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste material generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment."⁶

In addition, HSWA required that hazardous waste generators establish a waste program and certify on their waste shipment manifests that such a program is in place.

In 1988, DOE issued Order 5820.2A, *Radioactive Waste Management* and implementation guidance, which required that DOE facilities develop and implement waste minimization plans.^{5,6} Also in 1988, DOE issued order 5400.1, *General Environmental Protection Program*, which required that each DOE facility prepare a waste minimization program, with goals for minimizing the volume and/or toxicity of all wastes generated, with annual reductions if programmatic requirements allow.⁷ In 1989, EPA published guidance on the elements of a waste minimization program.⁸ Also in 1989, EPA made it clear that having a waste minimization plan in effect at LLNL was a necessary condition for renewal or issuance of further permits for waste treatment at LLNL.⁹

1.2 Purpose and Objectives of the Plan

LLNL is preparing a waste minimization plan covering activities at both the Livermore Site and Site 300; a draft of the plan was issued in 1989. (Ref. 9) All LLNL programs, including Lasers, are required to prepare individual program plans or mini-plans for inclusion in the overall LLNL Plan.

This *Laser Programs Waste Minimization Plan* is intended to be used not only as an insert to the overall *LLNL Waste Minimization Program Plan* but also as a stand-alone guidance document for use by the Laser Programs at LLNL.

The *Laser Programs Waste Minimization Plan* is intended to be flexible and adaptable in order to address the diversity of projects within the Laser Programs. For current operations, the amounts and characteristics of wastes generated are to be defined, generators identified, processes described, waste minimization alternatives identified, and waste minimization activities implemented. The Plan incorporates three principal overall objectives: (1) to instill in Laser Programs personnel a continuing

awareness of the importance of waste reduction in program activities; (2) to consider waste minimization in the advance planning of new projects or activities, and to try to incorporate waste minimization considerations in the design and operation of new activities; and (3) to achieve overall net reductions in the levels of waste generated by the Laser Programs as a function of the level of program activity. At the same time, the Plan recognizes that, in some instances, wastes may actually increase. When

- (1) new projects are started, when existing projects are expanded or changed, (2) when major demonstrations are conducted, or when new experiments are added, the absolute level of wastes generated may increase on an interim basis. Notwithstanding the fact that this plan recognizes that, for certain projects, absolute quantities of waste generated from a given program area may temporarily increase, the plan requires that such activities be planned and conducted in a manner to minimize the waste generated to the extent that it is environmentally and programmatically practical.

This *Laser Programs Waste Minimization Plan* is intended to be used to support ongoing and planned Laser Programs activities including operation of the Nova laser, the Laser Demonstration Facility (LDF), the Engineering Demonstration System (EDS), and UDS, as well as selected support activities including analytical laboratories.

2. Laser Programs Policy on Waste Minimization

February 5, 1990

LASER PROGRAMS POLICY STATEMENT ON WASTE MINIMIZATION

Laser Programs is strongly committed to minimizing the generation of hazardous and radioactive wastes in Laser Programs activities. Its goal is to minimize hazardous and radioactive waste streams through careful planning, reduced generation, increased recycling, process changes, employee awareness and administrative controls.

Each major program or project should establish waste minimization goals, develop plans, and assign responsibilities for achieving these goals. A waste minimization committee, with members from each Laser Programs element, will provide guidance and monitor progress. The success of waste minimization will depend on active participation and contribution from every member of Laser Programs. New projects will incorporate waste minimization considerations in their design and operations.

The Laser Programs' effort supports the Director's statement on Waste Minimization.

J. I. Davis
Associate Director for Lasers

3. Elements of the Plan

There are seven elements to the *Laser Programs Waste*

Minimization Plan:

- Top management support.
- Characterization of waste generation.
- Waste minimization assessments.
- Cost allocation system.
- Technology transfer.
- Program evaluation.
- Quality assurance.

The Plan is intended to address applicable DOE^{5,6} and EPA³ guidance. It follows the EPA format suggested in Reference 3, which contains the first six elements above. The seventh element, quality assurance, has been added to highlight the importance of the QA function for waste minimization and to address explicitly a DOE requirement.^{5,6}

3.1 Top Management Support

Laser Programs management has placed waste minimization in program activities as a high priority. In 1989, the Program Leader of the Laser Isotope Separation (LIS) Program assigned personnel to begin work on a waste minimization program for LIS. A parallel effort was also initiated in the ICF Program. In early September 1989, the Associate Director for Lasers called a meeting of Laser Programs managers to discuss the importance of compliance with applicable health, safety, and environmental requirements, including waste considerations. The following week, as part of a Laser Programs reorganization, he established at the Deputy Associate Director (DAD) level an Assurances function with responsibility for development and oversight of a waste minimization program for the Laser Programs.

Other manifestations of top management support for waste minimization include the following:

- Issuance of a Laser Programs Policy Statement on Waste Minimization (February 1990).
- Membership on LLNL Waste Minimization Steering Committee (starting in May 1989).
- Establishment of a Laser Programs Waste Minimization Committee (January 1990).
- Establishment of a Waste Manager position for the Laser Programs (December 1989). (Ref. 10)

- Obtaining contract support for waste management and waste minimization (October 1989).
- Scheduling waste management training for over 300 Laser Programs personnel (August 1989).

3.1.1 Training and Awareness

Laser Programs personnel, from management to operators and including contractors, must be aware that waste minimization is part of everyday business and is everyone's concern. Employee awareness of waste minimization may range from what they read in the Laboratory newspaper to mandatory attendance at formal training sessions and to specific information contained in guidance documents. All Laser personnel handling feed materials or waste streams, or involved in process operations are required to attend formal training sessions. Traditionally, formal training sessions have been conducted by the Environmental Protection Department (EPD). For example, selected Laser Programs personnel were recently trained in "Hazardous Waste Handling." Other classes available through EPD are "Guidelines for Waste Accumulation Areas" and "Preparation Guide for Generators of Hazardous Chemicals and Radioactive Waste at LLNL." An attendance record is maintained to assure that all personnel receive appropriate training, with periodic refresher classes as needed. Waste minimization information from the published literature, vendor information, or trade shows is disseminated through informal briefings by managers or supervisors.

3.1.2 Responsibilities

Laser Programs management, beginning with the Associate Director, is committed to the achievement of waste minimization objectives and compliance with applicable environmental requirements. In particular, the Laser Programs subscribe to the statement about waste minimization in the LLNL Environmental Policy Statement,¹¹ which makes strong support for waste minimization a Laboratory policy.

The Associate Director for Lasers holds his deputies and subordinate managers responsible for implementation of this Plan and of the Laser Programs Policy Statement on Waste Minimization.

3.2 Characterization of Waste Generation

Data on waste generated by the Laser Programs is captured in a data base maintained by the Hazardous Waste Management (HWM) Division of

the EDP. In 1989, the Laser Programs requested several reports from this data base on selected program activities for analysis of waste generation forms, quantities, locations, and generators. In 1989, this effort focused on copper and process laser operations.

In 1990, the Laser Programs waste characterization effort will be expanded to the entire Laser Programs. The other Laser Programs whose waste generation forms, levels, and patterns will be characterized are the non-laser portions of the U-AVLIS and SIS Programs, the ICF Program, and the Advanced Applications Program. In addition, waste generation data for copper and process lasers in the Laser Technology Program will be updated.

Also in 1990, anticipated waste generation levels for the planned EDS and UDS demonstrations will be characterized and waste minimization considerations will be factored, as practical, into plans for the design and operations of these demonstrations.

3.3 Waste Minimization Assessments

3.3.1 Performance Assessments

The Laser Programs initiated a program of waste management assessments in 1989. An Assessments Manager position has been created and staffed in the Laser Program Assurances office, and the focus of work in this position to date has been on waste management practices in the Laser Programs. The Assessments Manager prepares reports of his findings and line management is tasked for corrective action. Corrective actions are subsequently reviewed for adequacy. In 1990, this ongoing assessment effort will be supplemented by contract help with expertise in waste minimization. In addition, there are multiple surveillances, assessments, and appraisals of laser waste management practices performed by the LLNL Environmental Protection Department and Hazards Control Department. The findings are communicated to the Laser Assurances Organization and to cognizant line managers who are responsible for corrective action. A responsibility of the Laser Program Waste Manager position will be to develop and oversee waste minimization assessments, and to maintain records of waste minimization assessments conducted.

An Assurances data base containing information on a broad range of internal and external health, safety, and environmental appraisals will be established in 1990. This data base will facilitate both the program assessment and the program evaluation (see Section 3.6) functions.

3.3.2 Analytic Assessments

In addition, one of the responsibilities of the Laser Programs Waste Minimization Committee will be to perform waste minimization analyses of selected program activities. Included in these analyses, assessments will be performed to track materials that end up as waste from the time of receipt, if possible, to the point at which they become a waste. Part of the intent of these broad assessments will be to identify targets of opportunity at points in a process where materials can be prevented from becoming a waste (e.g. by using less material, recycling, finding substitutes, or making equipment changes).

3.4 Cost Allocation System

Laser Programs representatives on the LLNL Waste Minimization Steering Committee were very active in helping develop a proposed Laboratory-wide recharge system for waste generators in FY89. The LLNL recharge system, targeted for implementation on October 1, 1989, has not been implemented because of expected changes in the DOE waste management program, which would cause waste management functions at DOE sites to be funded directly as a program by DOE.

Because cost is an important factor in waste management efforts, the analytic waste minimization assessments described in Section 3.3.2 will include waste management costs as a consideration in developing suggestions for improvements in waste minimization.

3.5 Technology Transfer

Exchange of technical information on waste minimization is an important constituent of the Laser Programs Waste Minimization Plan. In 1989, such exchanges were fostered through the following avenues:

- Participation of Laser Programs personnel in Laboratory-wide waste minimization activities (e.g., memberships on LLNL Waste Minimization Steering Committee).
- Participation of Laser Programs personnel in DOE-wide waste minimization activities [e.g. membership in reduced waste generation working group of the Materials Management Exchange Committee (MMEC)].
- Formation of a Waste Minimization Committee within the LIS Program with representation from each major technology area.
- Attendance at professional meetings on waste management and environmental protection.

- Hiring consultants with waste minimization expertise.
- Sponsoring the development of new or modified technology to help reduce identified waste streams.
- Frequent contact with the technical staff of the Environmental Protection Department and its Hazardous Waste Management Division.

All of the above avenues for technology transfer will continue in 1990. The LIS Waste Minimization Committee has been expanded and reorganized as a Laser Programs-wide committee.

3.6 Program Evaluation

The *Laser Programs Waste Minimization Plan* is subject to several levels of program evaluation. They include:

- Performance assessments by the Assessment Manager.
- Evaluation of program implementations by Waste Minimization Committee.
- Oversight by the Laser Assurances Office.
- Reviews and assessments by the Environmental Protection and Hazardous Control Departments.
- Reviews and assessments by DOE.
- Annual Laser Programs input to annual LLNL summary of waste reduction activities (submitted as an appendix to the *LLNL Waste Management Plan* by the LLNL Waste Program Manager).

All these types of review and evaluations are expected to take place in 1990.

3.7 Quality Assurance

The constituents of the Quality Assurance Program for waste minimization are incorporated in the waste minimization elements described above. For ease of reference, they are listed below:

- Waste Minimization Plans.
- Management support.
- Oversight by Assessment Manager, Laser Programs Waste Minimization Committee, Laser Assurances Office, and by Hazards Control and Environmental Protection Departments.
- Compliance data base.
- Corrective action.

4. General Guidance on Waste Minimization

Over a period of time, a hazardous waste management hierarchy has evolved and has been accepted as a standard by waste management experts (see Table 1).⁸ The hierarchy recognizes a range of practices and technologies to reduce waste generation. The priority system embodied in the hazardous waste management hierarchy has been adopted by the Laboratory.⁹ The highest priority is to reduce the generation of all wastes at the source—source reduction. All wastes have some potential for source reduction through such activities as good housekeeping practices, product changes, chemical substitution, and process changes. The second priority is to recycle remaining wastes wherever possible. Both off-site and on-site recycling have been applied to such wastes as solvents, oils, metals, acids, and empty containers. Third, wastes which cannot be eliminated or recycled may be treated to minimize the volume.

Laser personnel should use the standard hierarchy, evaluating the appropriateness of each method and selecting those which are suitable. Some are being adopted; others have already been incorporated.

The success of source reduction within Laser Programs will depend on personnel becoming better educated and more conscious of environmental issues. The learning process and implementation will follow an orderly phased progression which has been successful in similar (commercial, industrial) off-site applications. Good housekeeping, the first step, generally produces significant reductions at small costs. Following this initial phase, formal operating procedure improvements produce additional waste reduction. The third phase is process modifications or changes, wherein new equipment may be installed and/or actual process stream components are changed or modified. This third phase usually requires significant engineering effort, capital equipment investment, and possible building modifications—all requiring significant expenditure of both time and money.

Methods	Activities	Waste streams
Source reduction (highest priority)	<p>Good housekeeping practices (production management)</p> <ul style="list-style-type: none"> • Training • Waste stream segregation • Inventory control • Employee involvement • Spill/leak prevention <p>Product change (switching to products that are less hazardous to produce)</p> <p>Chemical substitution (substituting less hazardous chemicals)</p> <p>Technology modification</p> <ul style="list-style-type: none"> • Improved production management (reducing spills, leaks, evaporation, mixture errors, and bad product runs) • Process change (production changes resulting in less and/or safer chemical use) • Equipment change/redesign • Energy/water conservation 	All wastes have some potential for source reduction
On-site/off-site recycling	<ul style="list-style-type: none"> • Reuse • Reclamation 	Solvents, oils, metals, acids, developers, empty containers
Treatment (lowest priority)	<ul style="list-style-type: none"> • Neutralization • Precipitation • Filtration • Evaporation • Incineration 	Acids, bases, cyanides, plating wastes

Table 1. The hazardous waste management hierarchy.

4.1 Methods Used to Minimize Waste

The methods used to minimize waste⁴ usually fall into one of the following categories:

- Improve housekeeping practices.
- Segregate wastes.
- Reduce wastewater flows.
- Change materials purchasing and methods.
- Substitute less toxic materials.
- Change production methods.
- Delist wastes that are not toxic.
- Recycle or reclaim wastes.
- Treat waste to reduce volume and/or toxicity.

The first four categories are typical good housekeeping practices. Sloppy housekeeping generally results in excess waste generation; good housekeeping tends to minimize waste generation. For instance, chemical leaks from a pump because of improper maintenance procedures may result in a large volume of waste, which includes the chemical itself and possibly a larger volume of other chemicals and materials used in the cleanup. Leaks may be kept at a minimum through proper and periodic scheduled maintenance.

Waste segregation provides many benefits. For instance, when a hazardous waste is mixed with a non-hazardous waste, the mixture becomes hazardous. Through segregation, only the hazardous waste is generated. Similarly, segregation of two hazardous wastes where each is recyclable is preferred to mixing them into a non-recyclable hazardous mixture.

Processes using rinse waters may be modified so that a smaller volume of more concentrated rinse water is generated. Useful materials may be recovered more economically from the concentrate.

Volume and toxicity of wastes may be controlled through front end materials purchasing and control. Fewer types of chemicals purchased in bulk effectively reduces the range of wastes produced and the number of chemical containers that must be disposed. A smaller chemical and material inventory reduces the amount of expired shelf-life chemicals sent to disposal.

Substitution of less toxic or non-toxic chemicals in the feed streams effectively reduces the toxicity of waste streams. Other benefits are improvements to operators' health and safety. Changes in production methods or processes are typically the most difficult to implement because of conversion costs and perturbations in operations, but, if well planned and

Figure 2

Waste Minimization Strategy

Tables Ia, Ib, and Ic displays proposed and implemented Site 300 waste minimization activities for the three wastestreams described above. Reduction activities for each wastestream is receiving high management priority and will be undertaken to the degree determined to be technically feasible and economically practicable.

Cost Allocation System

HWM has been studying the feasibility of implementing a hazardous waste cost recharge system for all LLNL program and support organizations, and is discussing funding and implementation issues with LLNL program and support groups and the DOE. After these funding and implementation issues are resolved, the approved LLNL system shall be implemented at Site 300.

In addition, DAD/ND is evaluating positive incentive alternatives to reward those employees and/or groups who suggest waste reduction techniques that are adopted, as part of the Site 300 Waste Minimization Program.

Technology Transfer

Site 300 programs and support organizations interact with other DOE, trade, and academic organizations to obtain information on waste reduction technologies and strategies through the ND Waste Minimization Coordinator. A conscientious effort is made to network with those organizations who have common waste reduction needs. Within Site 300, information related to waste reduction techniques is maintained in the Site 300 Administration Library (Building 871, Room 115).

Waste minimization techniques and strategies developed and implemented at LLNL Site 300 are transferred via established DOE information transfer systems, through professional publications, and through presentations at technical conferences.

CY88 Data:

HE Fines K044	} 2018 lbs. (0.1%) ¹
HE Bulk D003	
HE-contaminated Solid Wastes ²	} 7200 cu. ft.
[Packing Material Kimwipes, etc.]	
Ash ² 3,000 lbs. (0.2%)	

Note: ¹ Percent of total 1988 RCRA waste volume shown in parentheses.

² Packing materials may contain solid D006 and/or D007 components
Status of Kimwipes and cloth exposed to listed solvents under evaluation due
to recent regulatory interpretations.

Figure 3a. Waste Generation Data

CY88 Data [based on Input]

Gravel¹ 375 yd³ × 2564 lbs/yd³ = 961,500 lbs.

Wood¹ 85 yd³ × 824 lbs/yd³ = 70,040 lbs.

Plastic¹ 65 yd³ × 400 lbs/yd³ = 34,000 lbs.

Total Debris

[D008 + Low - Level Radioactive] 1,065,540 lbs. (57.7%)²

Notes:

- ¹ Estimated values
- ² Percent of total 1988 RCRA waste volume shown in parenthesis

Figure 3b. Waste Generation Data

Note: Percent of total 1988 RCRA waste volume shown in parentheses.

Figure 3c. Waste Generation Data

Table 1.2
High Explosive (HE) Formulation and Processing Wastes

Process waste	Minimization proposal	Cost	Schedule	Comments
HE fines	Recycle HE fines on-site for reuse in high explosives testing operations.	To be evaluated	CY90	Technology modification, process changes required.
HE bulk	Technology modification, production changes.	To be evaluated	CY90	Training and procedure implementation required.
HE-contaminated solid wastes (packing material, Kimwipes, etc.)	Good house keeping practices, waste stream segregation, training, inventory control, and spill prevention.	Acceptable costs	CY90	Training required.

**Table 1.b
Debris from HE Tests**

Process waste	Minimization proposal	Cost	Schedule	Comments
Debris	Materials substitution, using non-hazardous materials in place of hazardous material.	Acceptable	Initiated in CY89 (on-going)	Administrative controls have been placed on the use of lead in experiments. Since lead was the constituent that made the debris a RCRA waste, its control has resulted in a waste stream that is most often characterized as low-level radioactive, rather than mixed.
	Technology modification on design of firing table tents	Acceptable	In-place CY89	New type of structure used, resulting in a significant reduction in the volume of waste generated.

Table 1.c
Miscellaneous Wastes from Dynamic/Thermal and Beam Research Operations,
Machine Shops, and Maintenance Operations

Process waste	Minimization proposal	Cost	Schedule	Comments
Ignitable waste	Good housekeeping practices, training, employee involvement, waste stream segregation, inventory control.	Acceptable	CY90	Training required.
Halogenated	Chemical substitution, process changes, production technology modification.	To be evaluated	Initiate in CY90	Studies required to ascertain technical feasibility, adverse impacts on product quality.
Miscellaneous	Good housekeeping practices, waste stream segregation, spill prevention, inventory control	Acceptable	CY90	Training required.

Program Evaluation and Audits

The DAD/ND shall establish a Quality Assurance Program to audit the implementation of the Site 300 Waste Minimization Plan. A report shall be prepared to document annual progress on meeting reduction goals and to identify potential areas for improved waste minimization.

justified on technical and cost-benefit bases, they can offer substantial waste reduction potential.

Waste recycling not only reduces the amount of waste that must be sent to disposal, but also the amount of virgin materials purchased. Laser Programs wastes that must be treated are sent to the Hazardous Waste Management Division.

A more general description of these methods as well as examples of their application are found in Reference 4.

4.2 Responsibilities and Implementation

It is incumbent on each person working in the Laser Programs to endeavor to minimize the hazardous or radioactive waste that may be generated as a result of activities in which he or she is involved.

All operations with hazardous materials require an Operational Safety Procedure (OSP) that must be approved by program management. All Laser Programs OSPs are required to have a section discussing wastes generated from operations and steps taken to minimize such wastes. OSPs approved prior to the issuing of a formal *LLNL Waste Minimization Program Plan* will be required to add a waste minimization section by the next annual review.

The overall goal is to reduce the volume of waste generated over the next several years when considered as a function of the overall level of program activity. Using the general guidance provided by this plan and by the Laboratory, each directorate, program, project, or activity, as appropriate, should define its own waste minimization goals. Responsibilities at each level are described below.

4.2.1 Laser Programs Office

Waste minimization responsibilities of the Laser Programs Office are the following:

- Issues Laser Programs Policy Statement on Waste Minimization.
- Issues and updates Laser Programs Waste Minimization Plan.
- Conducts waste minimization performance assessments, maintains records.
- Oversees waste minimization training, keeps training records.
- Chairs Laser Programs Waste Minimization Committee.
- Is the point of contact with other organizations on waste minimization (e.g., DOE, EPA, LLNL's Environmental Protection Department and Hazards Control Department).
- Approves specific waste minimization plans.

4.2.2 Line Management

Waste minimization responsibilities of line management are the following:

- Implements Laser Programs waste minimization policy and plan.
- Sets goals for waste minimization in their programs.
- Assigns responsibilities and allocates resources to achieve the waste minimization goals.
- Considers waste minimization objectives up front in new projects and selects process alternatives that contribute to achieving waste minimization goals.
- Develops *specific waste minimization plans* for major programs and projects under their cognizance (e.g., U-AVLIS, Laser Technology, UDS, EDS).
- Appoints representatives to Laser Programs Waste Minimization Committee.

4.2.3 Waste Minimization Committee

Waste minimization responsibilities of the Waste Management Committee are the following:

- Reviews and recommends approval of specific waste minimization plans prepared by line organizations.
- Evaluates implementation of the overall *Laser Programs Waste Minimization Plan* and specific waste minimization plans prepared by line organizations.
- Evaluates candidate waste minimization proposals, including process changes.
- Conducts *waste minimization analytical assessments*.
- Provides advice and guidance to Laser Programs line organizations on waste minimization.

5. Glossary¹²

AEA: Atomic Energy Act of 1954, as amended. Establishes requirements for managing radioactive materials and waste.

EPA: U.S. Environmental Protection Agency. Federal Agency responsible for enforcing environmental laws. Although some of this responsibility may be delegated to state and local regulatory agencies, EPA retains oversight authority to ensure protection of human health and the environment. EPA administers the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, as it is commonly known, and works with state and local agencies to provide technical oversight for cleanup activities at federal facilities regulated by the Superfund program.

EPD: Environmental Protection Department (LLNL).

Hazardous wastes: wastes exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test). In addition, EPA has listed as hazardous other wastes that do not necessarily exhibit these characteristics. Although the legal definition of hazardous waste is complex, the term more generally refers to any waste that EPA believes could pose a threat to human health and the environment if managed improperly. RCRA regulations set strict controls on the management of hazardous wastes.

HSWA: Hazardous and Solid Waste Amendments of 1984 to RCRA. These amendments to RCRA greatly expanded the scope of hazardous waste regulation. In HSWA, Congress directed EPA to take measures to further reduce the risks to human health and the environment caused by hazardous wastes.

HWMD: Hazardous Waste Management Division of the Environmental Protection Department (LLNL).

Land Ban: a regulatory program that identifies hazardous wastes that are restricted from land disposal. The regulations incorporate a phasing-in of restrictions in three stages.

LLW: low-level radioactive waste.

NEPA: National Environmental Policy Act of 1969. A federal statute that imposed the first requirements on federal agencies to consider the environmental effects that may result from agency actions. One provision of NEPA requires the preparation of an Environmental Impact Statement by federal agencies when "major" actions are taken.

Radioactive mixed waste: waste containing both radioactive and hazardous components regulated by the AEA and RCRA, respectively. The term "radioactive component" refers only to the actual radionuclides dispersed or suspended in the waste substance.

Radioactive waste: solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, and of negligible economic value considering costs of recovery.

RCRA: Resource Conservation and Recovery Act of 1976. RCRA is an amendment to the first federal solid waste legislation, the Solid Waste Disposal Act of 1965. In RCRA, Congress established initial directives and guidelines for EPA to regulate hazardous wastes.

TRU: transuranic (containing transuranium nuclides).

Waste management: the planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated surveillance and maintenance activities (DOE Order 5820.2A).

Waste minimization: the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, stored, or disposed of. It includes any source reduction or recycling activities undertaken by a generator that results in either (1) the reduction of total volume or quantity of hazardous waste, or (2) the reduction of toxicity of the hazardous waste, or both, so long as such reduction is consistent with the goal of minimizing present and future threats to human health and the environment (EPA's Report to Congress, 1986, EPA/530-SW-86-033).

6. References

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DIRECTORATE MINI PLAN

for

NUCLEAR DESIGN

WASTE MINIMIZATION MANAGEMENT PLAN
LAWRENCE LIVERMORE NATIONAL LABORATORY
NUCLEAR DESIGN PROGRAM
SEPTEMBER 15, 1989

William B. Shuler
Acting Associate Director
Nuclear Design Program

1.0 INTRODUCTION

1.1 OBJECTIVE

This document presents the Nuclear Design Program management strategy for minimizing the future generation of hazardous, radioactive, and mixed waste at the Lawrence Livermore National Laboratory. When applicable, this plan shall also address the minimization of nonhazardous industrial wastes, in particular those wastestreams that cannot be released to the environment or to sewer systems without treatment and, therefore, are processed as if they were hazardous.

1.2 WASTE MINIMIZATION POLICY

The Nuclear Design Program shall adopt the Laboratory's goal of reducing wastestreams by a major factor in the next three to five years by reducing generation and increasing recycling, as stated in the Director's Statement on Waste Minimization dated March 8, 1989. In working towards this goal, the Program shall comply with DOE Order 5820.2A and all applicable federal, state and local requirements.

1.3 NUCLEAR DESIGN WASTESTREAMS

The following section describes the major wastestreams generated by the Nuclear Design Program:

- o Large volumes of waste (approximately 600 cubic yards per year) is generated in high explosives tests conducted at Site 300. The wastestreams generated are most often classified as a low-level radioactive waste because depleted uranium is used in most of the tests. Beryllium, lead, copper, and barium are used in some experiments but, with the exception of lead, they have been present in concentrations that do not exceed hazardous waste threshold limits. Operational changes were made in 1987 to eliminate the use of lead bricks and to keep concentrations below hazardous waste threshold levels.
- o Large volumes of waste are also generated in the Engineering and Chemistry areas in support of Nuclear Design programs at the Livermore Site. These wastes, are often classified mixed wastes.
- o Photochemical wastes are also generated in Nuclear Design Program facilities. The Site 300 wastestreams are collected and transported to Livermore for silver reclamation without volume reduction at the source. Photochemical wastes from Livermore also undergo silver reclamation processing.

- o Oils and cutting solutions are generated at several Program facilities. The Site 300 wastestreams are collected and transported to Livermore and are eventually reclaimed at on-site or off-site facilities. Livermore Site oils and cutting solutions are also reclaimed.
- o Nonhazardous wastewaters are also generated by Nuclear Design. In some instances, these nonhazardous wastewaters exceed sewer discharge limits and, therefore, need to be processed as hazardous wastes. Typical contaminants are oil and grease, trace organics, and trace metals.

2.0 IMPLEMENTATION AND RESPONSIBILITIES

2.1 IMPLEMENTATION APPROACH

The plan to minimize the generation of wastes in Nuclear Design requires consideration of the following strategies in the early stages of planning new experiments and facilities and in the management of current wastestreams. The general approach to be taken to implement waste minimization shall be as follows:

- o Establish a review/audit process in the Nuclear Design Program that will ensure that waste minimization goals are being included in projects.
- o Review future use of materials and survey facilities for current use of materials that will become hazardous waste.
- o Utilize the techniques illustrated in Figure 1, with the most desirable technique being source reduction, followed by recycling and, if source reduction and recycling are not feasible, treatment.
- o Ensure that compliance is being achieved through regularly scheduled audits.

2.2 RESPONSIBILITIES

Associate Director

Assume responsibility for establishing waste minimization as a priority within the Nuclear Design Program.

Ensure that a system is in place to allow waste minimization objectives to be realized.

Program Leaders/
Facility Managers

Ensure that waste minimization elements are included in experiments.

Oversee project teams involved with waste minimization treatability studies and implementation.

Program Experimenters

Evaluate materials to be used in experiments and strive to minimize the amount of hazardous, mixed or radioactive waste to be generated.

WASTE MINIMIZATION TECHNIQUES

DRAFT

Lawrence Livermore National Laboratory

Site 300 Facility

Waste Minimization Plan

M. A. Gonzalez
Nuclear Design Program

R. A. Heckman
Environmental Protection Department

February 2, 1990

Preface

The following Waste Minimization Plan has been prepared to reduce the volume and/or toxicity of hazardous, mixed, and radioactive wastes generated at Site 300. This Plan, which has been prepared by LLNL's Nuclear Design Program (NDP) with assistance from LLNL's Environmental Protection (EPD) and Hazards Control (HC) Departments, describes the goals, management support, roles and responsibilities, waste targets, information transfer and reporting, and evaluation and auditing elements of NDP's Waste Minimization Program.

This Plan has also been prepared to meet the permit requirements specified by the U.S. Environmental Protection Agency (EPA) in the Resource Conservation and Recovery Act (RCRA) permit for the Building 883 Hazardous Waste Storage Facility at Site 300 (EPA I.D. Number CA289009002) issued in 1989.

LLNL's Nuclear Design Program management endorses this Plan, and will include its elements in its existing and new activities.

Eugene C. Draney
Deputy Associate Director
for Assurances
Nuclear Design Program

Executive Summary

Waste minimization has received top management support at LLNL. A Waste Minimization Plan has been developed for LLNL Site 300, and it is being implemented by the programs and support organizations residing at the site.

Three major wastestreams have been identified at Site 300. They are: (1) debris generated from the high explosives testing operations; (2) wastes from high explosive formulation and processing operations; and (3) miscellaneous wastes resulting from dynamic/physical and particle beam testing operations, machine shops, and general facility and equipment maintenance activities. Following characterization, work was initiated to identify potential alternatives for reducing the characterized wastestreams. In several areas, alternatives have already been selected and implemented.

LLNL NDP management has established a waste reduction goal of 25% reduction over the next 3 to 5 years, with the base year being CY 1988. It is NDP's intent to give priority to source reduction and recycling over treatment of wastes, employing methods that are technically feasible and economically practicable.

Site 300 Waste Minimization Plan

Background

Site 300 comprises eleven square miles, located in both Alameda and San Joaquin counties. The site was established as a remote explosives test facility to support nuclear weapons theoretical and developmental work performed at the LLNL Livermore Site for the U.S. Department of Energy (DOE). The Site 300 population is approximately 300 employees, including approximately 270 full-time employees and 30 supplemental workforce personnel. The area surrounding Site 300 is sparsely populated with the majority of land used to support sheep and cattle ranching operations and windmill power generators.

Site 300 is used primarily for performing high explosives tests with sophisticated diagnostics. Dynamic/thermal testing operations, high explosives formulation and processing operations and, in recent years, particle beam research are also conducted at Site 300. Site 300 operations are conducted in conformance with federal, state, and local safety and environmental laws, DOE Orders, the LLNL Health and Safety Manual, and the Site 300 Safety and Operational Manual.

The industrial wastes generated at Site 300 include hazardous and low-level radioactive wastes and, on occasion, mixed wastes. Facilities at Site 300 that generate hazardous wastes include the high explosives test firing tables with associated diagnostic and data recording operations, the dynamic/thermal testing operations, the particle beam research experiments, and ancillary support facilities associated with conducting operations at Site 300. The high explosives test operations also generate low-level radioactive wastes which primarily consists of depleted uranium and, infrequently, mixed waste which generally contains both depleted uranium and heavy metals.

The importance of minimizing waste generation through source reduction, recycling, and treatment has been acknowledged by Site 300 management. Through assessment of waste generating processes and identification of waste minimization alternatives, information is being obtained to implement the changes that will result in reductions in the toxicity and/or volume of wastes generated at Site 300.

Waste Minimization Organization

The Waste Minimization Policy Statement of March 8, 1989 (Attachment 1), issued by the LLNL Laboratory Director, reflects the strong commitment by top management to implement waste minimization efforts at LLNL. To reinforce the need for inclusion of the Director's policy in daily operations, Nuclear Design Program management has also developed a more specific policy statement applicable to waste minimization at Site 300 (Attachment 2).

As illustrated in Figure 1, several LLNL organizations have roles and responsibilities in carrying out the Site 300 Waste Minimization Program. The Nuclear Design Program Deputy Associate Director (DAD) for Assurances has the responsibility for management of Site 300 safety and environmental programs, as delegated by the Associate Director for Nuclear Design (ND). The Site 300 Resident Manager has the responsibility for daily oversight of Site 300 safety and environmental programs. Knowledge of environmental compliance and operational safety requirements and implementation of these requirements is the responsibility of the programs and support organizations operating each facility or complex. Work is performed at these facilities in accordance with established Operational Safety Procedures and in compliance with environmental regulations. The DAD/ND, Site 300 Resident Manager, and program and operational support managers receive guidance and assistance in implementation from safety and environmental specialists assigned to Site 300.

With respect to waste minimization, the DAD/ND provides the system for reviewing and auditing programmatic and support activities to ensure that waste minimization goals are being addressed. The Site 300 Resident Manager provides the oversight to ensure that routine operations receive the proper review to ensure that both LLNL and Site 300 waste minimization policies are being incorporated into activities. The Nuclear Design Waste Minimization Coordinator coordinates assessment and implementation activities of all Nuclear Design operations and ensures that Site 300 waste minimization information is communicated between Site 300 personnel and LLNL/DOE Waste Minimization Program personnel.

Figure 1. Functional Organization Chart – Site 300 Waste Minimization Program

Solid lines denote lines of responsibility. Broken lines denote support organizations.

Each Site 300 program and support organization manager establishes specific waste minimization goals and plans, and identifies and assigns responsibility for achieving these goals to a specific Waste Reduction Coordinator (WRC). In addition, program and support organization managers are responsible for ensuring that formal training of personnel in waste minimization and hazardous waste management practices is provided, and that required recordkeeping systems are implemented and maintained.

The safety and environmental specialists from the Hazards Control Department (HC) and the Environmental Protection Department (EPD) are responsible for providing interpretations of codes, standards, and DOE Orders, and for conducting training courses, evaluations, and audits, as requested by the DAD/ND. In addition, the Hazardous Waste Management Division Leader of LLNL's EPD is responsible for operations conducted in Building 883 and for ensuring that records and certifications required by 40 CFR 264.73 (b) (9) are maintained in the facility operating record until closure of Building 883.

Waste Minimization Goals

LLNL NDP management has established a Site 300 waste reduction goal of 25% reduction over the next 3 to 5 years, with the base year being CY1988.

Waste Minimization Assessments and Proposals

Waste minimization assessments conducted at Site 300 shall include three major steps: (1) information gathering; (2) identification and screening of potential waste minimization options; and (3) evaluation of technical and economic aspects of potential options. Implementation of the recommended options shall follow the assessment process. At Site 300, the waste minimization assessment process shall be an on-going program, not a one-time effort. The DAD/ND shall arrange for an annual audit to identify additional opportunities for source reduction and recycling. These annual reviews will emphasize the application of new technologies for waste reduction as they become known, with priority being given to source reduction and recycling over treatment of wastes, as illustrated by the example shown in Figure 2.

The Hazardous Waste Division of EPD develops and maintains a waste accounting system to track the types, amounts, composition, and generation dates of all hazardous wastes. The Facility Hazardous Waste Report is based on data extracted from the HWM data base. The three major wastestreams generated at the site are: (1) debris from high explosives testing operations; (2) wastes from high explosive formulation and processing operations; and (3) miscellaneous wastes resulting from dynamic/physical and particle beam testing operations, machine shop wastes, and general facility and equipment maintenance activities. Waste generation flow sheets for the 1988 base year are shown in Figures 3a, 3b, and 3c. It should be noted that the percentages shown are based on the total waste volume (by weight), which was derived by adding the volumes of the wastestreams shown in Figures 3a, 3b, and 3c.