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Evaluation of DERA Funded HAZMIN Projects, 1988-1991

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13. ABSTRACT *(Maximum 200 words)*

Since 1985, the U.S. Army has funded approximately 75 installations and activities to conduct various projects related to hazardous waste minimization (HAZMIN). This report describes the findings of a study to follow up on over 100 projects funded between 1988 and 1991 and address their fate and effectiveness in terms of waste reduction and cost savings.

These projects were categorized by project type (e.g., equipment purchase and installation, test and evaluation, etc.) and by targeted waste (e.g., solvents, metals, reactive, etc.).

In general, many of the HAZMIN projects were found to have resulted in apparent cost savings and waste reduction as well as less tangible benefits such as increased awareness of and involvement in HAZMIN initiatives.

In addition to an evaluation of successful HAZMIN projects, impediments to the success of HAZMIN projects were identified.

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In July 1992, the U.S. Army Toxic and Hazardous Materials Agency (now the U.S. Army Environmental Center{AEC}) contracted Arthur D. Little, Inc. to conduct an assignment entitled "Study of the Effectiveness of Various HAZMIN Projects at Army Installations." This task involved the examination of over 75 hazardous waste minimization (HAZMIN) projects funded through the Defense Environmental Restoration Account (DERA) from 1988 through 1991.

Approach

The DERA-funded HAZMIN projects were evaluated with respect to: final project costs, motivation behind the projects, verification of project completion, project documentation, resulting cost savings and waste reduction, and overall project effectiveness. The basic approach taken in this evaluation included the following steps:

- Acquire and review existing HAZMIN documentation provided by AEC and develop a master list of projects funded from 1988 through 1991;
- Review of available data and information provided by AEC and the Major Commands (MACOMS) regarding these projects;
- Conduct of telephone surveys of points of contact for each of the projects to supplement the limited amount of available data and information;
- Preparation of Project Summaries to document all information obtained; and
- Conduct of site visits to nine selected installations to further the understanding of the projects as well as to gain insight into the general HAZMIN programs and initiatives of the installations.

HAZMIN Project Categorization

The master list of HAZMIN projects contains a total of 75 different projects. These projects were organized by both project type and by the targeted waste being addressed. A total of five project types were identified including:

- Equipment Purchase and Installation – These projects include various phases of the acquisition, installation, and operation of equipment to effect waste reduction;
- Test and Evaluation (T&E) – These projects include efforts designed to test and/or evaluate HAZMIN initiatives (e.g., pilot testing, feasibility and design studies, and evaluation of HAZMIN efforts);
- HAZMIN Program Support – These projects include a variety of efforts to address the development or enhancement of a HAZMIN program (e.g., personnel support, hazardous material/waste tracking system development, hardware/software procurement, development of plans, training and workshops, and waste delisting efforts);
- HAZMIN Audits – These projects include audits and surveys to identify opportunities for waste reduction and cost savings; and

- Not Specified – There was too little information available regarding these projects to allow for their classification.

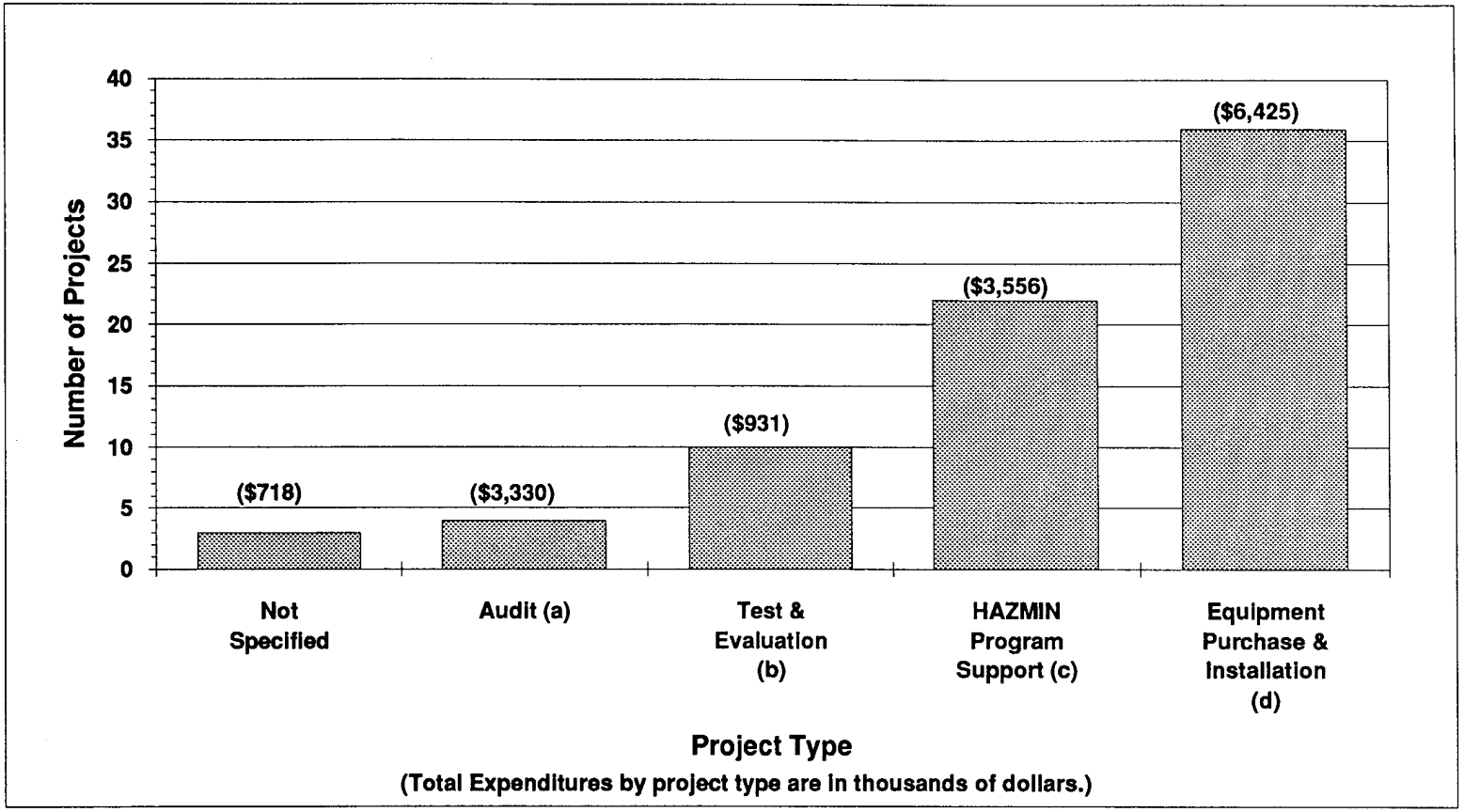
A graphical presentation of the number of HAZMIN projects (and expenditures) by these project types is provided in Figure ES-1. As can be seen, the largest number of projects (36) and the highest level of funding (greater than $6.4 million) relate to the acquisition, installation, and/or operation of equipment to reduce hazardous waste generation.

For the 75 projects evaluated, targeted wastes were identified and the projects that address these targeted wastes were organized into the following categories:

- General – These projects apply to hazardous waste in general (e.g., audits, hazardous waste/material tracking system development, HAZMIN plan development, workshops, etc.);
- Solvents – These projects address the replacement or recovery/reuse of various solvents used for degreasing and cleaning;
- Waste Oils/Fuels – These projects are applicable to the management (including recovery/reuse) of waste oils, waste fuels, used oils, and used fuels;
- Painting/Depainting – These projects address waste reduction in the areas of paint application, depainting, and corrosion removal;
- Reactive/Explosive – These projects address the management and reduction of reactive and explosives wastes (e.g., pinkwater, off-specification and waste energetic materials, and demilitarization wastes);
- Plating – These projects involve the reduction of wastes generated during metal plating and finishing operations;
- Chemical Agents – These projects address chemical agent-related wastes and include waste delisting efforts and decontamination solution treatment and disposal;
- Miscellaneous – These projects address a wide variety of wastes grouped together because each of the wastes represents only a single project. Wastes addressed include acid/base neutralization, antifreeze, groundwater sampling, radioactive wastes, scrap metal, laboratory wastes, and medical wastes;
- Not Specified – There was too little information available regarding these projects to allow for their classification.

A graphical presentation of the number of HAZMIN projects (and expenditures) by these targeted wastes is provided in Figure ES-2. As can be seen, the largest number of projects (22) and the highest level of funding (greater than $6 million) relate to projects that address hazardous wastes in general.

Figure ES-1: Summary of DERA Funded HAZMIN Projects (1988-1991) by Project Type



NOTES:

(a) Includes waste minimization opportunity assessments.

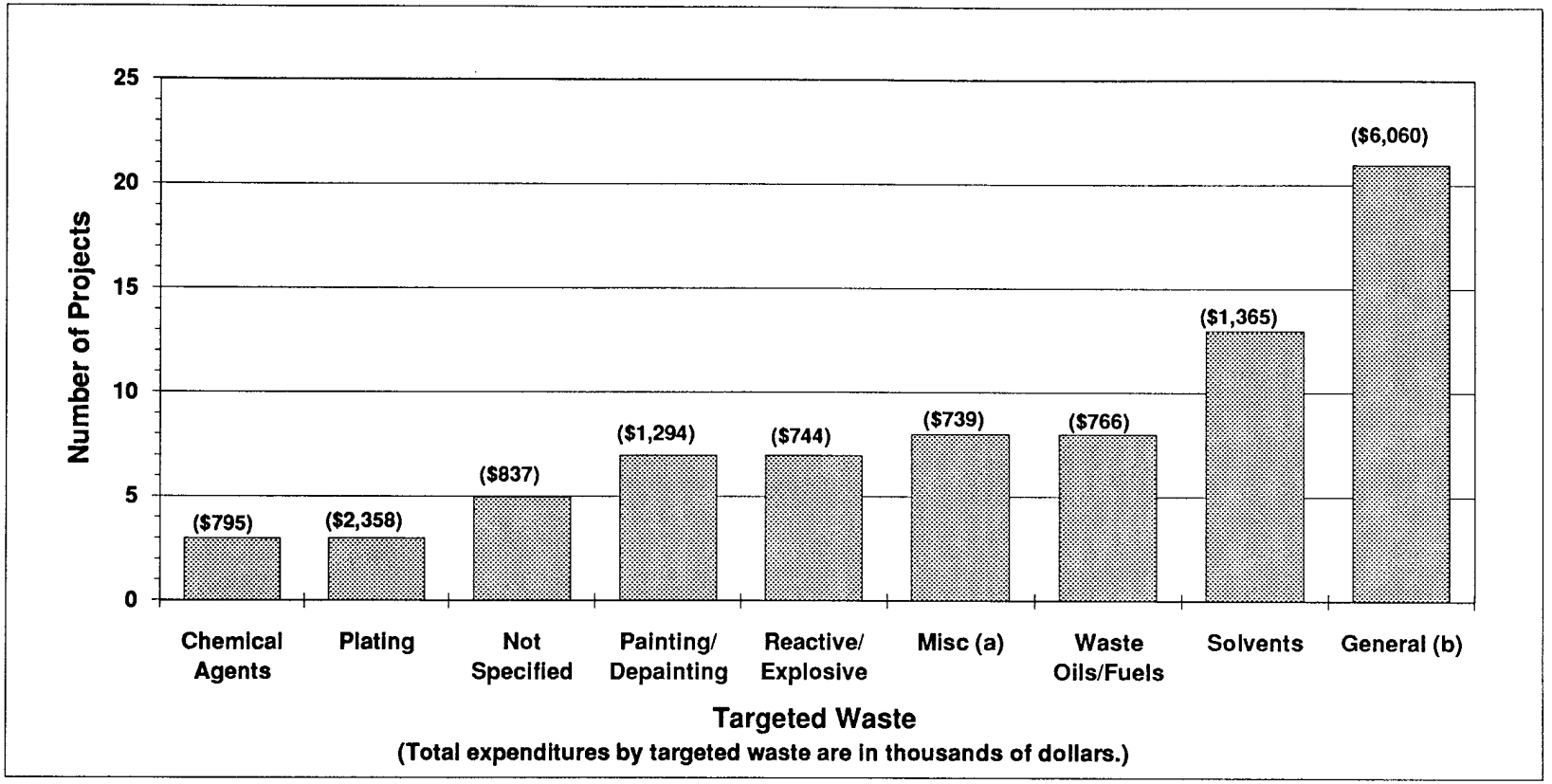
(b) Includes projects such as pilot tests, studies, and evaluations.

(c) Includes database development, software development, delisting efforts.

(d) Includes equipment purchases, installation, construction, and training.

Source: Arthur D. Little, Inc.

Figure ES-2: Summary of HAZMIN Projects Funded (1988-1991) by Targeted Waste



NOTES:

(a) Miscellaneous includes Battery Waste, Waste Antifreeze, Contaminated Groundwater, Mixed Ammunition and Radioactive Waste, Scrap Metal, Laboratory Waste, and Medical Waste.

(b) Applicable to hazardous waste in general.

Source: Arthur D. Little, Inc.

Evaluation Findings

The DERA-funded HAZMIN program has resulted in the implementation of many successful projects resulting in apparent cost savings and waste reduction. In addition, less tangible benefits of the HAZMIN projects were observed. Primary among these benefits are increased awareness of and involvement in HAZMIN initiatives in general.

Despite the successes, a number of less successful projects were identified. In some cases, it was possible to relate the relative lack of success of these projects with specific impediments. Many of the impediments represented institutional characteristics that were beyond the control of the individual installations.

Evaluation of Success. The apparent success of the HAZMIN projects is a subjective measurement. An objective assessment of success is difficult since the definition of success cannot be generalized for the variety of HAZMIN projects evaluated. For the purpose of this evaluation, a successful project was identified as one in which one or more of the following has occurred or will occur: a waste reduction initiative has been implemented; results of the initiative have been obtained; and/or the implementing installation is satisfied that the objective of the initiative has been met.

In a review of the HAZMIN projects, a number of factors that contribute to the apparent success or lack of success of the projects were identified. For the purpose of this discussion, these factors have been divided into *Facilitators* leading to success and *Impediments* that either impeded or prevented success.

Facilitators. There were definite factors that contributed to the successes of HAZMIN projects and the strength of the HAZMIN programs. These factors included:

- Technical expertise and creativity;
- Strength of the individual installation's HAZMIN program;
- Degree of worker involvement;
- HAZMIN awareness; and
- Technology transfer.

Successful HAZMIN projects were, in general, conducted at facilities that had one or more of the above characteristics. In some cases, a few key individuals propagated a sense of enthusiasm and proactive attitudes that encouraged the continuation of HAZMIN efforts. Installations with the ability to adequately document waste sources, types, and disposal costs were able to prioritize their efforts and readily assess their success. Good cooperation and involvement of operators also contributed to success. Personnel involvement is also evident at installations with active HAZMIN programs that train and encourage their employees.

Technology transfer among facilities was in general observed to be effective. The Army Depot Systems Command (DESCOM) Center of Technical Excellence (CTX) program was often cited as contributing positively to the high level of technology transfer among

the depots. In addition, regularly scheduled technical meetings and conferences sponsored by major commands (MACOMs), joint services, and other federal organizations enhanced technology transfer. It was also observed that informal technology transfer often occurs between personnel (including operators, engineers, and commanders) of various installations.

Impediments. A number of issues that impeded the success and implementation of HAZMIN efforts were identified. These included:

- Schedule;
- Acquisition requirements;
- Customer process and product specifications;
- Personnel resources;
- Technology transfer among Government-Owned/Contractor-Operated installations (GOCOs); and
- Accountability of HAZMIN results.

Many of these impediments are institutional and are usually beyond the control of installation personnel. Schedule problems arise from the short time frame available to obligate funds. This is especially difficult for equipment projects. In addition, equipment installation projects can incur long schedules because of the steps required to complete, often taking several years before any results are observed.

Acquisition requirements (primarily those imposed by the Federal Acquisition Regulations [FAR]) often make it difficult for an installation to obtain the desired equipment. A specification must be written adequately specific to describe the need, yet general enough to meet competitive bid requirements. The low bidder is often awarded the contract which may result in inferior or impractical equipment.

Manufacturing and maintenance specifications often impeded the consideration and implementation of HAZMIN initiatives. Specifications that specify types of materials and processes to be used in maintenance and production operations are often out of date and were prepared with minimal (or no) consideration of the environment. These requirements make it difficult to use alternative processes or materials that are environmentally sound but are not approved or are prohibited based on these specifications.

Lack of personnel to install equipment was also a problem for installations. Equipment that had been purchased was often idle because of the absence of available tradespeople to install it.

It was observed that a lesser degree of technology transfer occurred between GOCO facilities. This reluctance to pursue technology transfer was observed to exist because of potential competition with other contractors. This had the potential to result in inadequate exposure of successful HAZMIN projects for applications at other facilities.

It was not possible to complete the evaluation of some of the DERA-funded HAZMIN projects because of a lack of information and turnover of personnel at the implementing installation. In addition, some projects could not be fully evaluated because of a lack of data and information needed to determine project results. This was a common problem that most often related to the determination of waste reduction and cost savings. Tracking waste reductions and cost savings due to HAZMIN project implementation was made difficult due to: the lack of a normalized baseline for waste generation and costs; variable product requirements and production rates; and the absence of a suitable measurement and accounting system.

Final Observations and Recommendations

It was observed during this evaluation that the DERA-funded HAZMIN projects had positive effects – not only based on waste reduction and cost savings, but on the overall level of HAZMIN awareness, enthusiasm, and involvement.

One may think of the HAZMIN involvement process as analogous to the "activation energy" in a chemical reaction pathway as illustrated in Figure ES-3. Initially, the Army has invested time and resources in educating installation personnel on the advantages of HAZMIN through enacting waste reduction mandates and establishing requirements for formal HAZMIN programs at each facility. This is further enhanced by the opportunities provided by AEC through DERA funding and technical support for HAZMIN initiatives. The levels of acceptance and implementation of a HAZMIN program are observed to be variable and different for each facility. Many facilities have not yet developed aggressive approaches to HAZMIN and are still on the uphill climb thus requiring additional investments in assistance and encouragement. Other facilities have reached the point where HAZMIN efforts are self-initiating because of the benefits that have been demonstrated through the implementation of previous initiatives. This self-initiation is resulting in significant cost savings and waste reduction to the Army (from projects that may or may not be funded by DERA). With time and continued Army support, more facilities will incorporate HAZMIN into their culture and more HAZMIN initiatives will be implemented resulting in further waste reduction and cost savings. This increasing level of involvement and implementation is illustrated as the downward curve on Figure ES-3. Many times, through the aggressive implementation of HAZMIN efforts, the facility or installation can operate more efficiently than it did prior to the investment into HAZMIN. Lastly, continued Army support will ensure that this trend is maintained through continued education and awareness training.

Continued support is required to move installations further along the initial uphill climb. To enhance this process, it is recommended that the strengths and successes noted above continue to be encouraged. In addition, impediments to HAZMIN should be addressed to the maximum extent possible to increase opportunities for facilities to implement strong HAZMIN programs and projects. Such support and encouragement can be enhanced by consideration and implementation of the following:

1. Define realistic goals for each type of project so that success can be better evaluated.

2. Develop a means to track the progress of DERA-funded projects once funding is obligated to allow the Army to know where funds have been allocated and assess their status.

3. Assist the facilities in developing baseline strategies to allow further assessment of the success of projects (including the quantification of waste reduction and cost savings). This recommendation is a simple one to make, but has proven to be difficult to perform. The difficulty of developing a baseline is an often-discussed and sometimes controversial subject in industry as well as the Army.

4. Encourage the development of strong HAZMIN programs at each facility including effective waste tracking capabilities, strong technical expertise, and the tools to prioritize and address each waste stream.

5. Continue to support technology transfer through programs such as the Centers for Technical Excellence (CTX).

6. Address the issue of technology transfer among GOCOs.

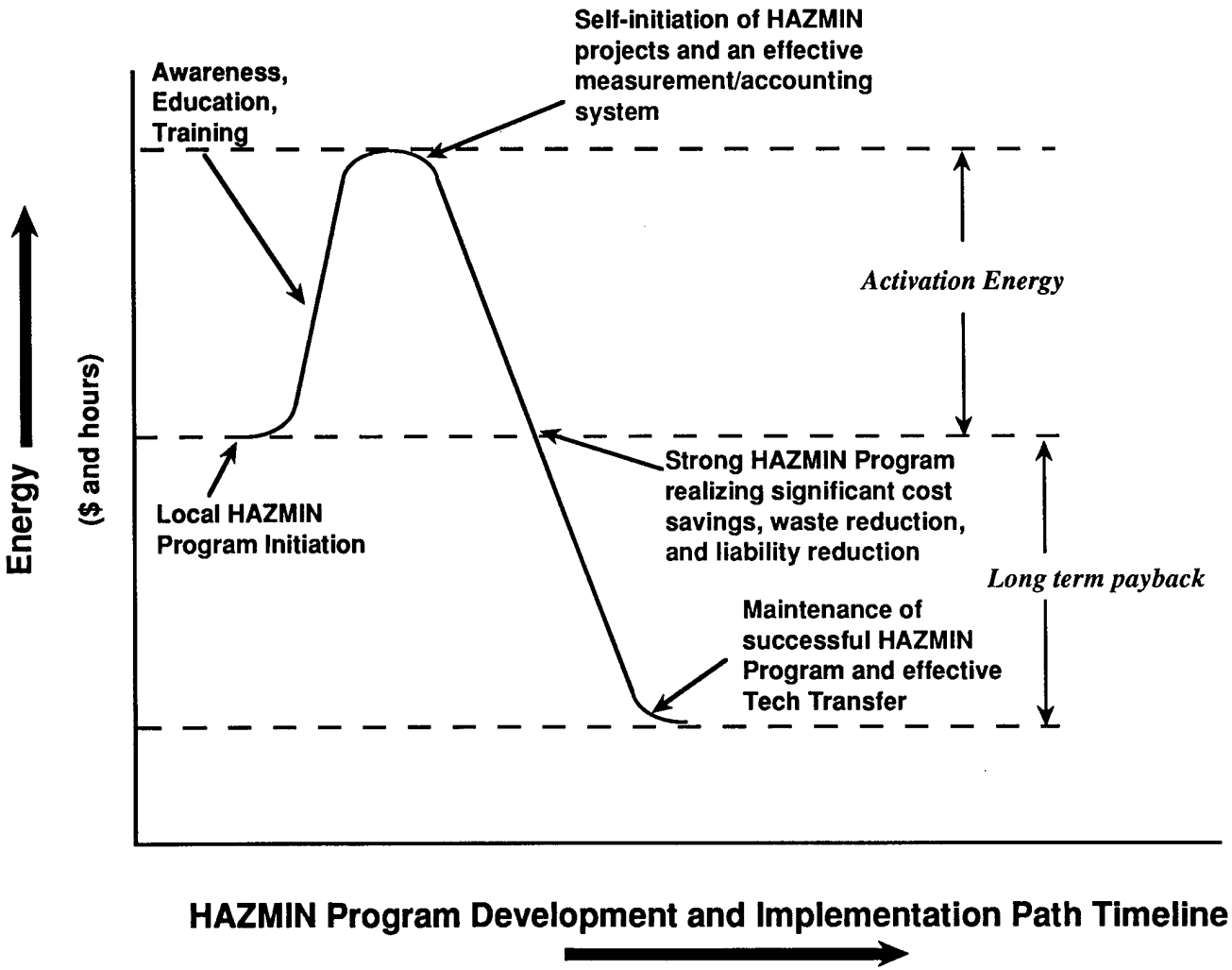
7. Continue to improve operator awareness of HAZMIN programs and issues to encourage their suggestions and involvement.

8. Address the issue of outdated process and product specifications. This may include the development of an easier avenue to obtain waivers. In addition, research and development that is conducted to prepare these Technical Data Packages should consider HAZMIN and environmental issues.

9. Consider emphasis on continued funding of projects addressing specific installation needs rather than those projects that address waste reduction in general and are not waste or installation-specific.

Implementation of the above would increase the likelihood of achieving a successful HAZMIN program. The true test of a successful HAZMIN program is that it becomes a part of the culture and acts as a stepping stone for ultimate "design for the environment."

Figure ES-3: Development Stages and Goals of a HAZMIN Program



Source: Arthur D. Little, Inc.

Since 1985, the Army's hazardous waste minimization (HAZMIN) program has funded approximately 75 installations and activities to conduct various projects related to waste reduction. Funding through the Defense Environmental Restoration Account (DERA) has been provided on the local level to make these installations and activities, as well as cognizant major Army commands (MACOMs), aware of the long-term economic and environmental benefits of waste reduction.

Among the types of projects supported by funding from the HAZMIN program are:

- Studies of various waste streams to identify potential waste reduction opportunities;
- Identification and development of substitutes to replace existing materials with those that generate less quantity or less toxic wastes;
- Purchase of alternative process equipment with capability to reduce waste generation; and
- Purchase of equipment for the recovery and/or recycling of wastes for reuse.

Although the Army has maintained an accounting of the funds provided for the various HAZMIN projects, there are no centralized records of the results of the projects. In order to fill in these knowledge gaps and thereby enhance the effectiveness of the DERA-funded HAZMIN program, the task described in this report was initiated.

The objectives of this task include the tracking, assessment and compilation of HAZMIN project successes, failures and lessons-learned. This was accomplished through document and data reviews, telephone interviews and site visits.

2.0 Approach

2.1 Review of Available Data and Development of Master Project List

A variety of documents were initially reviewed to develop a master project list and to obtain as much information as possible about each project and each facility. These documents, provided by the U.S. Army Environmental Center (AEC) and MACOMs, include:

- HAZMIN Program Fiscal Year Workplans;
- EPA 3500-7 and supplemental 1383 reports prepared by installations as an initial request for funding;
- Funding documentation maintained by AEC budget analysts; and
- HAZMIN progress reports and audit reports prepared for the Army Material Command (AMC).

From this information, a master project list was developed to provide the following information: project title, MACOM, installation or performing organization, funding amount and year, and project point of contact (POC). This master list was revised as necessary as additional information was received. These revisions included deletion of projects when it was found that funding had not been issued or when funds had been returned. In addition, projects were combined when it was observed that a specific project had been funded for more than one year and thus appeared as separate projects in the initial master list.

2.2 Development of Interview Guides and Conduct of Interviews

Upon completion of the master project list, additional information was obtained for each of the projects through telephone interviews to the project POCs. To conduct these interviews, tailored telephone interview guides were developed for each project. These guidelines were the basis for obtaining information on each of the projects and were used to develop individual project summaries. An example of a generalized interview guide is provided in Figure 2-1.

After the development of the interview guide, the process of interviewing each POC for was initiated. The primary information requested included whether or not the funding was received and utilized, the time frame in which it was utilized, the success or failure of the project, the resulting waste and cost reduction, and any lessons learned or other valuable information. Many times the initial POC referred us to other contacts who were more familiar with the project or who could provide additional information. At the completion of each interview, an interview summary was prepared to document the information obtained. These interview summaries are provided in Appendix B of this report. In addition, supplemental information and documentation provided for some of the projects by the POCs is included in Appendix D.

At the request of AEC, a series of reports resulting from HAZMIN audits of 16 AMC facilities were reviewed. Among the objectives of these HAZMIN audits was the development of recommendations for HAZMIN opportunities at each of the facilities.

Figure 2-1: Data Collection Guide

HAZMIN Project Data Collection Guide

Project Title:
Department/Command:
Installation/Organization:
ADL Project Number:
DERA Hazmin Funding:

Equipment Purchases

a. Was the equipment purchased? If so, when?

b. Was the equipment installed? If so, what date(s)?

c. What was the actual cost of the equipment?

d. What type of waste does this project apply to?

e. Summarize the start-up and operation of the equipment:
   [1] Description of operation/purpose of equipment
   [2] Site-specific problems
   [3] Difficulties inherent to the equipment (e.g., facility modifications, unforeseen installation costs, process add-ons and retrofits, etc.)
   [4] Problems related to military specifications (MILSPECs)
   [5] Advantages and success stories relating to equipment

f. Prior to purchasing/implementing the equipment, what was the anticipated waste reduction (quantity and type)? Anticipated cost savings?

g. What was the actual reduction in waste (quantity and type) attributable to use of the equipment? Actual cost savings? (If available, break down into use into use of the raw material, disposal, labor, liability, etc.)

h. What was the overall motivation for conducting or implementing this project? (i.e., command order, potential liability, regulatory compliance, etc.)

i. Is there any project documentation (e.g., reports, vendor literature, etc.) available?

Figure 2-1 (continued): Data Collection Guide

Studies and Investigation Expenditures

a. Was the study or investigation initiated? If so, when (year)?

b. Was the study or investigation completed? If so, when?

c. What was the estimated cost?

d. What was the actual cost?

e. Summarize the purpose, conclusions, and recommendations of the study.

f. Which recommendations were implemented?

g. Prior to conducting the study or investigation, what was the anticipated waste reduction (quantity and type)? Anticipated cost savings?

h. What was the actual waste reduction (quantity and type) attributable to implementation of the recommendations? Actual cost savings?

i. What was the overall motivation for conducting or implementing this project? (i.e. command order, potential liability, regulatory compliance, etc.)

j. Is there any project documentation (e.g., reports) available?

Figure 2-1 (continued): Data Collection Guide

Program Management Expenditures

a. Was the work initiated? If so, when (year)?

b. Was the work completed? If so, when (year)?

c. What was the estimated cost?

d. What was the actual cost?

e. What type of waste does this project apply to?

f. How were the funds allocated? Examples include hiring personnel, conducting raining courses, attending training courses, developing documents/software, providing MACOM oversight, etc.

g. Summarize the purpose, conclusions, and recommendations of the work?

h. Which recommendations were implemented?

i. What was the waste reduction (quantity and type), if any, directly attributable to these program management expenditures?

j. What were the cost savings, if any, directly attributable to these program management expenditures?

k. What was the overall motivation for conducting or implementing this project? (i.e. command order, potential liability, regulatory compliance, etc.)

l. Is there any project documentation (e.g. report, video) available?

Source: Arthur D. Little, Inc.

These recommendations were reviewed and compiled. Of these 16 facilities, a representative subset of five were selected for a follow-up. Telephone interviews were conducted with these five facilities to identify the current status of the HAZMIN recommendations with respect to: feasibility of the recommendations, implementation of the recommendations, and resulting waste reduction or cost savings, if available. The compilation of recommendations and their status are discussed in Section 5.4 of this report.

2.3 Site Visits

To supplement the information obtained through the review of documents and the conduct of telephone interviews, site visits were made to selected installations. Nine sites were selected based on a number of factors. These factors include (in no particular order):

- Large dollar investment in project;
- Active HAZMIN program at the site with a wide range of HAZMIN projects underway;
- Representative installation or project;
- Apparent success of project;
- Potential for Army-wide implementation of HAZMIN initiative;
- Recommended by MACOM or installation;
- Member of Depot Systems Command (DESCOM) Center for Technical Excellence (CTX) program; and
- Lack of information available by telephone or mail.

During the site visits, information on the specific DERA-funded project(s), other HAZMIN projects, the facility's HAZMIN program, HAZMIN activities, and other useful information regarding environmental issues was obtained. In addition, discussions with engineers and operators provided information on the ease of HAZMIN equipment operation, the ability of an alternative process to adhere to military specifications, the impact of the alternative process on production rates and overall quality, the opinion of the operators, and lessons learned. Site visits were documented with photographs and trip reports were prepared to summarize the findings. The trip reports and selected photographs are provided in Appendix C of this report.

2.4 Data Analysis and Reconciliation

After completion of the interviews and the site visits, all of the information that was obtained was reviewed. This information was reviewed for common themes

experienced or expressed by several facilities such as administrative difficulties in obtaining and obligating funds within a specified time period, difficulties in installing equipment, successful ways to implement HAZMIN programs, etc. When necessary, follow up phone calls were made to verify information. The information obtained was also manipulated to provide useful information on overall expenditures for a specific targeted waste, overall expenditures for a specific project type, project schedules, and waste and cost reduction.

3.0 Summary of DERA-Funded HAZMIN Projects

A total of 75 projects were identified and evaluated in this study. These projects were examined and organized in three different ways: by MACOM, by project type, and by targeted waste. The tables presented in this chapter display the projects sorted by the three categories and enable the reader to cross reference any of the projects by number to their MACOM, project type, or targeted waste.

A project list organized by MACOM is presented in Table 3-1. As shown, projects at AMC installations comprise the majority of the projects, followed by those at FORSCOM and TRADOC installations.

A project list organized by the project type is presented in Table 3-2. A total of five project types were identified as follows:

- Equipment Purchase and Installation – These projects include various phases of the acquisition, installation, and operation of equipment to effect waste reduction;
- Test and Evaluation (T&E) – These projects include efforts designed to test and/or evaluate HAZMIN initiatives (e.g., pilot testing, feasibility and design studies, and evaluation of HAZMIN efforts);
- HAZMIN Program Support – These projects include a variety of efforts to address the development or enhancement of a HAZMIN program (e.g., personnel support, hazardous waste material/waste tracking system development, hardware/software procurement, development of plans, training and workshops, and waste delisting efforts);
- HAZMIN Audits – These projects include audits and surveys to identify opportunities for waste reduction and cost savings; and
- Not Specified – There was too little information available regarding these projects to allow for their classification.

Projects arranged according to targeted wastes are presented in Table 3-3. The following categories of targeted waste were selected:

- General – These projects apply to hazardous waste in general (e.g., audits, hazardous waste/material tracking system development, HAZMIN plan development, workshops, etc.);
- Solvents – These projects address the replacement or recovery/reuse of various solvents used for degreasing and cleaning;
- Waste Oils/Fuels – These projects are applicable to the management (including recovery/reuse) of waste oils, waste fuels, used oils, and used fuels;
- Painting/Depainting – These projects address waste reduction in the areas of paint application, depainting, and corrosion removal;

Table 3-1: Project List by MACOM

Project Number	Organization/ MACOM	Brief Project Title	Installation/ Performer	Project Type	Targeted Waste	FUNDING ($000) FY88-FY91
1	AMC	HAZMIN Workshops	HQ AMC	Program	General	20.0
2	AMC	HAZMIN Audits	PBMA/INEL	Audit	General	3040.0
3	AMC	Solvent Distillation	Crane AAA	Equipment	Solvent	36.5
4	AMC	Reactive HW Thermal Treatment	Kansas AAP	T&E	Reactive/Explosive	4.9
5	AMC	Equip/Testing to Min Reactive Wastes	Kansas AAP	T&E	Reactive/Explosive	204.4
6	AMC	Incinerator Minimization Study	Lone Star AAP	T&E	Reactive/Explosive	28.2
7	AMC	Paint Booth Filter	Louisiana AAP	Equipment	Painting/Stripping	58.3
8	AMC	Pilot Test of UV/Ozone Tmt System	Louisiana AAP	T&E	Reactive/Explosive	91.1
9	AMC	Spent Carbon Regeneration at LAPs	Louisiana AAP	T&E	Reactive/Explosive	55.7
10	AMC	Trailerized Fuel Transfer Tank	McAlester AAP	Equipment	Waste/used Oils/fuels	8.6
11	AMC	Dry Vacuum System for LAP	Milan AAP	Equipment	Reactive/Explosive	290.0
12	AMC	Activate Pilot Plant for Recovery of STB	Pine Bluff Ars	Equipment	Chem agent	345.0
13	AMC	Hazardous Waste Metal Shredder	Pine Bluff Ars	Equipment	Scrap metal wastes	80.0
14	AMC	Spray Wash Cabinets	Stratford AEP	Equipment	Solvents	287.7
15	AMC	Spray Cleaning Cabinets	Anniston AD	Equipment	Solvents	146.9
16	AMC	Aluminum Ion Vapor Deposition (AIVD)	Anniston AD	Equipment	Plating	1378.0
17	AMC	Gas Chromatograph	Anniston AD	Equipment	Groundwater samples	40.0
18	AMC	Equipment Maintenance	Anniston AD	Not specified	Not specified	199.0
19	AMC	Acquisition and Assembly of Paint Booth	Anniston AD	Equipment	Painting/Stripping	25.0
20	AMC	Reclamation of Cr from Plating Baths	Corpus Christi AD	Equipment	Plating	80.0
21	AMC	AIVD Equipment/Support	Corpus Christi AD	Equipment	Plating	900.0
22	AMC	Vapor Degreaser Distillation	Letterkenny AD	Equipment	Solvents	131.6
23	AMC	Solvent Distillation Systems	Red River AD	Equipment	Solvents	259.6
24	AMC	Used Oil Reclamation System	Red River AD	Equipment	Waste/used oils/fuels	200.0
25	AMC	Solvent Recovery Facility	Sacramento AD	Equipment	Solvents	25.2
26	AMC	Acid/Base Neutralization	Seneca AD	Equipment	Acids and bases	1.6
27	AMC	Solvent Distillation	Seneca AD	Equipment	Solvents	32.2
28	AMC	LP/HV Paint Spray Systems	Tobyhanna AD	Equipment	Painting/Stripping	18.3
29	AMC	Paint Sludge/Walnut Dust Incineration	Tooele AD	T&E	Painting/Stripping	74.5
30	AMC	Supercritical Fluid Demilitarization	Redstone Ars	T&E	Reactive/Explosive	70.0
31	AMC	Delisting/Treatment of HW	CRDEC	Program	Chem agent	199.9
32	AMC	New Toxicological Analytical Method	CRDEC	T&E	Laboratory wastes	150.0
33	AMC	Delisting of 3X/5X Material	HQ TECOM	Program	Chem agent	250.0
34	AMC	Audit of CSTA's HAZMIN Program	CSTA	Audit	Ammo/Radioactive	66.9
35	AMC	Inventory of HW Generation	Aberdeen PG	Program	General	162.1

Table 3-1: Project List by MACOM

Project Number	Organization/ MACOM	Brief Project Title	Installation/ Performer	Project Type	Targetad Waste	FUNDING ($000) FY88-FY91
36	AMC	Waste Oil Reduction	Aberdeen PG	Not specified	Waste/used oils/fuels	120.1
37	AMC	Liquid Waste Minimization	Aberdeen PG	Not specified	Not specified	399.3
38	AMC	Evaluation of Waste Streams	Aberdeen PG	Program	General	195.6
39	AMC	Drum Storage Shed	Aberdeen PG	Equipment	Not specified	12.6
40	AMC	Produce HAZMIN Video	Aberdeen PG	Program	General	10.0
41	AMC	Solvent Recovery Stills	White Sands MR	Equipment	Solvents	41.8
42	AMC	Waste Minimization Opportunities	White Sands MR	Program	General	180.0
43	AMC	Stream Analysis	Yuma PG	Program	General	144.0
44	FORSCOM	Waste Oil Collection Truck	Ft. Campbell	Equipment	Waste/used oils/fuels	87.4
45	FORSCOM	Jet Washers	Ft. Carson	Equipment	Solvents	107.0
46	FORSCOM	Waste Oil Vacuum Truck	Ft. AP Hill	Equipment	Waste/used oils/fuels	110.3
47	FORSCOM	Personnel Spt for HAZMIN Program	Ft. Lewis	Program	Not specified	151.5
48	FORSCOM	Solvent Recycling Facility	Ft. Lewis	Equipment	Solvents	194.2
49	FORSCOM	Paint Storage Cabinets	Ft. Lewis	Equipment	Painting/Stripping	131.0
50	FORSCOM	Vacuum Pump Truck	Ft. Meade	Equipment	Waste/used oils/fuels	91.3
51	FORSCOM	Equipment for Antifreeze Recycling	Ft. Meade	Equipment	Antifreeze	3.0
52	FORSCOM	Hot Water Jet Rinse Equipment	Ft. Ord	Equipment	Solvents	24.9
53	FORSCOM	High Pressure Water Cleaning Equipment	Ft. Hunter Liggett	Equipment	Solvents	65.0
54	FORSCOM	Sediment and Soil Drying Beds	Ft. Polk	Equipment	POL wastes	170.0
55	USACE	HAZMIN Plans in Support of FORSCOM	CERL/FORSCOM	Program	General	292.7
56	USACE	Personnel Spt for FORSCOM HAZMIN	CERL/FORSCOM	Program	General	123.8
57	USACE	Equip to Spt HWMIS at FORSCOM Instal.	CERL/FORSCOM	Program	General	77.6
58	USACE	Development of Econ Analysis Model	CERL	Program	General	73.8
59	USACE	Hazardous Mat'l Tracking System	CERL	Program	General	39.0
60	USACE	Intra-Government Personnel Act	CERL	Program	General	196.0
61	USACE	Software Conversion for Comp w/AAEMIS	CERL	Program	General	511.0
62	USACE	Integrated Hazardous Material Plan	CERL	Program	General	60.0
63	USACE	Env Analy/Tech Assess/Database Dev	DOE/ANL	Program	General	400.0
64	WESTCOM	USARPAC HAZMIN Study	Ft. Shafter	T&E	General	148.0
65	HSC	HAZMIN Surveys/Audits	AEHA	Audit	General	145.8
66	HSC	Prep of MDI and Update	AEHA	Program	Medical wastes	227.2
67	HSC	Laboratory Solvent Recycling	Fitzsimmons AMC	Equipment	Solvents	12.0
68	MDW	HAZMIN Computer Tracking Equipment	Ft. Belvoir	Program	General	12.5
69	MDW	AAEMIS Development as ISM	Ft. Belvoir	Program	General	175.0
70	NGB	Purchase/Install PMB Equipment	AV MSARNG	Equipment	Paint/stripping	637.7
71	TRADOC	HAZMIN Software/Hardware	HQ TRADOC	Program	General	53.5

Table 3-1: Project List by MACOM

Project Number	Organization/ MACOM	Brief Project Title	Installation/ Performer	Project Type	Targeted Waste	FUNDING ($000) FY88-FY91
72	TRADOC	Fuel Tank Purge Study	Ft. Eustis	T&E	Waste/used oils/fuels	104.5
73	TRADOC	Oil Vacuum Truck	Ft. Eustis	Equipment	Waste/used oils/fuels	43.6
74	TRADOC	PMB Equipment for Helicopter Stripping	Ft. Rucker	Equipment	Painting/Stripping	349.0
75	TRADOC	In-House HAZMIN Audits/Support	Ft. Sill	Audit	Not specified	74.9
				Total		$14,957.8

Equipment denotes Equipment Purchase and Installation

Audit denotes Audit

Program denotes HAZMIN Program Support

T&E denotes Test and Evaluation

Source: Arthur D. Little, Inc. and Army Documentation

Table 3-2: Project List by Project Type

Project Number	Project Type	Brief Project Title	Organization/ MACOM	Installation/ Performer	Targeted Waste	FUNDING ($000) FY88-FY91
2	Audit	HAZMIN Audits	AMC	PBMA/INEL	General	3040.0
34	Audit	Audit of CSTA's HAZMIN Program	AMC	CSTA	Ammo/Radioactive	66.9
65	Audit	HAZMIN Surveys/Audits	HSC	AEHA	General	145.8
75	Audit	In-House HAZMIN Audits/Support	TRADOC	Ft. Sill	Not specified	74.9
3	Equipment	Solvent Distillation	AMC	Crane AAA	Solvent	36.5
7	Equipment	Paint Booth Filter	AMC	Louisiana AAP	Painting/Stripping	58.3
10	Equipment	Trailerized Fuel Transfer Tank	AMC	McAlester AAP	Waste/used Oils/fuels	8.6
11	Equipment	Dry Vacuum System for LAP	AMC	Milan AAP	Reactive/Explosive	290.0
12	Equipment	Activate Pilot Plant for Recovery of STB	AMC	Pine Bluff Ars	Chem agent	345.0
13	Equipment	Hazardous Waste Metal Shredder	AMC	Pine Bluff Ars	Scrap metal wastes	80.0
14	Equipment	Spray Wash Cabinets	AMC	Stratford AEP	Solvents	287.7
15	Equipment	Spray Cleaning Cabinets	AMC	Anniston AD	Solvents	146.9
16	Equipment	Aluminum Ion Vapor Deposition (AIVD)	AMC	Anniston AD	Plating	1378.0
17	Equipment	Gas Chromatograph	AMC	Anniston AD	Groundwater samples	40.0
19	Equipment	Acquisition and Assembly of Paint Booth	AMC	Anniston AD	Painting/Stripping	25.0
20	Equipment	Reclamation of Cr from Plating Baths	AMC	Corpus Christi AD	Plating	80.0
21	Equipment	AIVD Equipment/Support	AMC	Corpus Christi AD	Plating	900.0
22	Equipment	Vapor Degreaser Distillation	AMC	Letterkenny AD	Solvents	131.6
23	Equipment	Solvent Distillation Systems	AMC	Red River AD	Solvents	259.6
24	Equipment	Used Oil Reclamation System	AMC	Red River AD	Waste/used oils/fuels	200.0
25	Equipment	Solvent Recovery Facility	AMC	Sacramento AD	Solvents	25.2
26	Equipment	Acid/Base Neutralization	AMC	Seneca AD	Acids and bases	1.6
27	Equipment	Solvent Distillation	AMC	Seneca AD	Solvents	32.2
28	Equipment	LP/HV Paint Spray Systems	AMC	Tobyhanna AD	Painting/Stripping	18.3
39	Equipment	Drum Storage Shed	AMC	Aberdeen PG	Not specified	12.6
41	Equipment	Solvent Recovery Stills	AMC	White Sands MR	Solvents	41.8
44	Equipment	Waste Oil Collection Truck	FORSCOM	Ft. Campbell	Waste/used oils/fuels	87.4
45	Equipment	Jet Washers	FORSCOM	Ft. Carson	Solvents	107.0
46	Equipment	Waste Oil Vacuum Truck	FORSCOM	Ft. AP Hill	Waste/used oils/fuels	110.3
48	Equipment	Solvent Recycling Facility	FORSCOM	Ft. Lewis	Solvents	194.2
49	Equipment	Paint Storage Cabinets	FORSCOM	Ft. Lewis	Painting/Stripping	131.0
50	Equipment	Vacuum Pump Truck	FORSCOM	Ft. Meade	Waste/used oils/fuels	91.3
51	Equipment	Equipment for Antifreeze Recycling	FORSCOM	Ft. Meade	Antifreeze	3.0
52	Equipment	Hot Water Jet Rinse Equipment	FORSCOM	Ft. Ord	Solvents	24.9
53	Equipment	High Pressure Water Cleaning Equipment	FORSCOM	Ft. Hunter Liggett	Solvents	65.0

Table 3-2: Project List by Project Type

Project Number	Project Type	Brief Project Title	Organization/ MACOM	Installation/ Performer	Targeted Waste	FUNDING ($000) FY88-FY91
54	Equipment	Sediment and Soil Drying Beds	FORSCOM	Ft. Polk	POL wastes	170.0
67	Equipment	Laboratory Solvent Recycling	HSC	Fitzsimmons AMC	Solvents	12.0
70	Equipment	Purchase/Install PMB Equipment	NGB	AV MSARNG	Paint/stripping	637.7
73	Equipment	Oil Vacuum Truck	TRADOC	Ft. Eustis	Waste/used oils/fuels	43.6
74	Equipment	PMB Equipment for Helicopter Stripping	TRADOC	Ft. Rucker	Painting/Stripping	349.0
18	Not specified	Equipment Maintenance	AMC	Anniston AD	Not specified	199.0
36	Not specified	Waste Oil Reduction	AMC	Aberdeen PG	Waste/used oils/fuels	120.1
37	Not specified	Liquid Waste Minimization	AMC	Aberdeen PG	Not specified	399.3
1	Program	HAZMIN Workshops	AMC	HQ AMC	General	20.0
31	Program	Delisting/Treatment of HW	AMC	CRDEC	Chem agent	199.9
33	Program	Delisting of 3X/5X Material	AMC	HQ TECOM	Chem agent	250.0
35	Program	Inventory of HW Generation	AMC	Aberdeen PG	General	162.1
38	Program	Evaluation of Waste Streams	AMC	Aberdeen PG	General	195.6
40	Program	Produce HAZMIN Video	AMC	Aberdeen PG	General	10.0
42	Program	Waste Minimization Opportunities	AMC	White Sands MR	General	180.0
43	Program	Stream Analysis	AMC	Yuma PG	General	144.0
47	Program	Personnel Spt for HAZMIN Program	FORSCOM	Ft. Lewis	Not specified	151.5
55	Program	HAZMIN Plans in Support of FORSCOM	USACE	CERL/FORSCOM	General	292.7
56	Program	Personnel Spt for FORSCOM HAZMIN	USACE	CERL/FORSCOM	General	123.8
57	Program	Equip to Spt HWMIS at FORSCOM Instal.	USACE	CERL/FORSCOM	General	77.6
58	Program	Development of Econ Analysis Model	USACE	CERL	General	73.8
59	Program	Hazardous Mat'l Tracking System	USACE	CERL	General	39.0
60	Program	Intra-Government Personnel Act	USACE	CERL	General	196.0
61	Program	Software Conversion for Comp w/AAEMIS	USACE	CERL	General	511.0
62	Program	Integrated Hazardous Material Plan	USACE	CERL	General	60.0
63	Program	Env Analy/Tech Assess/Database Dev	USACE	DOE/ANL	General	400.0
66	Program	Prep of MIDI and Update	HSC	AEHA	Medical wastes	227.2
68	Program	HAZMIN Computer Tracking Equipment	MDW	Ft. Belvoir	General	12.5
69	Program	AAEMIS Development as ISM	MDW	Ft. Belvoir	General	175.0
71	Program	HAZMIN Software/Hardware	TRADOC	HQ TRADOC	General	53.5
4	T&E	Reactive HW Thermal Treatment	AMC	Kansas AAP	Reactive/Explosive	4.9
5	T&E	Equip/Testing to Min Reactive Wastes	AMC	Kansas AAP	Reactive/Explosive	204.4
6	T&E	Incinerator Minimization Study	AMC	Lone Star AAP	Reactive/Explosive	28.2
8	T&E	Pilot Test of UV/Ozone Tmt System	AMC	Louisiana AAP	Reactive/Explosive	91.1
9	T&E	Spent Carbon Regeneration at LAPs	AMC	Louisiana AAP	Reactive/Explosive	55.7
29	T&E	Paint Sludge/Walnut Dust Incineration	AMC	Tooele AD	Painting/Stripping	74.5

Table 3-2: Project List by Project Type

Project Number	Project Type	Brief Project Title	Organization/ MACOM	Installation/ Performer	Targeted Waste	FUNDING ($000) FY88-FY91
30	T&E	Supercritical Fluid Demilitarization	AMC	Redstone Ars	Reactive/Explosive	70.0
32	T&E	New Toxicological Analytical Method	AMC	CRDEC	Laboratory wastes	150.0
64	T&E	USARPAC HAZMIN Study	WESTCOM	Ft. Shafter	General	148.0
72	T&E	Fuel Tank Purge Study	TRADOC	Ft. Eustis	Waste/used oils/fuels	104.5
				Total		$14,957.8

Equipment denotes Equipment Purchase and Installation

Audit denotes Audit

Program denotes HAZMIN Program Support

T&E denotes Test and Evaluation

Source: Arthur D. Little, Inc. and Army Documentation

Table 3-3: Project List by Targeted Waste

Project Number	Targeted Waste	Brief Project Title	Organization/ MACOM	Installation/ Performer	Project Type	FUNDING ($000) FY88-FY91
26	Acids and bases	Acid/Base Neutralization	AMC	Seneca AD	Equipment	1.6
34	Ammo/Radioactive	Audit of CSTA's HAZMIN Program	AMC	CSTA	Audit	66.9
51	Antifreeze	Equipment for Antifreeze Recycling	FORSCOM	Ft. Meade	Equipment	3.0
33	Chem agent	Delisting of 3X/5X Material	AMC	HQ TECOM	Program	250.0
12	Chem agent	Activate Pilot Plant for Recovery of STB	AMC	Pine Bluff Ars	Equipment	345.0
31	Chem agent	Delisting/Treatment of HW	AMC	CRDEC	Program	199.9
1	General	HAZMIN Workshops	AMC	HQ AMC	Program	20.0
2	General	HAZMIN Audits	AMC	PBMA/INEL	Audit	3040.0
35	General	Inventory of HW Generation	AMC	Aberdeen PG	Program	162.1
38	General	Evaluation of Waste Streams	AMC	Aberdeen PG	Program	195.6
40	General	Produce HAZMIN Video	AMC	Aberdeen PG	Program	10.0
42	General	Waste Minimization Opportunities	AMC	White Sands MR	Program	180.0
43	General	Stream Analysis	AMC	Yuma PG	Program	144.0
55	General	HAZMIN Plans in Support of FORSCOM	USACE	CERL/FORSCOM	Program	292.7
56	General	Personnel Spt for FORSCOM HAZMIN	USACE	CERL/FORSCOM	Program	123.8
57	General	Equip to Spt HWMIS at FORSCOM Instal.	USACE	CERL/FORSCOM	Program	77.6
58	General	Development of Econ Analysis Model	USACE	CERL	Program	73.8
59	General	Hazardous Mat'l Tracking System	USACE	CERL	Program	39.0
60	General	Intra-Government Personnel Act	USACE	CERL	Program	196.0
61	General	Software Conversion for Comp w/AAEMIS	USACE	CERL	Program	511.0
62	General	Integrated Hazardous Material Plan	USACE	CERL	Program	60.0
63	General	Env Analy/Tech Assess/Database Dev	USACE	DOE/ANL	Program	400.0
64	General	USARPAC HAZMIN Study	WESTCOM	Ft. Shafter	T&E	148.0
65	General	HAZMIN Surveys/Audits	HSC	AEHA	Audit	145.8
68	General	HAZMIN Computer Tracking Equipment	MDW	Ft. Belvoir	Program	12.5
69	General	AAEMIS Development as ISM	MDW	Ft. Belvoir	Program	175.0
71	General	HAZMIN Software/Hardware	TRADOC	HQ TRADOC	Program	53.5
17	Groundwater samples	Gas Chromatograph	AMC	Anniston AD	Equipment	40.0
32	Laboratory wastes	New Toxicological Analytical Method	AMC	CRDEC	T&E	150.0
66	Medical wastes	Prep of MDI and Update	HSC	AEHA	Program	227.2
18	Not specified	Equipment Maintenance	AMC	Anniston AD	Not specified	199.0
37	Not specified	Liquid Waste Minimization	AMC	Aberdeen PG	Not specified	399.3
39	Not specified	Drum Storage Shed	AMC	Aberdeen PG	Equipment	12.6
47	Not specified	Personnel Spt for HAZMIN Program	FORSCOM	Ft. Lewis	Program	151.5
75	Not specified	In-House HAZMIN Audits/Support	TRADOC	Ft. Sill	Audit	74.9

Table 3-3: Project List by Targeted Waste

Project Number	Targeted Waste	Brief Project Title	Organization/ MACOM	Installation/ Performer	Project Type	FUNDING ($000) FY88-FY91
70	Paint/stripping	Purchase/Install PMB Equipment	NGB	AV MSARNG	Equipment	637.7
7	Painting/Stripping	Paint Booth Filter	AMC	Louisiana AAP	Equipment	58.3
19	Painting/Stripping	Acquisition and Assembly of Paint Booth	AMC	Anniston AD	Equipment	25.0
28	Painting/Stripping	LP/HV Paint Spray Systems	AMC	Tobyhanna AD	Equipment	18.3
29	Painting/Stripping	Paint Sludge/Walnut Dust Incineration	AMC	Tooele AD	T&E	74.5
49	Painting/Stripping	Paint Storage Cabinets	FORSCOM	Ft. Lewis	Equipment	131.0
74	Painting/Stripping	PMB Equipment for Helicopter Stripping	TRADOC	Ft. Rucker	Equipment	349.0
16	Plating	Aluminum Ion Vapor Deposition (AIVD)	AMC	Anniston AD	Equipment	1378.0
20	Plating	Reclamation of Cr from Plating Baths	AMC	Corpus Christi AD	Equipment	80.0
21	Plating	AIVD Equipment/Support	AMC	Corpus Christi AD	Equipment	900.0
54	POL wastes	Sediment and Soil Drying Beds	FORSCOM	Ft. Polk	Equipment	170.0
4	Reactive/Explosive	Reactive HW Thermal Treatment	AMC	Kansas AAP	T&E	4.9
5	Reactive/Explosive	Equip/Testing to Min Reactive Wastes	AMC	Kansas AAP	T&E	204.4
6	Reactive/Explosive	Incinerator Minimization Study	AMC	Lone Star AAP	T&E	28.2
8	Reactive/Explosive	Pilot Test of UV/Ozone Tmt System	AMC	Louisiana AAP	T&E	91.1
9	Reactive/Explosive	Spent Carbon Regeneration at LAPs	AMC	Louisiana AAP	T&E	55.7
11	Reactive/Explosive	Dry Vacuum System for LAP	AMC	Milan AAP	Equipment	290.0
30	Reactive/Explosive	Supercritical Fluid Demilitarization	AMC	Redstone Ars	T&E	70.0
13	Scrap metal wastes	Hazardous Waste Metal Shredder	AMC	Pine Bluff Ars	Equipment	80.0
3	Solvent	Solvent Distillation	AMC	Crane AAA	Equipment	36.5
14	Solvents	Spray Wash Cabinets	AMC	Stratford AEP	Equipment	287.7
15	Solvents	Spray Cleaning Cabinets	AMC	Anniston AD	Equipment	146.9
22	Solvents	Vapor Degreaser Distillation	AMC	Letterkenny AD	Equipment	131.6
23	Solvents	Solvent Distillation Systems	AMC	Red River AD	Equipment	259.6
25	Solvents	Solvent Recovery Facility	AMC	Sacramento AD	Equipment	25.2
27	Solvents	Solvent Distillation	AMC	Seneca AD	Equipment	32.2
41	Solvents	Solvent Recovery Stills	AMC	White Sands MR	Equipment	41.8
45	Solvents	Jet Washers	FORSCOM	Ft. Carson	Equipment	107.0
48	Solvents	Solvent Recycling Facility	FORSCOM	Ft. Lewis	Equipment	194.2
52	Solvents	Hot Water Jet Rinse Equipment	FORSCOM	Ft. Ord	Equipment	24.9
53	Solvents	High Pressure Water Cleaning Equipment	FORSCOM	Ft. Hunter Liggett	Equipment	65.0
67	Solvents	Laboratory Solvent Recycling	HSC	Fitzsimmons AMC	Equipment	12.0
50	Waste/used oils/fuels	Vacuum Pump Truck	FORSCOM	Ft. Meade	Equipment	91.3
73	Waste/used oils/fuels	Oil Vacuum Truck	TRADOC	Ft. Eustis	Equipment	43.6
10	Waste/used Oils/fuels	Trailerized Fuel Transfer Tank	AMC	McAlester AAP	Equipment	8.6
24	Waste/used oils/fuels	Used Oil Reclamation System	AMC	Red River AD	Equipment	200.0

Table 3-3: Project List by Targeted Waste

Project Number	Targeted Waste	Brief Project Title	Organization/ MACOM	Installation/ Performer	Project Type	FUNDING ($000) FY88-FY91
36	Waste/used oils/fuels	Waste Oil Reduction	AMC	Aberdeen PG	Not specified	120.1
44	Waste/used oils/fuels	Waste Oil Collection Truck	FORSCOM	Ft. Campbell	Equipment	87.4
46	Waste/used oils/fuels	Waste Oil Vacuum Truck	FORSCOM	Ft. AP Hill	Equipment	110.3
72	Waste/used oils/fuels	Fuel Tank Purge Study	TRADOC	Ft. Eustis	T&E	104.5
				Total		$14,957.8

Equipment denotes Equipment Purchase and Installation

Audit denotes Audit

Program denotes HAZMIN Program Support

T&E denotes Test and Evaluation

Source: Arthur D. Little, Inc. and Army Documentation

- Reactive/Explosive – These projects address the management and reduction of reactive and explosives wastes (e.g., pinkwater, off-specification and waste energetic materials, and demilitarization wastes);

- Plating – These projects involve the reduction of wastes generated during metal plating and finishing operations;

- Chemical Agents – These projects address chemical agent-related wastes and include waste delisting efforts and decontamination solution treatment and disposal;

- Miscellaneous – These projects address a wide variety of wastes grouped together because each of the wastes represents only a single project. Wastes addressed include acid/base neutralization, antifreeze, groundwater sampling, radioactive wastes, scrap metal, laboratory wastes, and medical wastes; and

- Not Specified – There was too little information available regarding these projects to allow for their classification.

4.0 Discussion of Projects

The following is a general discussion of the various types of projects that were investigated. The discussion covers general trends and observations in funding, project completion, waste reduction and cost savings, project motivation, project documentation, and other comments.

In summary, of a total of 75 projects, 36 involve equipment purchase and installation projects, 22 address HAZMIN program support efforts, 10 are test and evaluation projects, and four involve the conduct of audits (or HAZMIN opportunity assessments). The remaining three projects were grouped in a "not specified" category because of the lack of information on these projects.

4.1 Equipment Purchase and Installation

There are a total of 36 projects in the Equipment Purchase and Installation category as summarized in Table 4-1. These projects include the purchase of equipment, installation, and related expenditures such as training and construction. Projects in this category were grouped into ten subcategories which describe the equipment type and targeted waste: Solvent Recovery Systems, Spray Wash Cabinets/Aqueous Cleaning, Used Oil Collection and Segregation, Plastic Media Blasting Equipment, Paint/Depaint Operations, Plating Waste Recovery, Reactive/Explosive Waste, Chemical Agent Related Waste, and Miscellaneous. The Miscellaneous subcategory includes one project for which too little information was available to categorize it.

4.1.1 Funding

As shown in Table 4-1, funding in this category was allocated primarily in 1989 and 1991. Very little funding was provided during 1988 and 1990. The funding amounts range from $4,400 to $1,378,000 for a variety of types of equipment-related projects. The largest funding category was Plating Waste Recovery which accounted for approximately 37% of the funds allocated in the equipment category. This is followed by the plastic media blasting equipment at 15%, solvent distillation at 11% and spray wash cabinets/aqueous cleaning at 10%. The remaining categories accounted for less than 6% of the total each.

The primary issue cited by the POCs regarding funding in this category is the time frame allocated to obligate the funds. Funding becomes available in early spring and must be obligated by September 30 (the end of the Fiscal Year). Equipment projects often require the development of a Request for Quotation (RFQ) or specification. If a formal bidding process is required, the RFQ must be advertised for a certain length of time, then the bids must be reviewed before an award can be made. Once awarded, if a protest letter is received, it must be addressed. All of these steps can take several months and make obligating funds difficult. Many times, the installations prepare the RFQ prior to receiving the funding and take the chance that they will be approved for the funding. If the funding is not approved, government resources (as well as the vendor's resources) may be wasted.

Table 4-1: Equipment Purchase and Installation Funding

Project #	Project Description	MACOM/ Organization	Installation	Funding Amount ($) FY88	FY89	FY90	FY91
	Solvent Distillation Stills						
23	Solvent Distillation Systems	AMC	Red River AD		259,600		
67	Laboratory Solvent Recycling	HSC	Fitzsimmons AMC				12,000
48	Solvent Recycling Facility	FORSCOM	Ft. Lewis		151,500	20,100	22,600
3	Solvent Distillation	AMC	Crane AAA				36,500
25	Solvent Recovery Facility	AMC	Sacramento AD		25,200		
27	Solvent Distillation	AMC	Seneca AD		32,200		
41	Solvent Recovery Stills	AMC	White Sands MR	41,800			
22	Vapor Degreaser Distillation	AMC	Letterkenny		131,600		
	TOTAL			41,800	600,100	20,100	71,100
	Spray Wash Cabinets/Aqueous Cleaning						
14	Spray Wash Cabinets	AMC	Stratford AEP				287,700
15	Spray Cleaning Cabinets	AMC	Anniston AD		146,900		
45	Jet Washers	FORSCOM	Ft. Carson		107,000		
52	Hot Water Jet Rinse Equipment	FORSCOM	Ft. Ord			24,900	
53	High Pressure Water Cleaning Equipment	FORSCOM	Ft. Hunter Liggett				65,000
	TOTAL			0	253,900	24,900	352,700
	Used Oil Collection and Segregation						
10	Trailerized Fuel Transfer Tank	AMC	McAlester AAP		8,600		
44	Waste Oil Truck	FORSCOM	Ft. Campbell		87,400		
46	Waste Oil Vacuum Truck	FORSCOM	Ft. A.P. Hill		110,300		
50	Vacuum Pump Truck	FORSCOM	Ft. Meade		91,300		
73	Oil Vacuum Truck	TRADOC	Ft. Eustis		43,600		
	TOTAL			0	341,200	0	0
	Used Oil Reclamation						
24	Used Oil Reclamation System	AMC	Red River AD		200,000		
	TOTAL			0	200,000	0	0

Table 4-1: Equipment Purchase and Installation Funding

Project #	Project Description	MACOM/ Organization	Installation	Funding Amount ($) FY88	FY89	FY90	FY91
	Plastic Media Blasting Equipment						
70	Purchase/Install PMB Equipment	NGB	AV MSARNG		4,400		633,300
74	PMB Equipment for Helicopter Stripping	TRADOC	Ft. Rucker	30,000			319,000
	TOTAL			30,000	4,400	0	952,300
	Paint/Depainting Operations						
49	Paint booth Filter	AMC	Louisiana AAP		58,300		
50	Paint Storage Cabinets	FORSCOM	Ft. Lewis				131,000
19	Acquisition and Assembly of Paint Booth	AMC	Anniston AD				25,000
28	LPHV Paint Spray Systems	AMC	Tobyhanna		18,300		
	TOTAL			0	76,600	0	156,000
	Plating Waste Recovery						
16	Aluminum Ion Vapor Deposition (AIVD)	AMC	Anniston AD				1,378,000
20	Reclamation of Cr from Plating Baths	AMC	Corpus Christi AD		80,000		
21	AIVD Equipment/Sypport	AMC	Corpus Christi AD				900,000
	TOTAL			0	80,000	0	2,278,000
	Reactive/Explosive Waste						
11	Dry Vacuum System for LAP	AMC	Milan AAP		290,000		
	TOTAL			0	290,000	0	0
	Chemical Agent Waste						
12	Pilot Plant for STB Recovery	AMC	Pine Bluff Arsenal		345,000		
	TOTAL			0	345,000	0	0

Table 4-1: Equipment Purchase and Installation Funding

Project #	Project Description	MACOM/ Organization	Installation	Funding Amount ($) FY88	FY89	FY90	FY91
	Miscellaneous						
13	Metal Shredder	AMC	Pine Bluff Arsenal		80,000		
51	Equipment for Antifreeze Recycling	FORSCOM	Ft. Meade		3,000		
26	Acid/Base Neutralization	AMC	Seneca AD		1,600		
54	Sediment and Soil Drying Beds	FORSCOM	Ft. Polk				170,000
17	Gas Chromatograph	AMC	Anniston AD		40,000		
39	Drum Storage Shed	AMC	Aberdeen PG		12,600		
	TOTAL			0	137,200	0	170,000
	TOTAL			71,800	2,328,400	45,000	3,980,100

Source: Arthur D. Little, Inc., and Army Documentation

Most projects appeared to have been completed within the amount funded. Two projects were known to have required additional funds from other sources for completion. In some cases, DERA HAZMIN funds allowed implementation of the project to a certain point and additional funds will be required for completion.

4.1.2 Completion of Projects

Assessment of completion in equipment-related projects is easier than other types of projects. Approximately 25 of the 36 projects have resulted in actual implementation of equipment that is currently in operation and realizing a cost savings or a waste reduction. The aluminum ion vapor deposition (AIVD) projects and the antifreeze recycling projects have resulted in installation of operational equipment, however, they are not yet been used to their full potential. The AIVD process could replace the current use of cadmium plating, but it is not yet approved for use by the customer (in this case, the Army Aviation Command). The antifreeze recycling equipment is in use, however, the recycled antifreeze is being stockpiled because of a change in mission at Ft. Meade.

The remaining 11 projects represent equipment that is not operating for various reasons. Three of the projects involve solvent stills which are not in use because of the phase out of trichloroethane (TCA). Those which are in use are stills that were purchased with the flexibility to recover a solvent other than TCA, or stills which were purchased specifically to recover additional solvents. One project was not completed because a process change was implemented and recovering the solvent was no longer necessary. In another case, a suitable piece of support equipment could not be located, thus the equipment is still not operational. Three projects are pending due to the lack of tradespeople for installation or requirements for facility modification. One project was funded only for the purchase of the equipment, additional funds from another source are being used to build and install the equipment. One piece of equipment is not functioning because of operational problems encountered. One project has no information available to determine whether or not is was completed.

4.1.3 Waste Reduction and Cost Savings

Waste reduction and cost savings in this project category are most often the result of one or more of the following mechanisms: recycling and recovery; new technology which utilizes or generates less toxic materials; segregation of waste; and materials substitution. These mechanisms result in either the generation of less waste (thus less money is spent on disposal), or the elimination of waste. In addition, with recovery and recycle, requirements for the purchase of raw materials are reduced. When available, detailed information on waste reduction and cost savings for each project is provided in the Project Summaries found in Appendix B.

Quantification of waste reductions and cost savings were not available for many of the projects surveyed. The reasons for this are varied. At some installations there were not enough personnel available to perform the quantification. Other installations simply did not attempt any quantification. A variable workload at some installations made waste reduction difficult to calculate, since determining an accurate baseline was not easily accomplished. Also, some of the equipment has only been operational for a short period of time, thus savings and reduction information is not yet available. Many of the waste reduction and cost savings included in the project summaries were taken from the estimates developed by the installation in the original request for funds. Those

installations with good record keeping and tracking systems had more information regarding waste reduction and cost savings.

Some cost savings were not obvious and quantifiable due to the nature of the projects. For example, a structural improvement at Fort Polk was built to satisfy regulators by preventing the overflow of water from a POL (petroleum, oil, and lubricants) contaminated soils drying bed. The replacement of vapor degreasers at Fort Carson had decreased the health risks of the operators and would therefore lower the liability of the installation. In both of these cases, potential monetary penalties from regulatory fines were avoided.

Specific types of waste reduction and cost savings for project categories are discussed below.

Solvent Waste. Cost savings and waste reduction were realized very quickly for solvent reclamation systems because of the immediate ability to recycle and eliminate/reduce the generation of hazardous waste requiring disposal. Some cost savings were limited because of maintenance specification requirements that allow for a maximum concentration of 25% recycled TCA (thus 75% of that used must be newly purchased virgin material). Some stills that were purchased exclusively for TCA reclamation are currently not being utilized. Other stills which were purchased with the flexibility to be used for reclaiming numerous solvents have been converted and remain in operation, resulting in a sustained cost savings and waste reduction.

Used Oil Collection and Segregation. Segregation of oily waste has provided for greater flexibility in recycling and reusing the oil. Utilizing bulk containers for transferring the material has resulted in a reduced potential for spills (previous methods included the filling, transportation, and draining of drums). Training was required in some cases to ensure that oils were not mixed and to eliminate the risk of violating an incineration permit. Waste reduction and cost savings are primarily attributed to fewer fees associated with cleaning the combined oil trucks/vessels and reduced disposal fees for contaminated oils, which are now segregated and recycled or burned.

One project involved the purchase and installation of equipment to actually reclaim the oil for on-site use. The equipment has been installed, however, there have been operational difficulties which have resulted in no reclamation of used oil.

Plastic Media Blasting (PMB) Equipment. These systems have high capital costs, but have resulted in significant waste reductions and cost savings in specific applications. The primary purpose of PMB is to replace chemical paint stripping and cleaning operations with abrasive blasting using plastic media. In typical operations at one facility, paint stripping and cleaning chemicals (including methyl ethyl ketone, acetone, and toluene) were used at a combined average rate of 105 gallons per aircraft skin (based on the UH-1H helicopter). Plastic media blasting was expected to reduce the use of chemical strippers and clean-up solvents at this facility by an estimated 90%. The remaining 10% was assumed to be required to strip parts for which PMB was thought to be ineffective due to part geometry. Actual operations have shown that PMB can be used exclusively for specific purposes and chemical stripping operations can be eliminated. Further waste reductions have been achieved by replacing the chemical paint stripping of components (e.g., starter motors, generators, rotor heads, alternators,

etc.) with PMB. In addition paint stripping, PMB has also been shown to serve as an effective surface cleaning method thereby allowing for further waste reductions. Despite the demonstrated success of PMB in reducing wastes generated at the facilities surveyed, it should be noted that its success is very application-specific. PMB may not reduce waste or even be appropriate for other applications.

Paint Operations. These projects have resulted in cost savings and waste reductions through proper storage of paint, through recycling of paint booth filter water, and through the use of high volume low pressure (HVLP) spray painting systems.

Plating Waste Recovery. The AIVD systems have the capability of replacing cadmium plating, thus eliminating cadmium-laden rinse waters and cadmium-laden sludge. The systems require large capital investments but also have large cost savings and significant waste reduction. One estimate shows a payback period of less than one year at one facility because of savings in sludge disposal, rinse water treatment, chemical consumption, laboratory testing, and oven energy (for stress relief of cadmium-plated parts).

Where chromium plating operations are still performed, a chromium recovery system results in the elimination of chromium in the wastewater and sludge. Additional cost savings are attributable to the recycling of the water reducing the volume of makeup water as well as reducing the quantity of wastewater sent to the industrial wastewater treatment plant (IWTP).

Pinkwater. One project involved the reduction of pinkwater. Milan AAP has installed dry vacuum systems to collect waste explosives and to reduce the quantity of pinkwater. Several steps were taken to ensure safe operation of the new system which has resulted in significant waste reduction and cost savings.

Chemical Agent Decontamination. Pine Bluff Arsenal has purchased equipment to process out-of-spec subtropical bleach (STB) and restore it to within a specified chlorine content. This project will result in the ability to reclaim STB that is currently stored at Pine Bluff, as well as that stored at the Defense Reutilization and Marketing Office (DRMO) facility. In addition, it will result in large cost savings by reducing the quantity of virgin STB required to be purchased and the disposal of the stockpiles of out-of-spec STB. Additional funds are currently being processed to install and start-up this system. The estimated start-up date is late 1994.

Miscellaneous. Smaller, unrelated projects were grouped in the miscellaneous category. The largest cost savings in this category is associated with the metal shredder project which is actually shredding solid waste, not hazardous waste. Other savings in these projects are a result of recycling and accurate waste characterization.

4.1.4 Project Motivation

One common reason for the initiation of DERA HAZMIN projects was cited by many of the POCs at AMC facilities: the 50% hazardous waste reduction goal set by HQAMC. Keeping within potential regulatory requirements, lowering expenditures, and protecting employees' health were also cited. A few facilities were also very proactive in their hazardous waste minimization efforts and were taking initiatives on

their own. In contrast, some facilities initiated the project because they were required to do so by the Army.

The issue of competition as a motivation also arose. In the case of GOCO's, the contractor must attempt to reduce as many costs as possible to ensure the Army will continue to utilize the facility. One mechanism to increase efficiency and lower costs is to operate a good environmental program which includes waste reduction projects. This is also true for the Government-Operated facilities which are operating under the Defense Base Operating Fund (DBOF) concept. DBOF facilities are also feeling the pressure of competition which encourages them to initiate projects to become more efficient and cost effective.

4.1.5 Documentation

The amount and quality of the documentation for each project varied from site to site and from project to project. The documentation that was available for projects was primarily in the form of manuals, vendor literature, and economic analyses which were developed while preparing the funding request documentation (prior to funding approval). Supplemental documentation provided by the POC for some projects is provided in Appendix E.

The documentation available on waste reduction and cost savings was also sparse. The best information came from facilities with good recordkeeping systems. Estimates that were made prior to equipment installation were sometimes difficult to compare to the conditions after the equipment was installed because of variations in production levels. This is more difficult for the depots because their "product" is often the overhaul of a tactical equipment that can vary substantially. Different vehicles may require varying degrees of work in order to complete the job. A normalization of waste that would allow for a baseline of waste reduction to be developed would be useful to allow for measuring waste reduction and allowing for comparisons among facilities.

4.1.6 Comments

Overall, the equipment projects appear to be very successful. Many of the points of contact were optimistic about reducing hazardous waste generation with the projects that were implemented with DERA HAZMIN funds. Accurate documentation for waste reduction and cost savings was often not available, thus assistance in developing a baseline methodology would be helpful. Process and product specifications are often an impediment to waste reduction efforts because of the requirement to utilize specific processes or materials that are outdated and not environmentally sound. Insight into future trends in environmental regulations is required to prevent the procurement of equipment that will become obsolete (e.g., the purchase and installation of solvent stills to recover TCA).

4.2 Test and Evaluation

Of the DERA HAZMIN-funded projects reviewed, 10 were Test and Evaluation (T&E) projects. Six of these 10 projects addressed the minimization of explosive-related wastes. Several technologies were studied as alternative methods for treating these wastes. For example, spent activated carbon used to treat pinkwater is a large source of

hazardous waste so thermal regeneration of the carbon, as well as using ultraviolet oxidation for pinkwater treatment instead of carbon adsorption were considered. Thermal treatment systems for explosive-related wastes, such as a continuous flame system, incineration, and a supercritical (high pressure/high temperature) system were investigated. Also, laboratory analysis of the explosive waste was also performed in order to determine if it was all actually hazardous or if it could be reclassified as nonhazardous. The remaining four T&E projects concern HAZMIN efforts in the areas of paint sludge/walnut dust incineration, toxicological waste reduction, spent solvents, and fuel waste.

4.2.1 Funding

About half of the funding for T&E projects is attributable to projects addressing explosive-related waste. As shown in Table 4-2, approximately $454,400, or 49% of the funds were allocated to projects studying alternative treatments methods for explosive-related wastes. The remaining four projects accounted for about $477,000, or 51% of the total funds for T&E projects.

4.2.2 Completion of Projects

Four of the six T&E projects involving alternative treatment methods for explosive-related wastes were completed. Two of the six have not yet been completed but are currently underway. The fuel tanker purging study and the spent solvent study were completed in June and September of 1989, respectively. However, there were some projects that have not yet been completed. The toxicological waste study was funded approximately $150,000 in 1991 and again in 1992, but another $150,000 is estimated to be necessary in order to complete this study. Similarly, although the walnut dust incineration study was completed in July 1991 and a feasibility study for paint sludge incineration was completed in 1990, an estimate of $70,000 was said to be necessary for the completion of this project.

4.2.3 Waste Reduction and Cost Savings

Actual values for waste reduction and cost savings directly attributable to these projects are difficult to determine primarily because the projects have not been completed long enough for sufficient data to be generated. However, estimates have been made for many of the projects and a few examples follow. In one project, reclassification of waste as nonhazardous has proven successful and waste reduction and cost savings estimates are 80,000 kg/yr and $200,000/yr, respectively. In a second example, although initial estimates indicated that thermal treatment of explosive wastes would reduce reactive wastes by 70,000 kg/yr and save $210,000/yr, results of the T&E project showed that the process would not be economical at this time. At this facility, open burning of these reactive wastes is continuing and funding of $90,000 to continue the development of the thermal process was returned. In a third example, a T&E project has shown that regeneration of spent activated carbon has the potential to reduce waste by 187,500 lbs/yr and thus save $328,000/yr.

4.2.4 Motivation

Overall, the largest motivation for these HAZMIN efforts was the HQAMC goal of at least 50% reduction of hazardous waste by 1992. Regulatory compliance, specifically the Resource Conservation and Recovery Act (RCRA) Land Ban Regulations that prohibit land disposal of reactive wastes, was the largest factor in the studies of

Table 4-2: Test and Evaluation Funding

Project #	Project Description	Macom/ Organization	Installation	Funding Amount ($) FY 88	FY 89	FY 90	FY 91
	Explosive Waste Treatment Technologies						
4	Design, Construct, & Install Reactive Thermal Trtmnt Process	AMC/AMCCOM	Kansas AAP	4,858			
5	Purchase Equipment/Testing to Minimize Reactive Wastes	AMC/AMCCOM	Kansas AAP				204,400
6	Incinerator Minimization Feasibility Study	AMC/AMCCOM	Lone Star AAP	28,257			
8	Pilot Test of UV/Ozone Pinkwater Treatment Process	AMC/AMCCOM	Louisiana AAP				91,118
9	Applicability of Spent Carbon Regeneration at LAPs	AMC/AMCCOM	Louisiana AAP				55,739
30	Supercritical Fluid Demilitarization	AMC/MICOM	Redstone Ars				70,000
	TOTAL			33,115			421,257
	Miscellaneous						
29	In-House Study of Paint Sludge and Walnut Dust Incineration	AMC/DESCOM	Tooele AD	56,700	17,765		
32	Develop Analytical Procedure to Minimize Toxic Lab Waste	AMC/AMCCOM	CRDEC				150,000
64	USARPAC HAZMIN Study (Solvent Wastes)	WESTCOM	Ft. Shafter	145,000		3,000	
72	Evaluation of HAZMIN Tech. for Fuel Tanker Purging at Ft. Story	TRADOC	Ft. Eustis	104,462			
	TOTAL			306,162	17,765	3,000	150,000
	TOTAL			339,277	17,765	3,000	571,257

Source: ADL and Army Documentation

alternative treatment of explosive-related wastes. In addition, there is a possibility that open burning will be severely restricted or prohibited in the future.

4.2.5 Documentation

Final reports and additional documentation are available for five of these projects through the project POCs. Additional documentation for one of the projects is provided in Appendix E of this report. Specific citations of documentation and details are provided in the Project Summaries in Appendix B.

4.2.6 Comments

Many of the points of contact were optimistic about reducing hazardous waste generation with the projects that were established through DERA HAZMIN funds. Further efforts should be made to quantify the waste reduced and determine cost savings. Dissemination of information regarding the results of projects with application to other Army facilities should be initiated or continued.

4.3 HAZMIN Program Support

The project type "HAZMIN Program Support" has been used to categorize administrative projects which are geared toward making the overall HAZMIN program management more effective but which do not necessarily apply to a specific waste stream. These 22 projects have been divided into six subcategories: Personnel Support, Software Development, Inventories of Waste Streams and Development of Management Plans, Hardware/Software Procurement, Training, and Delisting of Hazardous Waste. The objective of the Personnel Support subcategory was to acquire personnel support either to manage the HAZMIN programs or to provide expertise in technical areas related to hazardous waste minimization efforts. Software Development projects address attempts to standardize the performance of economic analyses and tracking of hazardous materials and wastes. The objective of four of the projects was to inventory, evaluate, or analyze hazardous waste streams. By obtaining an accurate account of the hazardous materials and waste flows through a process, determining hazardous waste minimization potential and identifying waste reduction opportunities become more feasible. Management plans were developed to serve as guidelines for hazardous waste minimization programs at several installations. Computer equipment and software was purchased with DERA HAZMIN funds in some projects for administrative purposes. Two of these HAZMIN Program Support projects were geared at training personnel in hazardous waste minimization efforts. Although Delisting pertains to explosive-contaminated waste, (a specific waste stream) it was assumed to be an administrative initiative because it did not involve a study of a new process to reduce a waste but simply a reclassification of waste.

4.3.1 Funding

The breakdown of the specific projects, the number of projects, and the amounts funded for each subcategory are presented in Table 4-3. The largest three subcategories, Personnel Support, Software Development, and Inventories, make up 15 of the 22 projects and account for 25%, 29%, and 29%, respectively, of the funds awarded for HAZMIN Program Support. The remaining three subcategories make up 17% of the funds awarded.

Table 4-3: Program Support Funding

Project #	Project Description	Macom/ Organization	Installation	Funding Amount ($) FY 88	FY 89	FY 90	FY 91
	Personnel Support						
47	Personnel Support for Management of HAZMIN Program	FORSCOM	Ft. Lewis		151,500		
56	Personnel Support for Management of HAZMIN Program	FORSCOM	CERL		123,800		
60	Intra-Government Personnel Act (Executive Support Program)	USACE/AEO	CERL	196,910			
63	Env. Analysis/Technology Assessment & Database Development	USACE/AEO	DOE/ANL	400,000			
	TOTAL			596,910	275,300		
	Software Development						
58	Development of Economic Analysis Model	COE	CERL		73,848		
59	Develop Hazardous Materials Tracking System	COE	CERL		38,998		
61	Convert Present Program to Format Compatible w/AAEMIS	USACE/AEO	CERL				511,000
66	Preparation of Military Item Disposal Instructions (MIDI) Database	HSC	AEHA		130,000		97,200
69	Development of AAEMIS as Part of ISM	MDW	Ft. Belvoir				175,000
	TOTAL				242,846	0	783,200
	Inventories of Waste Streams & Management Plans						
35	Provide Inventories of Hazardous Waste Generation	AMC/TECOM	Aberdeen PG	162,000			
38	Analyze & Evaluate Waste Streams	AMC/TECOM	Aberdeen PG	195,600			
42	Waste Minimization Opportunities	AMC/TECOM	Aberdeen PG	180,000			
43	Stream Analysis	AMC/TECOM	Yuma PG	144,000			
55	Preparation of 4 HAZMIN Plans	FORSCOM	CERL	292,675			
62	Preparation of an Integrated Hazardous Material Plan	USACE/AEO	CERL		59,839		
	TOTAL			974,275	59,839		
	Procurement of Hardware/Software						
57	Equipment to Support HWMIS at FORSCOM Installations	COE	CERL		77,612		
68	HAZMIN Computer Tracking Equipment	MDW	Ft. Belvoir		12,500		
71	Purchase Hardware/Software for HQTRADOC & Installations	TRADOC	HQTRADOC		53,500		
	TOTAL				143,612		

Source: Arthur D. Little, Inc. and Army Documentation

Table 4-3: Program Support Funding

Project #	Project Description	Macom/ Organization	Installation	Funding Amount ($) FY 88	FY 89	FY 90	FY 91
	Training						
1	HAZMIN Workshops	AMC	HQAMC	20,000			
40	Funds to Produce Video for Hazmin	AMC	TECOM		10,000		
	TOTAL			20,000			
	Delisting						
31	Study of Delisting & Treatment of Hazardous Waste	AMC	CRDEC	199,935			
33	Develop Delisting Package for 3X/5X Material-Utah	AMC/TECOM	HQTECOM				250,000
	TOTAL			199,935			250,000
	GRAND TOTAL			1,791,120	721,597	0	1,033,200

Source: Arthur D. Little, Inc. and Army Documentation

4.3.2 Completion of Projects

Determining the completion of these projects was difficult due to the lack of information available. The four projects for Personnel Support do not specify what types of work was performed but simply that funds were allocated to hire a contractor either to oversee the HAZMIN program or to supply expertise in technical areas. In some cases, it is not known whether the funding amount was allocated for one year or for several years.

There is a great deal of confusion surrounding the development of several software packages. Apparently, two tracking systems (the Hazardous Materials Identification System [HMID] and the Hazardous Waste Management Information System [HWMIS]), were originally developed by the U.S. Army Construction Engineering Laboratory (CERL) in FY89. These two tracking systems were then updated in FY90 as another DERA HAZMIN project to create the Army Automated Environmental Management Information System (AAEMIS). Several other software packages were also developed during this time (e.g., Inventory of Hazardous Waste, Economic Analysis, and Bar Code Tracking). It is unclear from the funding documentation which software was developed with each funding appropriation. In addition, there are differing opinions about the usefulness of these tracking and modelling systems. One reason given by the POC for why the tracking systems may not be as useful as possible is that the funding was received late in the fiscal year and there was not enough time to make all the necessary revisions by the obligation date.

Two of the hazardous waste stream analysis projects were verified by the POC as having been completed in the fall of 1989. The Aberdeen Proving Ground projects (two hazardous waste inventories) were assumed to have been completed but could not be verified. The five management plans prepared for FORSCOM were completed but their usefulness was not maximized because by the time they were finalized many of the issues mentioned in the plans had already been addressed or were obsolete. The hazardous material plan developed by CERL developed recommendations and conclusions but was never made official. Instead, some of the recommendations were incorporated into Army Environmental Office Strategy 2000 plan.

Although the funding amounts and years could not be verified, it is believed by the POCs interviewed that the projects involving procurement of hardware and software for HAZMIN program support were completed.

The HAZMIN training video project for Aberdeen Proving Ground was completed and was a "rousing success". The HAZMIN Lessons Learned workshops were also performed successfully (see the Project Summary in Appendix B).

Lastly, the delisting project for the Chemical Research Development and Engineering Center (CRDEC) was completed and all six agent decontamination solution treatment procedures were accepted by the Maryland Department of Environment and were delisted. The delisting project for HQTECOM has completed Phase I, creating the delisting plan, but Phase II, implementation and execution of the plan, is still underway.

4.3.3 Waste Reduction and Cost Savings

Due to the nature of the projects in this category, quantifying waste reduction and cost savings is often not possible. Although some estimates of waste reduction and cost

savings can be made for the delisting projects, it is not feasible to assign a value to such administrative expenses as personnel salaries, software development, management plans, and computer hardware and software procurement. It would be more appropriate to measure the benefit of these projects in terms of increased efficiency and effectiveness. For instance, a computerized hazardous waste tracking system not only saves time in terms of manhours but also allows for more accurate record keeping. However, it does not directly reduce the amount of waste generated.

4.3.4 Motivation

These projects were mostly in-house initiatives motivated by the growing need for accurate tracking of hazardous materials and wastes from "cradle to grave" for compliance and liability purposes. As hazardous waste regulations and disposal costs rise, hazardous waste minimization efforts become more vital, hence the need for additional personnel support as well as efficiency and accuracy provided by computerized systems.

4.3.5 Documentation

There is not a lot of documentation available for these projects. The funding documentation provided by AEC was often the only source of information for many of these projects. No information was available for verification of funding amounts, funding years, project completion or waste reduction and cost savings for Aberdeen Proving Ground projects because there was a change in personnel and the files appear to have been misplaced. It was assumed that the funding amounts taken from the funding documentation were correct and that all the projects were completed. The hazardous material and waste tracking software was a significant source of confusion and dispute in terms of funding amounts, funding years, completion, as well as applicability. Final reports and additional documentation available for these projects are located in Appendix E of this report or are available through the POCs. Specific citations of documentation and details are provided in the Project Summaries in Appendix B.

4.3.6 Comments

The biggest source of confusion regarding the funding and completion of these projects was in projects addressing the development of software for the purposes of tracking hazardous materials and wastes. Possible areas for improvement include accounting of funds as well as technology transfer and communication between installations. Lack of communication between installations seems to be allowing duplication of efforts in software development.

4.4 HAZMIN Audits and Opportunity Assessments

A significant investment in DERA HAZMIN funds was made between Fiscal Year 1989 and 1990 to support the conduct of HAZMIN audits and opportunity assessments at Army facilities. The bulk of the funding was provided to the U.S. Army Production Base Modernization Activity (PBMA) and the Idaho National Engineering Laboratory (INEL) for a series of 26 audits of AMC industrial facilities. The primary objectives of these audits included:

- Identification and quantification of hazardous waste streams resulting from production and maintenance processes; and

- Identification of opportunities to reduce these hazardous wastes and development of preliminary estimates of the costs of doing so and the benefits to be gained.

In addition to these audits, the U.S. Army Environmental Hygiene Agency (AEHA) was funded to conduct a series of 23 HAZMIN surveys at various Army facilities including those of AMC, FORSCOM, TRADOC, HSC, and AVSCOM. The objectives of these primarily qualitative surveys were to identify waste generation and disposal activities at these facilities and to provide recommendations for HAZMIN initiatives that could be pursued.

AMC Audits. The AMC audits, conducted under contracts to PBMA and INEL, were initiated in 1989 and essentially completed in 1991. The initial phases of these audits provided for an extensive assessment of waste-generating operations at AMC industrial facilities and a quantification of wastes resulting from those operations. Results of these initial phases provided identification of waste sources at each of the facilities surveyed and the acquisition of waste generation data from these sources. The acquired data would then be used to develop a "baseline" that could be used to support the prioritization of HAZMIN initiatives and track HAZMIN progress.

In the final phase of the audits, recommendations for potentially applicable HAZMIN initiatives relative to specific operations were developed. In most cases, these recommendations were supported by estimates of implementation costs as well as waste reductions and cost savings likely to result if the recommendations were implemented. As part of this present study, recommendations from 16 of the audits were compiled. These recommendations represent audits performed at the following installations:

Anniston Army Depot (ANAD)
Detroit Army Engine Plant (DATP)
Holston Army Ammunition Plant (HSAAP)
Louisiana Army Ammunition Plant (LAAP)
Lake City Army Ammunition Plant (LCAAP)
Letterkenny Army Depot (LEAD)
Longhorn Army Ammunition Plant (LHAAP)
Lone Star Army Ammunition Plant (LSAAP)
Riverbank Army Ammunition Plant (RBAAP)
Red River Army Depot (RRAD)
Redstone Arsenal (RSA)
Stratford Army Engine Plant (SAEP)
Sharpe Army Depot (SHAD)
Tooele Army Depot (TEAD)
Tobyhanna Army Depot (TOAD)
Watervliet Arsenal (WVA)

A full compilation of these recommendations is provided in Appendix D of this report. A summary of the number of recommendations by waste type for each of the installations surveyed is presented in Table 4-4. A roll-up of the number of recommendations by waste type is presented graphically in Figure 4-1.

As can be seen in Figure 4-1, recommendations in the areas of solvents, parts cleaning, painting, and depainting represent about 50% of the total recommendations. It is of interest to note that, as represented in Figure 1-1, the total dollar value of DERA-funded HAZMIN projects in these areas represents nearly 50% of the funds spent on waste-specific projects (excluding the projects in the General, Not Specified and Miscellaneous categories). Although there is no direct correlation between the audit recommendations and the targeted wastes of the HAZMIN projects, these findings may

Table 4-4: Summary of HAZMIN Audit Recommendations

Targeted Waste	Installation										
	ANAD	DATP	HSAAP	LAAP	LCAAP	LEAD	LHAAP	LSAAP	RBAAP	RRAD	RSA
Explosive Wastes					2		4				
General	1	1									2
Industrial Wastewater Treatment	2	1		3	5			6		2	
Machining/Metal Work	2	1	2	9					1		
Metal Finishing	2			3		2		2			
Miscellaneous (see note)		1	6	2	2		1	4	2		
Painting/Depainting	9	2	5	8	3	3	5	4	2		
Solvents/Part Cleaning Wastes	11		4	6	4	2	2	8	3	4	
Waste Oils/Oily Wastes			2		1	1		3	6		
Total	*27*	*6*	*19*	*31*	*17*	*8*	*12*	*27*	*14*	*6*	*2*
Note: Miscellaneous Wastes include:		batteries	utilities, batteries, packing	QA, load and pack	mercury wastes		shop main-tenance	laundry, rags	batteries		

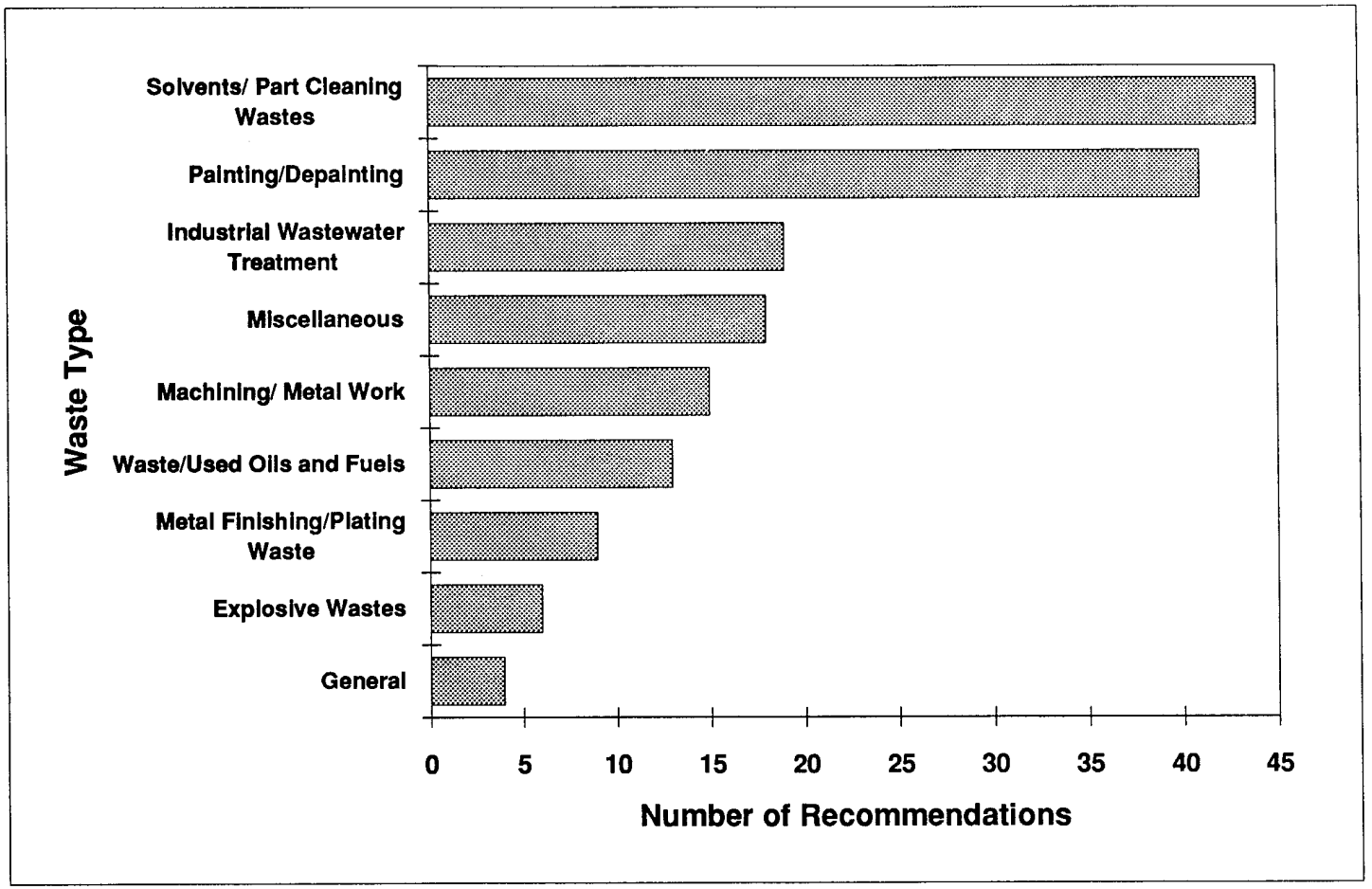
Source: Arthur D. Little, Inc. and Army Documentation

Table 4-4: Summary of HAZMIN Audit Recommendations (continued)

Targeted Waste	Installation					
	SAEP	SHAD	TEAD	TOAD	WVA	*Total*
Explosive Wastes						*6*
General	2	1	6	1	1	*4*
Industrial Wastewater Treatment	1		2	2	1	*19*
Machining/Metal Work					8	*15*
Metal Finishing	5			3	9	*9*
Miscellaneous (see note)				2	2	*18*
Painting/Depainting		4	11	4	2	*41*
Solvents/Part Cleaning Wastes			3		1	*44*
Waste Oils/Oily Wastes						*13*
Total	***8***	***5***	***22***	***12***	***24***	***169***
Note: Miscellaneous Wastes include:				photo shop	lab	

Source: Arthur D. Little, Inc. and Army Documentation

Figure 4-1: Number of Audit Recommendations by Waste Type



Source: Arthur D. Little, Inc. and U.S. Army Data

indicate that there are more opportunities for waste reduction in these areas and that these opportunities are more frequently pursued by the installations.

In order to identify the potential value and benefits of the recommendations made during the audits, recommendations for five of the audited installations were tracked. The installations (ANAD, LEAD, RRAD, SAEP, and TOAD) were contacted and each of the recommendations was discussed with respect to the current status of the recommendation. The results of this survey are presented in summary form in Table 4-5. More detailed responses are provided in Appendix D of this report.

In general, it does not appear that many of the recommendations were implemented based solely on the recommendations themselves. In many cases, the recommendations appeared to reflect activities that had been initiated by the installations on their own or under the direction of DESCOM prior to the audit.

AEHA Surveys. The AEHA surveys were initiated in 1989 and completed in 1990. Unlike the AMC audits, these surveys were short-term (approximately four days each), relatively low cost, and primarily qualitative in nature. The primary objective of these surveys was to identify waste reduction (or compliance) opportunities.

Surveys were conducted at the following Army facilities:

Ft. Bragg	Ft. Devens	Ft. Drum
Ft. Richardson	Ft. Wainwright	Ft. Greely
Ft. Riley	Ft. Bliss	Ft. Chaffee
Ft. Gordon	Ft. Jackson	Ft. Knox
Ft. Lee	McAlester AAP	Rock Island Arsenal
Tooele Army Depot	Ft. Polk	Ft. Indiantown Gap
Camp Grayling	Ft. Monroe	Walter Reed Army Medical Center
Carlisle Barrack	AVCRAD - Connecticut	

As can be seen, many of these surveys were conducted at troop installations, which typically do not have the depth in environmental and engineering support staff as do the Army industrial facilities.

The waste minimization opportunities identified in these surveys most often represent practical and low cost initiatives. Summaries of each of the surveys and the recommendations developed are provided in Appendix D of this report.

Table 4-5: Summary of Audit Recommendation Status

Installation	Recommendation	Status Summary
ANAD	1 Implement HAZMIN incentive program	Implemented prior to audit.
	2 Eliminate solvent disposal into waste oil collection pits	Implemented prior to audit.
	3 Implement use of alternative solvents in steam cleaning	Implemented prior to audit.
	4 Perform a study of water use in steam cleaning areas to identify opportunities for reduction in wastewater discharges	Action taken prior to audit.
	5 Replace most steam cleaning operations with aqueous washers	Implemented prior to audit.
	6 Adjust Safety Kleen service schedule based on contamination rates	Implemented prior to audit.
	7 Replace solvent washers with aqueous parts washers	Implemented prior to audit.
	8 Implement process to redistill TCE still bottoms	No action necessary. TCE use has been curtailed.
	9 Base disposal of chemical cleaning solutions on need	Implemented prior to audit.
	10 Implement procedures for in-tank treatment of acid and alkaline cleaners for discharge to the IWTP	No response.
	11 Install filtration and oil skimming processes to remove contaminants from alkaline corrosion removal baths and acid cleaning baths	No action possible. Oil contaminants are in sludge not on surface.
	12 Replace steam cleaning and chemical cleaning with aqueous parts washers and molten salt bath process	Implemented and investigated prior to audit.
	13 Implement preventative measures (such as removing toxic surface deposits and coatings prior to abrasive blasting) to minimize the introduction of toxic metals to blasting dusts	No action taken. Recommendation was not considered to be practical.

Source: Arthur D. Little, Inc. and Army Documentation

Table 4-5: Summary of Audit Recommendation Status (continued)

Installation		Recommendation	Status Summary
ANAD (continued)	14	Restrict use of deposits and coatings causing hazardous characteristics	No action possible. Use of coatings is driven by customer requirements.
	15	Implement offsite recycling of cutting and hydraulic oils.	Implemented prior to audit.
	16	Implement procedures to limit the number of different cutting and hydraulic oils used	No action possible. Number of oils used is already limited.
	17	Implement procedures for in-tank treatment of acid and alkaline cleaners	Under investigation.
	18	Implement procedures to improve maintenance of alkaline baths	Implemented prior to audit.
	19	Substitute single-component CARC paint for multiple-component paint currently used	No action possible. Use of coatings is driven by customer requirements.
	20	Coat paint pots with Teflon	No action taken. Use of Teflon considered too expensive.
	21	Install spray gun cleaning stations at each paint booth	Implemented prior to audit.
	22	Implement HVLP spray paint to reduce overspray and VOCs	Implemented prior to audit.
	23	Initiate onsite recycling of solvent	Imlemented prior to audit.
	24	Implement portable filter presses to improve paint sludge dewatering	No action necessary. Water wall paint booths replaced by dry booths.
	25	Develop in-house program for evaluating IWTP process changes	Implemented prior to audit.
	26	Investigate use of caustic for lime in IWTP	No action taken. Potential benefits of use of caustic are minimal.
LEAD	1	Investigate alternative blast media for abrasive stripping	Action taken prior to audit. Ongoing program to investigate alternatives.
	2	Replace current degreasing solvents with biodegradable solvents	Action taken prior to audit. Ongoing program to investigate alternatives.
	3	Continue efforts to initiate point-source recycling of TCA	No further action taken. Use of TCA being phased out.

Source: Arthur D. Little, Inc. and Army Documentation

Table 4-5: Summary of Audit Recommendation Status (continued)

Installation	Recommendation	Status Summary
LEAD (continued)	4 Investigate use of ultrasonic cleaning to replace vapor degreasing	Under investigation by the Army. Aqueous washers being used.
	5 Investigate use of HVLP paint spray systems	Implemented prior to audit. HVLP used where feasible.
	6 Investigate use of alternative coatings	Implemented prior to audit. Use of coatings is driven by customer requirements.
	7 Investigate potential for treatment and recyling of waste effluent at Building 1N and eliminate its discharge to the IWTP	No action taken. Extensive rework of entire operation would be required.
	8 Investigate potential for blending waste oil with diesel fuel for resource recovery	Under investigation.
RRAD	1 Substitute nonhalogenated solvent for TCA	Initiated prior to audit.
	2 Implement distillation process to recover Stoddard solvent	No action taken. Offsite reclamation considered more practical.
	3 Investigate potential for recovery of MEK by distillation	Action taken prior to audit. Only pure MEK being recovered for reuse.
	4 Initiate field testing of the use of high-flashpoint naptha or alkaline detergents as degreasing agents	Initiated prior to audit at direction of DESCOM.
	5 Investigate procedures to remove cadmium from the influent wastewater at the IWTP	No action necessary. Cadmium plating has been eliminated.
	6 Initiate application to delist F006 sludge once cadmium is eliminated from IWTP influent	No action possible. F006 sludge cannot be delisted due to the presence of heavy metals other than cadmium.
SAEP	1 Update engineering documents to eliminate obsolete documents	Under investigation.
	2 Implement improved methods of recording or accounting for waste sources and quantities as well as raw material use	Implemented prior to audit.

Source: Arthur D. Little, Inc. and Army Documentation

Table 4-5: Summary of Audit Recommendation Status (continued)

Installation		Recommendation	Status Summary
SAEP	3	Implement cyanide-free copper plating process	Investigation initiated prior to audit.
(continued)	4	Replace cyanide-containing periodic reverse cleaner with cyanide-free metal cleaner	Investigation initiated prior to audit.
	5	Investigate potential for elimination of period reverse cleaning	Investigation initiated prior to audit.
	6	Implement procedures to cover vapor degreaser when not in use to reduce VOC emissions and solvent loss	Implemented prior to audit.
	7	Adhere to rigorous maintenance schedule to ensure that conductivity meters are used properly to limit contamination in rinse tanks	Under investigation.
	8	Identify sources of organic contamination in IWTP effluent	Under investigation.
TOAD	1	Convert water wash paint booths in Building 1A to dry booths	Implemented.
	2	If water wall paint booths retained, install filter press to enhance sludge dewatering	Not necessary. Dry booths have been implemented.
	3	Continue to install and use HVLP paint spray equipment	Implementation initiated prior to audit. Implementation continues.
		Identify substitute solvent for TCA	Not implemented.
	4	Replace Stoddard solvent with water-based solvents	Not implemented.
	5	Implement procedures to reduce the requirements for stripping vehicles	Not implemented.
	6	Modify the IWTP to allow for treatment of spent alkaline and acid solutions	Not implemented.

Source: Arthur D. Little, Inc. and Army Documentation

Table 4-5: Summary of Audit Recommendation Status (continued)

Installation		Recommendation	Status Summary
TOAD (continued)	7	Ivestigate the use of metal recovery processes for concentrated metal plating solutions	Not implemented.
	8	Investigate processes to reduce or eliminate discharges from plating operations	Implementation initiated prior to audit under direction of DESCOM.
	9	Modify pretreatment process to allow for optimum equilibration in dqualization tanks	Not implemented.
	10	Install filter press or sludge drying system to enhance dewatering of sulfide sludge	Implemented.
	11	Implement improved methods of recording or accounting of wastes	Not implemented.

Source: Arthur D. Little, Inc. and Army Documentation

5.0 Evaluation of the Success of HAZMIN Projects

5.1 Factors Leading to Success

The apparent success of a HAZMIN project depends on a number of factors. These factors may reflect the actual mechanics of developing and implementing a given HAZMIN project or enhancements that may be used to further the project along. Throughout the course of this study, it was observed that factors that contributed to the apparent success of HAZMIN efforts in general include:

- Adequate definition of the problem or need to be addressed;
- Identification and prioritization of waste reduction opportunities;
- Development and implementation of appropriate plans to address waste reduction opportunities; and
- Identification of means to measure success (qualitatively and quantitatively).

Of these factors, the first three are typically easier to observe and document. The latter factor is more elusive. In general, only qualitative information is available with respect to the apparent success of a HAZMIN project. For a number of reasons, to be discussed below, quantitative measures of a HAZMIN project's success typically have not been developed. This lack of a quantitative measure of HAZMIN projects makes the definition of a "successful" project less objective and more subjective. For the purposes of this discussion, a successful project is one in which implementation of a waste reduction initiative occurs, results have been obtained, and/or the implementing installation or facility is satisfied that the objective of the project has been, or will most likely, be met. These project objectives may include improved HAZMIN organization, waste reduction, cost savings, regulatory compliance, improved worker health and safety, an increased understanding of a given problem, and/or a determination of the feasibility of a process change or material substitution.

The most difficult of the HAZMIN projects to classify with respect to success are the programmatic types of projects including workshops, software development, HAZMIN plan preparation, waste tracking database development, and waste minimization opportunity assessments (including audits). In most of these cases, a quantification of waste reduction or cost savings is not possible. Generally, it was found that the most successful of these projects were those that directly addressed the specific needs of an installation. For example, workshops appeared to be most useful when subjects specific to an installation's HAZMIN needs were addressed and discussed. Workshop attendee comments were less favorable for those aspects of workshops that applied to general HAZMIN program topics than those aspects that addressed specific installation needs and requirements. Of the various audits or opportunity assessments that were conducted at Army installations, those that were geared toward a specific installation and conducted under the installation's management or with direct installation involvement were generally more successful.

The HAZMIN projects that involved test and evaluation efforts often served as stepping stones to the design of HAZMIN processes or the purchase of equipment. These types of projects often provided for a better understanding of a problem or technology application to allow for prioritization of HAZMIN efforts and the most beneficial expenditure of

HAZMIN funds. The success of these projects is not necessarily dependent on the implementation of a HAZMIN process or procedure resulting in the reduction of waste and/or a reduction of costs.

A majority of the surveyed projects involved various aspects of process modifications or material substitutions. The factors leading to the success of these projects include administrative requirements such as preparation of requests for funds and preparation of requests for procurement leading to the award of contract(s) for procurement of services or equipment. In addition, other, more site-specific factors that increased the potential for success were often observed. These factors include:

- Technical expertise and creativity;
- Strength of the individual installation's HAZMIN program;
- Degree of worker involvement;
- HAZMIN awareness; and
- Technology transfer.

Technical Expertise and Creativity. It was observed that personnel involved in the development and implementation of the most successful HAZMIN projects often had a proactive attitude in that they actively (and often independently) searched for ways to reduce waste generation. In some cases, there were one or two key personnel whose enthusiasm resulted in the expansion of HAZMIN ideas and efforts to other personnel. Often, the DERA-funded HAZMIN projects spawned the initiation of HAZMIN projects funded by the installation itself or other sources.

Strength of Installation HAZMIN Program. The most successful projects appeared to originate at the facilities with strong, active HAZMIN programs. Such programs often include a formal plan that establishes goals requiring a full understanding of waste generation and management. These installations document waste sources, type, and quantities, and the costs of disposing of the wastes. With this information, waste reduction opportunities can best be identified and prioritized. In addition, such information allows the installations to better assess the project after implementation to determine its degree of success.

Degree of Worker Involvement. Obtaining the cooperation and involvement of operators and other installation personnel in HAZMIN was a common implementation characteristic of most successful HAZMIN projects. Operators will often be the ultimate implementors and users of HAZMIN technology and processes and therefore their acceptance must be gained in order to effectively implement the technology or process. Operator reluctance to accept a HAZMIN approach may result from fears that it will negatively impact product quality or production throughput. By getting operator involvement early on in the HAZMIN effort, these fears may be allayed and operator input may contribute to a more effective implementation. One installation achieves this involvement by eliciting operator volunteers to participate in the demonstration, development, and operation of new processes or equipment. This involvement has been shown to result in operators with a true interest in the success of the project as well as

contributions from the operators into the development of operating guidelines for the processes and equipment.

HAZMIN Awareness. Making installation personnel aware of HAZMIN goals and efforts enhances the potential for success of HAZMIN efforts. The benefits of such awareness were observed to include: a higher degree of worker involvement (see above); the generation of new HAZMIN ideas and suggestions; and fewer unknowns with respect to the impact of implementation of HAZMIN processes and procedures. Awareness may be achieved through HAZMIN recognition and awards programs as well as training. One installation uses all three to achieve installation employee awareness. As a result, numerous HAZMIN suggestions from installation personnel have been received resulting in the initiation of a variety of small and large-scale HAZMIN efforts. In addition, cash awards to operators and their supervisors are made in recognition of outstanding HAZMIN efforts. Going a step further, HAZMIN-related issues have been made a part of employee performance appraisals to further increase employee awareness of the importance of waste reduction. As a result of these awareness efforts, installations have been able to initiate a number of successful HAZMIN projects.

Technology Transfer. One of the most significant (and perhaps most surprising) observations made during this survey of HAZMIN projects was the level of technology transfer that occurs between the various installations and the positive impact such technology transfer has on the implementation and success of HAZMIN initiatives. Of special note is the Centers of Technical Excellence (CTX) Program established by DESCOM in 1989.

Recognizing that resources necessary for each depot to individually address all aspects of waste minimization do not exist and that duplication of effort might occur, seven waste streams and waste types common to depots were targeted by the CTX program. These wastes include: petroleum degreasing solvents, chlorinated degreasing solvents, chemical paint strippers, plating wastes, aluminum conversion coatings, hazardous industrial waste treatment plant sludges, and chlorofluorocarbons. For each of these wastes, a specific depot was designated as the CTX. Each CTX is responsible for identifying and evaluating source reduction initiatives for the assigned waste which are to be applied across the depot system. The centrally-managed CTX program has been responsible for the implementation of a number of successful HAZMIN initiatives. For example, the CTX program management was responsible for the purchase and implementation of several aqueous-based parts washers to replace vapor degreasers at a number of depots.

Based on observations made during this study, the CTX program provided some degree of motivation for a number of HAZMIN projects undertaken by the depots. One important benefit of the CTX approach is the increase in the exchange of information and technology among the depots. In conversations with many of the HAZMIN project points of contact, the CTX program was often mentioned as a useful mechanism for the interchange of HAZMIN ideas, technology, and results.

Other technology transfer initiatives that were often cited in the survey of HAZMIN projects include regularly-scheduled multiple-service Joint Depot Environmental Panel (JDEP) meetings, HAZMIN lessons-learned workshops (AMC-sponsored), and technical meetings and conferences. In addition to these more formal technology transfer

mechanisms, informal contacts and discussions between engineers from different installations (and different MACOMs) appeared to be frequent.

Technology transfer activities allowed for installations to share specifications for equipment and services to be procured. By using a specification already developed for the successful procurement of HAZMIN-related equipment, an installation could often dramatically reduce the time required for procurement while taking advantage of lessons-learned by others.

5.2 Impediments to Success

During the course of this survey of HAZMIN projects, a number of issues surfaced regarding potential impediments to project success. These impediments may impact a HAZMIN project by causing an installation to lose funds, slowing or stopping a procurement action necessary for implementation of the project, slowing the progress of the project, impeding the successful implementation of the project at an installation, and delaying an assessment of quantitative and qualitative project success. Specific examples of potential impediments include:

- Schedule (including award of funds, procurement, and implementation);
- Acquisition Requirements;
- Customer Process and Product Specifications;
- Personnel Resources;
- Technology Transfer Among Government-Owned, Contractor-Operated Installations (GOCOs); and
- Accountability of HAZMIN Results.

Each of these impediments is discussed below. Unfortunately, many of these impediments are institutional and therefore beyond the control of the installations.

Schedule. This subject is fairly broad and covers the time required and difficulties encountered throughout the HAZMIN project cycle. To illustrate an example of the time required to implement a project, Figure 6-1 is provided. This figure, developed with input from Milan AAP, illustrates the time required from the initial request for funds by the installation (submission of the EPA Form 1383) through the award of funds, procurement, installation, and finally actual implementation. The project in this case involved the replacement of a wet vacuum system for collecting waste explosive generated at a load, assemble, and pack line with a dry vacuum system to reduce the quantity of pinkwater generated. As shown, nearly 52 months pass between the initial request for funds by Milan AAP to a point where the dry vacuum systems are operational. Further, nearly 36 months pass between the actual award of funds to the installation and initiation of operation. These times appear to be typical for government projects of this magnitude. One of the first observations that can be made from this timeline is that measurable results from the implementation of a HAZMIN project can

often not be made within a short time period after the funds for the project have been obligated to the installation. It can be seen that results of the Fiscal Year 1989 DERA funds made available to Milan AAP for this project (actual obligation of the funds was November 1989) will not be realized until well into calendar year 1993.

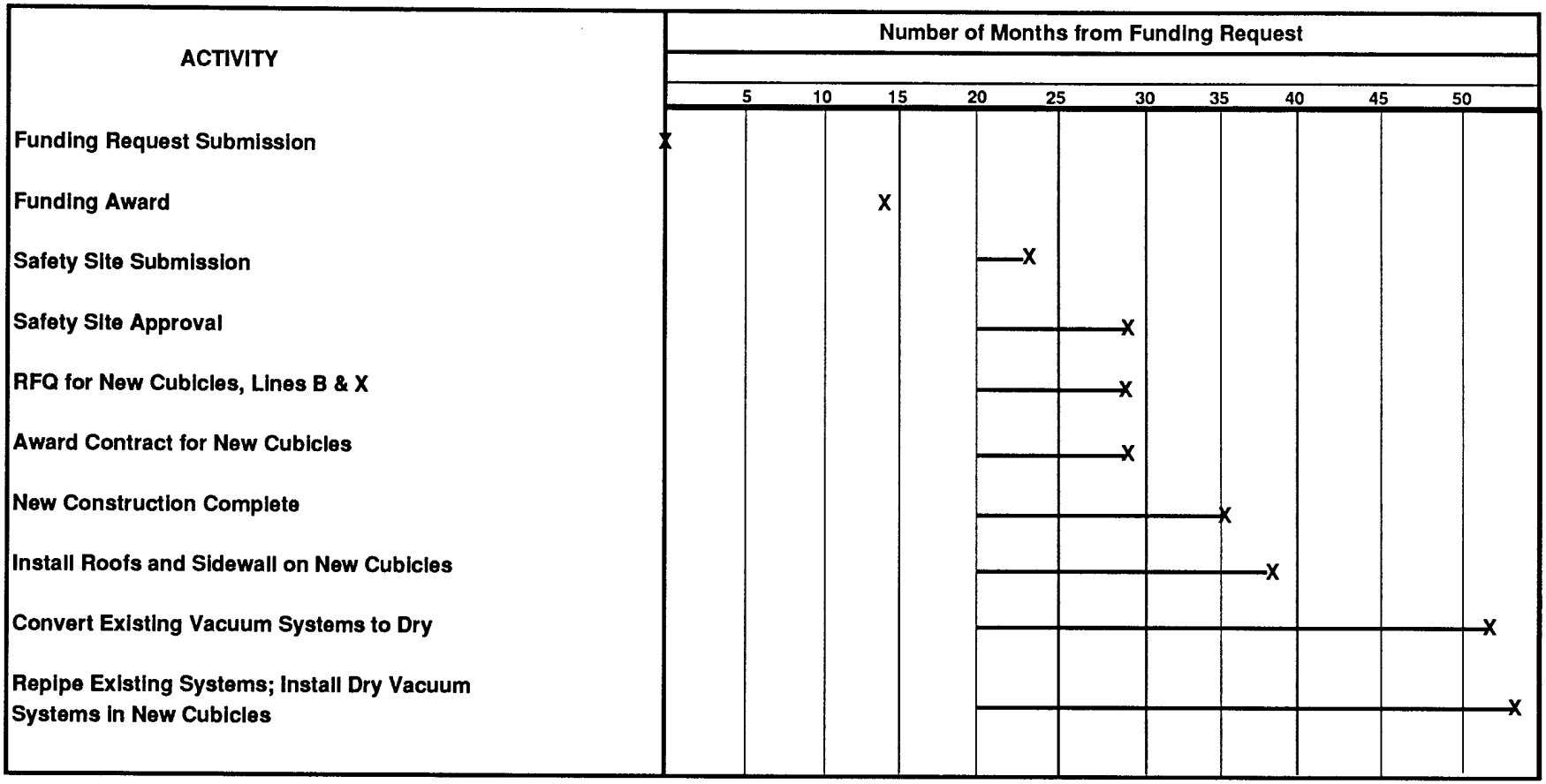
An additional aspect of schedules and timing that is of concern to some of the installations is the relatively short window for obligation of the funds received by the installations. Typically, funds do not become available to the installations until the beginning of the third quarter of the fiscal year. According to some installation points of contact, these funds must be obligated during that fiscal year or be returned. This has proven especially difficult for projects that require the preparation of a Request for Procurement, solicitation of competitive quotations or proposals, and evaluation of quotations or proposals. It is felt among the installations that have been impacted by this scheduling difficulty that the opportunities for future HAZMIN funding may be jeopardized by their inability to obligate the funds within the designated fiscal year.

Acquisition Requirements. Many of the installations surveyed cited acquisition requirements (specifically, the Federal Acquisition Regulations [FAR]) as the source of significant impediments to HAZMIN. The FAR requirements, in place to regulate the acquisition of equipment, services, and supplies and ensure fair competition, often result in delays in procurement of equipment and materials necessary for the implementation of HAZMIN projects. In a few cases, these acquisition requirements were responsible for the acquisition of equipment that not only did not meet the HAZMIN-related objectives, but could not even be implemented at the installation without significant facility modifications. When writing specifications for the procurement of equipment and materials, the installation must be as specific as possible to adequately describe their needs, but general enough not to preclude a competitive procurement. In addition, there is often pressure to make an award to a low bidder even though that bidder's product may be inferior with respect to meeting waste reduction objectives. As observed in this survey, preparing procurement requests to ensure that the desired item is procured is an acquired skill often resulting from failed attempts.

Customer Process and Product Specifications. Another issue that was often raised by the installations surveyed is the requirement to adhere to process and product specifications maintained by the customer. Such specifications include Depot Maintenance Work Requirements (DMWRs) and Technical Data Packages (TDPs) that specify types of materials and processes to be used in maintenance and production operations. Many of the specifications require that out-of-date processes be used to accomplish tasks that can be performed by more environmentally-sound methods. Common examples include the use of trichloroethane for degreasing and the use of cadmium plating for corrosion protection. In order for an installation to use a process that is not specified or approved, waivers and approvals must be obtained. Many times, the approving agency or organization is reluctant to make changes for reasons of potential liability. Since many of the installations are dependent on a customer base for their continued activity, there may be resistance at the installation level to pursue environmentally-sound methods of accomplishing their tasks.

Personnel Resources. A few of the installations surveyed cited the lack of adequate personnel resources as an impediment to HAZMIN. Due to budget cuts and reductions in

Figure 5-1: Equipment Purchasing Project Schedule, Milan AAP



Source: Arthur D. Little, Inc. and Milan AAP

personnel, some installations have experienced a shortage in trades people required for the installation of equipment and modification of facilities required for the implementation of a HAZMIN project. In some cases, equipment purchased with HAZMIN funds sits idle due to the lack of personnel to install such equipment.

Technology Transfer Among GOCOs. Although technology transfer was often a positive feature of the successful implementation of HAZMIN projects, it also may be considered an impediment as it concerns GOCOs. Contractors at these installations may be reluctant to participate in technology transfer activities because of the potential competition with other contractors. As a result, HAZMIN projects that may have application to more than one site may not receive adequate exposure.

Accountability of HAZMIN Results. It was observed throughout this study that there were a number of HAZMIN projects for which apparently no usable information or data were generated. In some cases, the actual use of the funds could not be explained. These phenomena were typically due to frequent turnover of personnel and, to a lesser extent, poor accounting of expenditure of funds.

An additional accountability impediment is the lack of quantification of HAZMIN project results with respect to the amount of waste reduced and cost savings. The primary difficulty encountered with respect to quantification is the lack of a suitable baseline for comparison. Since installation missions and levels of activity are not static, it is often impossible to determine the precise effect of a HAZMIN initiative. It is not clear whether, or how much, waste reduction or cost savings are due to the HAZMIN initiatives or due to fluctuations in production and activities. This difficulty is not restricted to the Army installations surveyed, but has been a major stumbling block throughout industry in assessing waste minimization (or pollution prevention) efforts and gaining their acceptance.

6.0 Conclusions and Recommendations

6.1 Conclusions

Arthur D. Little, Inc. reviewed and evaluated over 75 projects funded through the Army's DERA HAZMIN program. In this review, available information and data were accumulated, compiled, and assessed to determine the fate and effectiveness of these projects. Data acquisition was supplemented by telephone conversations with points of contact for each of the projects. Site visits were made to nine selected installations to further the understanding of the projects as well as to gain insight into the general HAZMIN programs and initiatives of the installations.

The types of information and data obtained and observations made during these investigations included: final project costs, motivation behind the projects, verification of project completion, project documentation, resulting cost savings and waste reduction, and overall project effectiveness.

The DERA-funded HAZMIN program has resulted in the implementation of many successful projects resulting in apparent cost savings and waste reduction. In addition, less tangible benefits of the HAZMIN projects were observed. Primary among these benefits are increased awareness of and involvement in HAZMIN initiatives in general.

Despite the successes, a number of less successful projects were identified. In some cases, it was possible to relate the relative lack of success of these projects with specific impediments. Many of the impediments represented institutional characteristics that were beyond the control of the individual installations.

Evaluation of Success. Evaluation of each project for success was difficult since the definition of success cannot be generalized. Successful projects were observed to be dependent upon a number of factors including:

- Definition of the problem to be addressed;
- Identification and prioritization of waste reduction opportunities;
- Development and implementation of mechanisms to address waste reduction opportunities; and
- Identification of means to measure success.

For the purpose of this evaluation, a successful project was identified as one in which one or more of the following will, or has, occurred: a waste reduction initiative has been implemented; results of the initiative have been obtained; and/or the implementing installation is satisfied that the objective of the initiative has been met. In general, the most difficult projects to evaluate with respect to their success were projects grouped in the HAZMIN Program Support and Test & Evaluation categories. Program support efforts allow for further educating personnel and improving HAZMIN programs, while T&E projects often serve as stepping stones to the design of HAZMIN processes or the purchase of equipment. Both functions are important and lead to a better understanding of a problem or technology application and allow for more efficient expenditure of future HAZMIN funds. However, quantification of waste reduction and cost savings is often not possible for such projects.

Other projects involved the implementation of equipment or process modifications. These projects were more easily evaluated with respect to success because the goals of these projects were most often to reduce waste generation or reduce costs. However, the ability of these installations to track waste and cost reductions was not always in place or feasible. Several of the projects were known to have resulted in reduced costs and waste generation, yet the actual amounts could not be quantified.

Facilitators to Success. There were definite factors that contributed to the successes of HAZMIN projects and the strength of the HAZMIN programs. These factors included:

- Technical expertise and creativity;
- Strength of the individual installation's HAZMIN program;
- Degree of worker involvement;
- HAZMIN awareness; and
- Technology transfer.

Successful HAZMIN projects were in general conducted at facilities that had one or more of the above characteristics. In some cases, a few key individuals propagated a sense of enthusiasm and proactive attitudes that encouraged the continuation of HAZMIN efforts. These efforts often spawned the initiation of other projects funded by the installation itself or other sources. Installations with the ability to adequately document waste sources, types, and disposal costs were able to prioritize their efforts and readily assess their success. Good cooperation and involvement of operators also contributed to success. Operators willing to learn new processes and offer suggestions resulted in positive attitudes and more efficient process operations. Personnel involvement is also evident at installations with active HAZMIN programs that train and encourage their employees to offer their suggestions on how to implement HAZMIN efforts.

Technology transfer among facilities was in general observed to be effective. The DESCOM CTX program contributed positively to the high level of technology transfer among the depots. In addition, regularly scheduled technical meetings and conferences sponsored by MACOMs, joint services, and other federal organizations enhanced technology transfer. It was also observed that informal technology transfer often occurs between personnel (including operators, engineers, and commanders) of various installations. These more informal technology transfer efforts allowed personnel to share information on various technologies including written specifications developed for specific HAZMIN equipment, operational problems and successes, and lessons learned.

Impediments. A number of issues that impeded the success and implementation of HAZMIN efforts were identified. These included:

- Schedule;

- Acquisition requirements;
- Customer process and product specifications;
- Personnel resources;
- Technology transfer among GOCOs; and
- Accountability of HAZMIN results.

Many of these impediments are institutional and are usually beyond the control of installation personnel. Schedule problems arise from the short time frame available to obligate funds. This is especially difficult for equipment projects that require the development of specifications, solicitation of quotations, and evaluation of quotations before an award can be given. In addition, equipment installation projects can incur long schedules because of the steps required to complete. In these cases, results may not be observed until several years after the initial obligation of funds.

Acquisition requirements (primarily those imposed by the FAR) often make it difficult for an installation to obtain the desired equipment. A specification must be written specifically enough to describe the need, yet general enough to meet competitive bid requirements. The low bidder is often awarded the contract which may result in inferior or impractical equipment.

Manufacturing and maintenance specifications often impeded the consideration and implementation of HAZMIN initiatives. Such specifications (including DMWRs and TDPs) that specify types of materials and processes to be used in maintenance and productions operations are often out of date and were prepared with minimal (or no) consideration of the environment. These requirements make it difficult to use alternative processes or materials that are environmentally sound but are not approved or are prohibited based on these specifications.

Lack of personnel to install equipment was also a problem for installations. In nearly a third of the equipment-related projects, equipment that had been purchased was idle because of the absence of available tradespeople to install it.

It was observed that a lesser degree of technology transfer occurred between GOCO facilities. This reluctance to pursue technology transfer was observed to exist because of potential competition with other contractors. This had the potential to result in inadequate exposure of successful HAZMIN projects for applications at other facilities.

It was not possible to complete the evaluation of some of the DERA-funded HAZMIN projects because of a lack of information and turnover of personnel at the implementing installation. In addition, some projects could not be fully evaluated because of a lack of data and information needed to determine project results. This was a common problem that most often related to the determination of waste reduction and cost savings. Tracking waste reductions and cost savings due to HAZMIN project implementation was made difficult due to: the lack of a normalized baseline for waste generation and costs; variable product requirements and production rates; and the absence of a suitable measurement and accounting system.

6.2 Recommendations

The Army should continue to enhance the strengths of the HAZMIN program and address the impediments to HAZMIN. The ultimate goal of such efforts would be for each installation to have a proactive attitude that results in active and ongoing HAZMIN programs and initiatives.

One may think of the HAZMIN involvement process as analogous to the "activation energy" in a chemical reaction pathway as illustrated in Figure 6-1. Initially, the Army has invested time and resources in educating installation personnel on the advantages of HAZMIN through enacting waste reduction mandates and requirements for formal HAZMIN programs at each facility. This is further enhanced by the opportunities provided by AEC through DERA funding and technical support for HAZMIN initiatives. The levels of acceptance and implementation of a HAZMIN program are observed to be variable and different for each facility. Many facilities have not yet developed aggressive approaches to HAZMIN and are still on the uphill climb thus requiring additional investments in assistance and encouragement. Other facilities have reached the point where HAZMIN efforts are self-initiating because of the benefits that have been demonstrated through the implementation of previous initiatives. This self-initiation is resulting in significant cost savings and waste reduction to the Army (from projects that may or may not be funded by DERA). With time and continued Army support, more facilities will incorporate HAZMIN into their culture and more HAZMIN initiatives will be implemented resulting in further waste reduction and cost savings. This increasing level of involvement and implementation is illustrated as the downward curve on Figure 6-1. Many times, through the aggressive implementation of HAZMIN efforts, the facility or installation can operate more efficiently than they did prior to the investment into HAZMIN. Lastly, continued Army support will ensure that this trend is maintained through continued education and awareness training.

Continued support is required to move installations further along the initial uphill climb. To enhance this process, it is recommended that the strengths and successes noted above continue to be encouraged. In addition, impediments to HAZMIN should be addressed to the maximum extent possible to increase opportunities for facilities to implement strong HAZMIN programs and projects. Such support and encouragement can be enhanced by consideration and implementation of the following:

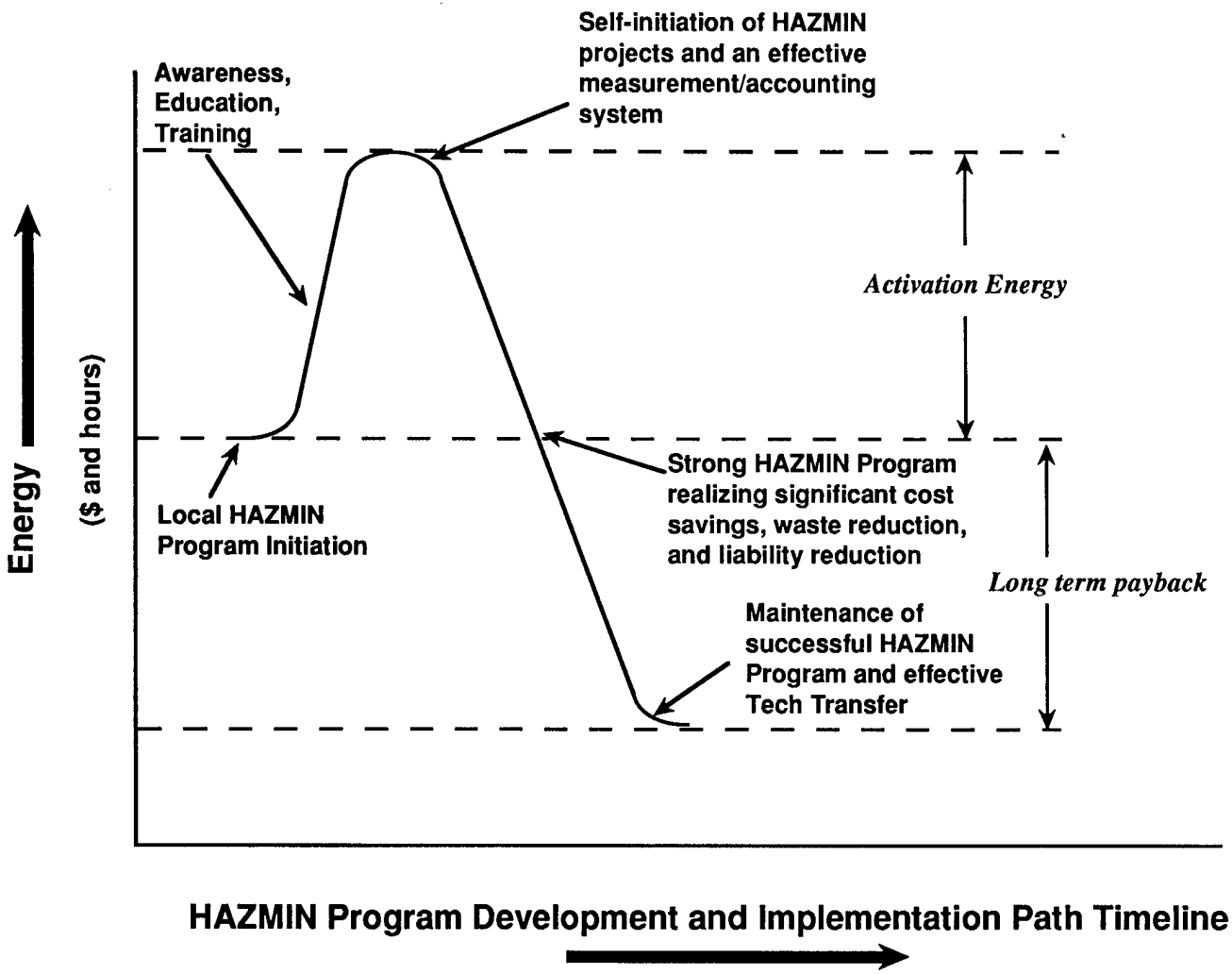
1. Develop a means to track the progress and completion of DERA-funded projects once funding is obligated.

2. Define realistic goals for each type of project so that success can be better evaluated. These goals will be different for different types of projects (e.g., program support, equipment, test and evaluation, etc.).

3. Assist the facilities in identifying a means to measure the success of projects (including the quantification of waste reduction and cost savings).

4. Encourage the development of strong HAZMIN programs at each facility including effective waste tracking capabilities, strong technical expertise, and the tools to prioritize and address each waste stream.

Figure 6-1: Development Stages and Goals of a HAZMIN Program



Source: Arthur D. Little, Inc.

5. Continue to support technology transfer through programs such as the Centers for Technical Excellence (CTX). This has been proven to provide for more knowledge of technology applications, encouragement of creative applications, reduction in schedule problems, and reduction in the amount of duplicated efforts. Similar programs for other commands within the Army should be considered.

6. Address the issue of technology transfer among GOCOs. Lack of technology transfer among these facilities increases the risk that many HAZMIN efforts could be duplicated and that successful technology applications are not being communicated.

7. Continue to improve operator awareness of HAZMIN programs and issues to encourage their suggestions and involvement. Often knowledge and awareness of the issues changes the attitudes of workers.

8. Address the issue of outdated process and product specifications. This may include the development of an easier avenue to obtain waivers. In addition, research and development that is conducted to prepare these Technical Data Packages should consider HAZMIN and environmental issues.

9. Consider emphasis on continued funding of projects addressing specific installation needs rather than those projects that address waste reduction in general and are not waste or installation-specific.