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HAZARDOUS WASTE

DOD Efforts to Reduce Waste

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The Honorable Vic Fazio
Chairman, Subcommittee on Legislative
Committee on Appropriations
House of Representatives

The Honorable Mike Synar
Chairman, Subcommittee on Environment,
Energy and Natural Resources
Committee on Government Operations
House of Representatives

This report responds to your request that we evaluate the Department of Defense efforts to minimize the generation of hazardous waste.

As arranged with your Office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the issue date. At that time we will send copies to the chairmen of other appropriate committees; the Secretaries of Defense, the Army, the Air Force, and the Navy; the Director, Office of Management and Budget; and other interested parties upon request.

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

The Department of Defense (DOD) is a major generator of hazardous waste. The Hazardous and Solid Waste Amendments of 1984 require that all hazardous waste generators have minimization programs. In response, DOD delegated responsibility for developing and implementing such programs to the Air Force, the Army, and the Navy.

The Chairman, Subcommittee on Environment, Energy and Natural Resources, House Committee on Government Operations, and the Chairman, Subcommittee on Legislative, House Committee on Appropriations, requested that GAO determine the status of DOD's program for reducing hazardous waste generation through source reduction. Specifically, GAO reviewed the efforts of the services to reduce generation through

- changes to production, repair, and maintenance processes;
- substitution of less hazardous materials for hazardous materials; and
- changes to technical documents that allow substitutions of less hazardous materials.

GAO also examined DOD's efforts to consider hazardous waste minimization when acquiring new weapon systems and other equipment and the data collection methods the services use to measure progress in meeting reduction goals.

Background

Even though the services had initiated their hazardous waste minimization efforts in the mid-1980s, the Deputy Assistant Secretary of Defense (Environment), in a February 6, 1987, policy letter, formally delegated DOD's hazardous waste program to the services. The letter endorsed reviewing and assessing existing technology, developing reduction goals and monitoring progress toward achieving them, accurately reporting hazardous waste generation data, and establishing minimization as an important consideration in all acquisition programs. GAO, in a July 1988 report, identified the elements needed for a long-term strategy for minimizing hazardous waste.

Results in Brief

The services began to implement minimization programs in the mid-1980s; however, the degree of implementation varies. Also, they may have difficulty measuring their progress toward meeting minimization goals due to problems with hazardous waste generation data. They have set a goal of reducing the amount of hazardous waste by 50 percent by the end of 1992.

The installations GAO visited have made some changes to production, repair, and maintenance processes, such as installing an in-line still to recover trichloroethylene. They have also made some substitutions of less hazardous materials in these processes, such as using water-based paint primers rather than toxic primers.

Only the Air Force has specifically required that technical documents be reviewed to identify opportunities for material substitutions. The services have not yet formally integrated hazardous waste minimization considerations into their processes for acquiring new weapons systems and equipment.

Principal Findings

Minimization Strategy

Through the services, DOD has made progress in meeting the required elements of a hazardous waste minimization strategy or plan by (1) establishing measurable goals and setting a time frame for accomplishing these goals, (2) initiating programs and developing plans outlining efforts on how to accomplish these goals, which include identifying some of the resources needed, and (3) making some organizational changes and studying others.

Services' Minimization Program Development

The services are identifying methods for reducing the quantity of waste generated, such as process changes and material substitutions. The Air Force and the Army delegated the management of the minimization program to their major commands, which, in turn, delegated much of the effort to the installations. The Navy requested that the Naval Civil Engineering Laboratory determine the processes that generate large quantities of waste and develop minimization technologies. The Air Force Logistics Command, which generates about 92 percent of the Air Force's waste, has evaluated its processes and identified ways to achieve reductions. The Army Materiel Command, which generates about 96 percent of the Army's hazardous waste, is reviewing its processes for minimization opportunities.

Technical Document Review for Material Substitutions

Technical documents provide the necessary information and instructions to repair and maintain systems and equipment items. Substituting a less hazardous material may require changes to the technical documents. The Air Force Logistics Command requires that technical documents governing all systems and equipment be reviewed to identify opportunities for hazardous waste minimization involving material substitutions. The Air Force Logistics Command delegated this responsibility to its five Air Logistics Centers. At the time of GAO's review, only the San Antonio Air Logistics Center had a recently approved plan for the review of the documents. The Army and the Navy have no requirements for a review of technical documents to identify minimization opportunities.

Minimizing Hazardous Materials During the Acquisition Process

Although the services have existing organizations, such as the Logistics Support Analysis group, systems program offices, and research and development centers, that could consider minimizing the use of hazardous materials in the acquisition process, they have not yet integrated such considerations into their formal acquisition process. However, they have taken some initial steps. For example, the Air Force Systems Command has outlined a plan to reduce the use of hazardous materials during the early stages of weapon system development, but this plan had not been implemented at the time of GAO's visit.

A Navy directive on the minimization program, finalized in May 1988, includes a requirement that the acquisition process for all weapons and support systems consider hazardous waste minimization. The Army has no formal procedures that focus on environmental and health factors as part of its initial acquisition process.

Unreliable Data Make DOD Progress in Source Reduction Difficult to Measure

The services are attempting to reduce hazardous waste generation levels by 50 percent by 1992, but they will have difficulty monitoring their progress because generation data are unreliable for several reasons. One reason is that the services' input to the Defense Environmental Status Report contains only total waste generation data, which is not correlated with changes in the amount of work being done. For example, a base may generate less waste because it repaired fewer weapons or equipment, not because the repair process was changed to use less hazardous materials per weapon.

Another reason generation data are unreliable is that the methods used to collect generation data varied among and within the services, and

some collection methods produced unreliable data. For example, installations were making assumptions on the composition of hazardous waste generated and the weight of the hazardous waste, for example, assuming that all 55-gallon drums contain 47 gallons of waste, when, in fact, some may contain 55 gallons and others 5 gallons.

Recommendations

To provide the services with accurate, consistent, and comparable hazardous waste generation data for monitoring minimization efforts and progress toward meeting waste reduction goals, GAO recommends that the Secretary of Defense establish a standard methodology for collecting and reporting hazardous waste generation data within DOD, which should include data on significant changes in production.

Agency Comments

GAO discussed the matters addressed in this report with service officials and considered their comments in preparing the report. At the Subcommittees' request, GAO did not obtain official agency comments on a draft of this report.

Contents

Abbreviations

CNO	Chief of Naval Operations
DOD	Department of Defense
DRMO	Defense Reutilization and Marketing Office
EPA	Environmental Protection Agency
GAO	General Accounting Office
OSD	Office of the Secretary of Defense

Introduction

The Department of Defense (DOD) is a major generator of hazardous waste. Hazardous waste includes contaminated sludge, solvents, acids, and heavy metals that are dangerous to humans and the environment if disposed of improperly. DOD generates over 400,000 tons each year from industrial processes primarily used to repair and maintain weapon systems (e.g., F-16 aircraft) and equipment (e.g., trucks). Data provided by the armed services show that in 1986 the Air Force, the Army, and the Navy generated about 96,000, 139,000, and 183,000 tons, respectively of hazardous waste. Appendix I shows the quantity of waste generated by the three services and their major commands.

National concern regarding the threats posed by hazardous waste has resulted in strict environmental laws, including the Resource Conservation and Recovery Act of 1976, as amended. The act established a regulatory program to correct the management of hazardous waste, including a manifest system to track hazardous waste from the point of generation to the point of disposal. The Hazardous and Solid Waste Amendments of 1984 set out, among other things, requirements for all hazardous waste generators to have programs in place that minimize,[1] to the extent practicable, the generation of hazardous waste and for them to state on waste manifests that such programs have been implemented.

In response to the amendments, in December 1985 the Joint Logistics Commanders[2] developed a minimization program outline for the largest generators of hazardous waste in the Army, the Air Force, and the Navy. The commanders developed this outline to provide the services with the basic concepts and requirements of a hazardous waste minimization program which the services should use in designing programs to fit their specific needs.

This outline reflected a 1986 Environmental Protection Agency (EPA) report to the Congress that (1) defined waste minimization, (2) called for voluntary hazardous waste minimization programs, and (3) emphasized

[1]EPA defined waste minimization as the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, stored, or disposed. It includes any source reduction or recycling activity undertaken by a generator that results in either (1) the reduction of total volume or quantity of hazardous waste or (2) the reduction of toxicity of hazardous waste, or both.

[2]The Logistics Commanders are the Commanders of the Army Materiel Command, Air Force Logistics and Air Force Systems Commands, and the Deputy Chief of Naval Operations (Logistics).

the need for minimization, stating that waste disposal costs are increasing because of new restrictions on land disposal of hazardous waste.[3]

EPA's preferred waste minimization method is source reduction, that is, any activity that reduces or eliminates the generation of a hazardous waste within a process, such as industrial production, repair, and maintenance processes. Other means of hazardous waste minimization include better management of hazardous materials and recycling, reuse, and treatment of hazardous wastes.

Objective, Scope, and Methodology

In an August 31, 1987, letter, the Chairman, Subcommittee on Environment, Energy and Natural Resources, House Committee on Government Operations, and the Chairman, Subcommittee on Legislative, House Committee on Appropriations, requested that we review DOD efforts to minimize the amount of hazardous waste it has to treat and dispose of.

Because the Chairmen's request covers a wide spectrum of issues, we divided the work into three reviews. This report details our review of DOD efforts to minimize hazardous waste generation through source reduction.

The objective of this review was to determine the status of the programs that the Air Force, the Army, and the Navy developed and implemented for reducing the generation of hazardous waste through source reduction. Specifically, we sought to identify DOD efforts to reduce hazardous waste generation through

- changes to production, repair, and maintenance processes;
- substitution of less hazardous materials for hazardous ones; and
- changes to technical documents[4] that allow substitution of less hazardous materials.

We also examined DOD's efforts to consider hazardous waste minimization when acquiring new weapon systems and other equipment and the

[3]The Congressional Budget Office estimated that industry costs for management of hazardous waste, including disposal costs, would increase from between $4.2 billion and $5.8 billion in 1983 to between $8.4 billion and $11.2 billion by 1990. The Office of Technology Assessment estimated that DOD spent approximately $1 million on waste reduction in fiscal year 1986.

[4]The term "technical documents" refers to publications that give specific technical directives and information with respect to inspection, operation, modification, and maintenance of given items and equipment. The Air Force calls these documents Technical Orders, whereas the Army and the Navy call them Technical Manuals.

data collection methods the services use to measure progress in meeting reduction goals.

Our review was made at Air Force, Army, and Navy installations geographically dispersed throughout the United States. The commands and installations we reviewed have a variety of missions, such as repair and maintenance of aircraft, tanks, and ships; research and development; and military training. Of the major commands that generate hazardous waste, we reviewed 6 of 14 Air Force commands, 3 of 9 Army commands, and 6 of 15 Navy commands. (See app. II for the complete list of the locations we contacted.) According to 1986 generation data, the 6 Air Force commands generated 99 percent of all Air Force hazardous waste, the 3 Army commands generated 99 percent of all Army hazardous waste, and the 6 Navy commands generated 90 percent of all Navy hazardous waste.

We interviewed DOD, Air Force, Army, and Navy headquarters officials in Washington, D.C., to obtain overall policy and guidance regarding hazardous waste minimization, especially source reduction. We obtained various DOD, service, and installations documents, such as policy statements, regulations, hazardous waste generation reports, and minutes from the services' and installations' environmental working group and committee meetings.

We discussed source reduction activities at the major command and installation levels, primarily with environmental, maintenance, and logistics officials. We also interviewed representatives of the services' support organizations, such as supply and internal audit. In addition, we interviewed appropriate officials at the services' research and development centers to determine proposed industrial process changes and substitutions for hazardous materials used in these processes.

As requested, we did not obtain formal agency comments on this report. However, we discussed its contents with service officials and incorporated their comments as appropriate. We conducted our review between January and October 1988 in accordance with generally accepted government auditing standards.

Hazardous Waste Minimization Efforts in the Department of Defense

Even though the services had initiated their hazardous waste minimization efforts in the mid-1980s, the Deputy Assistant Secretary of Defense (Environment), in a February 6, 1987, policy letter, formally delegated responsibility for the DOD hazardous waste minimization program to the services. The policy states that the services are responsible for ensuring that formal hazardous waste minimization plans exist for their installations and that these plans are implemented. The policy endorsed a hazardous waste minimization program outline provided by the Joint Logistics Commanders for the services to use as guidance in developing and implementing their plans.

The outline called for a minimization program to include reviewing all existing technology, assessing existing technology being used at activities, accurately reporting hazardous waste, controlling hazardous materials, developing command reduction goals and monitoring progress toward achieving them, and establishing hazardous waste minimization as an important consideration in all acquisitions. The services have delegated responsibility for developing hazardous waste minimization plans for their installations to their major commands.

Air Force Program

The Air Force has taken some initial steps to establish its minimization program. It delegated the responsibility for establishing hazardous waste minimization programs for its installations to its major commands. In a July 1986 telegram to all major commands, Air Force headquarters outlined the basic elements of a minimization program, including hazardous waste reduction techniques such as process modifications and material/chemical substitutions. Other headquarters guidance consisted of correspondence that showed the need for and funding of the Air Force program and set an Air Force-wide minimization goal of reducing the amount of hazardous waste disposed of by 50 percent by the end of 1992, compared to the amount generated in 1984. This goal can be accomplished through source reduction, better hazardous material management, recycling, reuse, and treatment of hazardous wastes.

As of August 1988, Air Force Headquarters was revising Air Force Regulation 19-11, Hazardous Material and Waste Management. The revised regulation will establish program responsibilities at the major command and installation levels and require major commands to establish minimization programs and consider hazardous materials minimization during the design of material and equipment.

Air Force Headquarters has also tasked its Environmental Protection Committee[5] with analyzing the hazardous material/waste streams[6] at Air Force installations. The analysis is made to determine (1) users of hazardous materials, (2) nonhazardous substitutes for hazardous materials in use, (3) methods to reduce hazardous waste generation, (4) waste disposal problems, and (5) governing technical documents. As part of this effort, the Committee will collect and analyze previous studies from major commands concerning industrial and maintenance process waste streams.

Air Force Logistics Command Program

The Air Force Logistics Command generates about 90 percent of the Air Force's hazardous waste. The Command oversees five industrial facilities, called Air Logistics Centers, and manages the technical documents that govern the maintenance processes used throughout the Air Force. The Command's overall goal is to reduce its hazardous waste generations by 50 percent by 1992, compared to the amount generated in 1984. To accomplish this goal, the Command established a minimization program called "Pacer Reduce" in November 1985. In July 1987 a Command regulation formalized the minimization program, requiring (1) an evaluation of current and proposed processes to determine methods for reducing hazardous waste generation and (2) a review and update of all required technical documents to support substitution of less toxic or hazardous chemicals for hazardous materials used in maintenance processes.

Through quarterly reports prepared by the five Air Logistics Centers, the Command's maintenance activities track 14 waste streams produced by 10 industrial processes. In addition to the command's goal of reducing hazardous waste by 50 percent by 1992, all the Air Logistics Centers have established reduction goals for selected waste streams and identified minimization opportunities to reach their individual waste stream goals.

The Department of Energy has developed a database for the Air Force Logistics Command to provide data and summary information on current processes at the Command's installations that produce hazardous wastes. The database will provide (1) information on the current

[5]The Environmental Protection Committees at the headquarters, major commands, and installations review environmental policy, facilitate coordination, and serve as a steering group to monitor the overall conduct of the environmental protection program.

[6]Flow of hazardous waste from point of generation to disposal or treatment.

volumes of hazardous wastes generated, their characteristics, and the processes that generate the wastes, (2) a method to analyze the effectiveness of hazardous waste minimization measures through trend analysis, and (3) a method to exchange information among the Command's facilities.

Other Air Force Commands' Programs

Four major commands—the Air Training Command, the Military Airlift Command, the Strategic Air Command, and the Tactical Air Command, which are smaller generators of hazardous waste than the Air Force Logistics Command—do not have written programs or plans. These commands have either contracted, or are in the process of contracting, with various private firms to identify waste streams and minimization opportunities at selected installations. The Air Force Systems Command has had a contractor identify its waste streams and minimization opportunities at 10 of its installations.

Army Program

The Army has taken some initial steps to establish its minimization program. Army Headquarters has delegated responsibility for management of installation hazardous waste minimization programs to its major commands. In a July 1987 letter, the Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health, Installations and Logistics, established the Army's minimization goal—a 50-percent reduction in hazardous waste generation by 1992 compared to the amount generated in 1985—and required the major commands to develop minimization programs.

At the time of our review, Army Headquarters had issued several regulations dealing generally with hazardous waste management and environmental matters, but none specifically addresses hazardous waste minimization. An Army Hazardous Waste Program Manager stated that a forthcoming change to Army Regulation 200-1, Environmental Protection and Enhancement, will include a section on hazardous waste minimization. In addition, the official stated that the Administrative Assistant to the Secretary of the Army plans to send a letter to the commands that will give further specific guidance on hazardous waste minimization programs. The Program Manager stated that the regulation changes and the revised guidance are expected to become effective by early 1989.

In another July 1987 letter, the Deputy Assistant Secretary established a Department of the Army Hazardous Waste Minimization Workgroup,

chaired jointly by the Deputy Assistant Secretary and the Office of the Assistant Chief of Engineers, which includes representatives of the Secretariat and the Army Staff. The letter states that the workgroup's purpose is to develop policy and guidance to reduce hazardous waste generation in the Army. In addition, the workgroup is to (1) develop a 5-year strategy to ensure progress toward meeting the Army's minimization goals, and (2) provide a summary report identifying problems and making recommendations for implementing waste minimization policies.

Army Materiel Command Program

Although the Army's formal goals and program requirements were not established until July 1987, the Army Materiel Command, which generates about 86 percent of the Army's hazardous waste, has had a hazardous waste program since as early as February 1983, according to a 1986 paper presented by personnel from the Command's Environmental Quality Division. At that time the Command formally listed as its number one hazardous waste management priority a reduction in the quantities of hazardous waste through the use of alternative materials and in-process recycling and reuse of hazardous materials.

In addition, at the direction of its Commander, the Command issued a formal hazardous waste minimization plan on March 6, 1986, which provided guidance on how to establish a minimization program at the installation level. The plan established a goal of reducing the volume of hazardous waste generation at its installations by 50 percent between 1985 and 1992 and eliminating all untreated hazardous waste by 1992. The plan also requires the Command's subordinate activities to develop minimization plans, gives specific guidance on what these plans should contain, and requires annual updating of plans and semiannual hazardous waste generation reports. Finally, the plan also discusses the makeup and duties of its Hazardous Waste Minimization Board and three working groups, the Incentives Working Group, the Technology Transfer Working Group, and the Productivity Projects Working Group.

Other Army Commands' Programs

The other two major Army commands contacted—the Training and Doctrine Command and the Forces Command—generate about 4 percent of the Army's hazardous waste. The Training and Doctrine Command has a written hazardous waste minimization plan, but the Forces Command does not yet have a hazardous waste minimization plan. According to a Forces Command environmental official, the Command received funding for the Construction and Engineering Research Laboratory, an Army

support agency, which will develop minimization plans for five installations in 1989, and to prepare an overall command hazardous waste minimization plan in 1989.

Navy Program

The Navy has taken some initial steps to establish its minimization program. In an October 1985 telegram to all commands and subordinate commands, the Navy outlined the basic elements of a reduction program, including hazardous waste reduction techniques such as process changes and material substitutions. In a March 1986 letter, the Chief of Naval Operations (CNO) for Logistics expanded on the program's concepts regarding process changes, material substitutions, and in-house recycling. Both documents were distributed to the major commands for developing and implementing hazardous waste minimization programs. However, the documents did not assign roles and responsibilities or establish time frames for implementing the program.

A November 1986 draft Naval Operations Notice, detailing the Navy's proposed program, was sent to the commands for review and comment, and on May 18, 1988, the Navy issued its formal hazardous waste program, which established roles and responsibilities for the major commands and activities. The program sets a Navy-wide goal of reducing the weight of hazardous waste generated by 50 percent by the end of 1992, compared to weight generated in 1987.

The Navy program also directed each major command to (1) implement the entire program at their shore activities, (2) monitor minimization goals, (3) substitute less hazardous materials for presently used hazardous materials, insofar as possible, and (4) evaluate new processes, process changes, facilities, and weapon systems to determine ways for minimizing the use of hazardous materials as much as possible.

Of the six major Navy commands we visited, only two—the Naval Air Systems Command and the Naval Sea Systems Command—were actively involved with minimization efforts at their shore activities. Both of these commands operate industrial installations that generate large amounts of hazardous waste.

Naval Air Systems Command

According to a Naval Air Systems Command Environmental Specialist, the Command was taking action to comply with mandated corrective actions on environmental issues at all five Naval Aviation Depots as of July 1988. For example, EPA had issued a cease and desist order to the

Naval Aviation Depot at Pensacola, Florida, because the hazardous paint stripper waste was contaminating the Depot's sewage treatment plant. The Depot installed an interim treatment system and is developing a final solution to this problem that involves the use of a nontoxic, but less efficient paint stripper solvent at a modest cost increase. In addition, the Air Systems Command has established an environmental management team consisting of (1) three environmental councils covering the Command's Range and Technical Field Activities, Naval Aviation Depots, and government-owned, contractor-operated industrial plants, (2) CNO environmental staff, and (3) the Naval Facilities Engineering Command and its support agencies. The councils provide forums for environmental managers to develop solutions to common environmental problems and share information on environmental technology.

Naval Sea Systems Command

In January 1987 the Commander, Naval Sea Systems Command, required that the eight Navy shipyards establish hazardous waste minimization programs by April 14, 1987. In response to the January 1987 directive, the shipyards have submitted program documents and collectively identified their top eight waste streams. In addition, the Command has conducted workshops and assigned minimization studies to each shipyard.

The Command monitors the eight shipyards through quarterly project reports and site reviews. In 1988 the shipyards began submitting semiannual reports of hazardous waste generation by waste stream to the Command. The Command has issued specific guidance for the above three monitoring methods. At the time of our review, site reviews at all eight shipyards were planned, quarterly project reports were being submitted, and a revised reporting format based on waste streams had been issued. In addition, the Command was providing feedback to the shipyards through conferences, newsletters, and an informal communication network between Command and its activity staff.

Level of Effort in Waste Minimization Varies Among Services

The outline for a hazardous waste minimization program, developed by the Joint Logistics Commanders, included source reduction methods such as process changes, material substitutions, and consideration of hazardous waste minimization as an important part in all acquisition programs. The Air Force Logistics Command, the Army Materiel Command, and the Naval Sea Systems Command—all among the largest generators of hazardous waste—have made progress in source reduction.

However, the services have not yet formally integrated hazardous waste minimization considerations into acquisition processes.

Source Reduction Efforts

We identified process changes and material substitutions, which are listed in appendixes III and V, that have been implemented at installations we visited. We may not have identified all process changes and material substitutions at the installations because some were not reporting process changes and material substitutions and because others had reports that were not complete and accurate.

Air Force

An Air Force Logistics Command regulation requires that current and proposed production, repair, and maintenance processes be evaluated to reduce the volume, quantity, and toxicity of hazardous waste generated to the degree economically practicable. Both Air Logistics Centers we visited had evaluated their processes, identified achievement methods to reduce hazardous waste generation in each process, and implemented process changes. Installations under the Air Training Command and the Tactical Air Command have changed production, repair, and maintenance processes to reduce their generation of hazardous waste. For example, Bergstrom Air Force Base has banned the use of hazardous solvents in its maintenance processes. Installations under the Military Airlift Command and the Strategic Air Command, which have not implemented process changes, have not received minimization guidance from their commands, according to base environmental coordinators.

Army

Army Regulation 200-1 establishes the Army's policy regarding hazardous materials management. The regulation states that the Commanding General, Army Materiel Command, will conduct research and technical investigations to identify alternative, less polluting industrial processes for use at Army Materiel Command industrial facilities. This regulation does not contain a similar requirement for the Forces Command or the Training and Doctrine Command.

At Army Materiel Command facilities, we identified some technical investigations that were intended to minimize hazardous waste that were either underway or completed. For example, in October 1987 a consultant at the Anniston Army Depot issued a report that evaluated minimization options at the Depot for cadmium- and cyanide-contaminated wastewater treatment sludge and chromium-contaminated wastewater, which were generated by electroplating operations, and solvent waste,

which were generated from paint stripping operations. In February 1986 a consultant issued a preliminary report on hazardous waste minimization alternatives in the electroplating shop at the Corpus Christi Army Depot.

We identified some process changes at both the Anniston and the Corpus Christi Army Depots, which are shown in appendix III. We were unable to identify any process changes that had been implemented at the Army Materiel Command's Redstone Arsenal or at the two Forces Command installations (Fort Campbell and Fort Stewart), which we visited.

Navy

According to the Program Manager of the Naval Civil Engineering Laboratory, Energy and Environment Department, the Naval Facilities Engineering Command requested in December 1985 that the Naval Civil Engineering Laboratory assess the Navy's hazardous waste management practices. The assessment included a comprehensive survey of the Navy's industrial processes that generate hazardous waste. In January 1988 the Laboratory issued the Hazardous Waste Minimization Initiation Decision Report, which included a comprehensive survey of hazardous waste generated during 1984 by 24 activities that generate 95 percent of the Navy's hazardous waste. Of the 33 processes identified as generating hazardous waste, the report examined the technology required to promote source reduction for the top 17 processes.

Additionally, based on preliminary information from the report, the Naval Energy and Environmental Support Activity developed draft hazardous waste reduction goals for the top 19 processes. In March 1986 the CNO disseminated the draft goals to the major commands for review. As of July 1988, the Navy was in the process of revising these goals based on suggested changes from the commands' review, and it expects to implement these goals by early 1989.

Of the installations we visited under the six major commands, only the two Naval Air System Command activities visited had made process changes. The Naval Aviation Depots at Norfolk, Virginia, and Alameda, California, have implemented plastic media blasting.[7] In addition, the Norfolk Aviation Depot had installed an ion vapor deposition system and hard chrome plating. The activities of the remaining four commands we visited were unable to identify any process changes implemented.

[7]A method of stripping paint and other materials from equipment and parts.

Technical Document Review for Material Substitutions

Technical documents, which include military specifications, provide the necessary information and instructions to operate, install, maintain, inspect, or modify system and equipment items, including materials used in repair, maintenance, and production processes. If a less hazardous material is approved as a substitute for a hazardous material, the substitute must meet the requirements of the military specifications.

The Air Force is the only service that has specifically required a review of technical documents to identify opportunities for substituting less hazardous materials for hazardous materials in industrial processes. However, the Air Logistics Centers do not make this review because they lack personnel, resources, and command direction. Although the Army and the Navy have made hazardous material substitutions, neither service requires a review of the technical documents to determine opportunities for material substitutions.

Air Force

The Air Force Logistics Command, which is responsible for managing technical documents that are used to install, maintain, inspect, or modify system and equipment items, has required its five Air Logistics Centers to initiate a review of technical documents for the systems they manage.

At the time of our visits, officials of the San Antonio and Ogden Air Logistics Centers' Directorates of Materiel Management told us that they did not have enough personnel to review technical documents. Furthermore, they had not received any guidance from the Air Force Logistics Command regarding how to review the technical documents they manage. After our visit, the San Antonio Air Logistics Center's Directorate of Materiel Management provided us with their plan to conduct a "cursory" review of the 200 to 300 technical documents that contain the majority of hazardous materials used in the systems and equipment it manages. The plan was approved by the Air Force Logistics Command.

Army

Army Regulation 200-1 requires the use of nonhazardous or nontoxic material substitutes to the extent practicable. We were unable to identify a specific requirement that technical documents be reviewed for opportunities to substitute less hazardous material.

The Army Deputy Chief of Staff for Logistics has responsibility for the overall supervision of logistics and equipment publications, including

technical manuals. However, the responsibility for preparing and revising the technical documents is decentralized among the various major and subordinate commands with primary interest in the weapon or equipment. For example, the Tank Automotive Command, a subordinate command of the Army Materiel Command, is responsible for ground mobility equipment, including the Bradley fighting vehicle. The Tank Automotive Command would be responsible for any revisions to the technical documents regarding substituting less hazardous materials for hazardous material.

At the time of our visit, environmental and maintenance personnel at the Army Materiel Command and three subordinate commands stated that there is no systematic review of technical documents to determine if less hazardous materials could be substituted for hazardous materials.

Navy

The regulation governing the Navy's Hazardous Waste Minimization Program dated May 18, 1988, assigns responsibility to its major commands for substituting less hazardous materials for presently used hazardous materials, insofar as possible. However, there is no requirement for the various commands to review technical documents to support the substitution of less hazardous materials for hazardous materials.

The CNO plans and implements technical manual management policies within the Navy. However, the technical manual management is assigned to the various commands. Each system's command manages the technical manuals differently. The environmental, maintenance, and technical management personnel that we contacted at the Naval Air Systems Command, Naval Sea Systems Command, and the Naval Facilities Engineering Command stated that they had no requirement to review the technical manuals.

Minimizing Hazardous Materials During the Acquisition Process

The acquisition process, including development, for weapon systems and equipment is the first stage in which decisions are made that could result in the procurement and use of hazardous materials. Development of new weapon systems and equipment could be planned to include development of new production, repair, and maintenance processes that minimize the use of hazardous materials to reduce the generation of hazardous wastes. Even though the services have existing organizations that could consider these issues during system design, they have not integrated hazardous material considerations into their formal acquisition processes.

Air Force

A 1978 Air Force regulation requires the consideration of environmental concerns in the acquisition process. However, according to the Chief, Bio-environmental Engineer, Air Force Systems Command, the Command had given little consideration to environmental concerns because the Command did not emphasize this requirement until an Air Force Scientific Advisory Board Ad Hoc Committee report was issued in 1986. This report, Selection and Use of Hazardous and Toxic Materials in the Weapons System Development and Acquisition Process, recommended (1) that the Office of the Secretary of the Air Force and the Office of the Chief of Staff amend the objectives and mission statements associated with the weapons systems acquisition process to include a specific element focusing on minimizing and managing the environmental and health factors on all materials, chemicals, and processes, (2) establishing an educational, training, and expert support base to address environmental safety and health requirements, and (3) implementing a coordinated program to minimize, contain, and manage hazardous and toxic materials.

In June 1987 the Air Force Systems Command was tasked to implement the report's recommendations. In August 1987 the Command outlined a plan to address these recommendations. At the time of our visit, the Command had

- identified regulations that would address health and environmental issues,
- identified instruction modules on health and environment issues to be incorporated into existing procurement and acquisition courses, and
- considered assigning bio-technical experts to the production divisions.

In addition, the Air Force is improving its Logistics Support Analysis[8] program to include hazardous material information. The Air Force Logistics Command's Acquisition Logistics Center, Wright-Patterson Air Force Base, Ohio, has developed a draft Hazardous Materials Summary as part of its Logistics Support Analysis process. According to a Logistics Management Specialist at Wright-Patterson, this summary provides a consolidated list of all hazardous materials associated with maintaining equipment design, as well as information on hazardous material quantity, storage costs, and disposal costs. The specialist told us that on June 29, 1988, the Air Force recommended to the Logistics Support

[8]The Logistics Support Analysis, along with the system or equipment design effort, evaluates the effect of alternative hardware designs on support requirements, costs, and operational readiness and assesses logistics risks.

Analysis Working Group, Office of the Secretary of Defense (OSD), that the services incorporate the Hazardous Materials Summary into the Logistics Support Analysis process. The specialist also said that incorporating this summary into the Logistics Support Analysis is the most effective method to identify system requirements for hazardous materials.

Army

Army Regulation 200-1, Environmental Protection and Enhancement, dated June 15, 1982, outlines the Army's policy pertaining to hazardous materials in the initial acquisition process. The regulation is general in nature and does not specifically address hazardous waste minimization. According to the Deputy Assistant Secretary of the Army for Environment, Safety, and Occupational Health, Installations and Logistics, the Army has no formal procedures that focus on environmental and health factors as part of its initial acquisition process.

Navy

In November 1986 the Navy issued a draft directive requiring that hazardous waste minimization issues be considered in the acquisition process for all weapon and support systems. The directive was finalized in May 1988 and expanded to require evaluations of new processes, process changes, facilities, weapon systems, and materials, to ensure that hazardous material usage is kept to the absolute minimum necessary for mission needs.

Efforts to Develop New Waste Minimization Technology

The services have ongoing efforts to develop new technologies to reduce hazardous waste generation. The various support agencies in each service are in the process of researching and developing these technologies. A brief description of some of these efforts follows.

Air Force

The Air Force Engineering and Services Center, the Air Force Logistics Command, and the Environmental Management groups for all the Air Logistics Centers have formed the "Pacer Impact" group to investigate new technology to reduce the use of hazardous materials and the generation of hazardous waste at the Air Logistics Centers. The Air Force Engineering and Services Center is currently conducting seven studies regarding minimization of hazardous materials/waste. The studies involve

- ion vapor deposition of aluminum,

- biodegradable solvents and cleaners,
- noncyanide strippers,
- solvent capacity,
- plastic bead blasting residue treatment,
- chromium reduction process optimization, and
- sodium sulfide/ferrous sulfate process.

The first four studies are specifically aimed at source reduction, and the remaining three are aimed at hazardous waste treatment after it has been generated. Appendix VI describes the four source reduction projects and their milestones.

Army

The Army Toxic and Hazardous Materials Agency maintains a research and development program to support the Army's waste minimization efforts. This program includes identifying technologies, processes, and techniques that can reduce hazardous waste generation, such as alternative chemical paint strippers and plastic media blasting. A list of studies in this program and their milestones is found in appendix VI.

Navy

The Navy's Hazardous Waste Minimization Initiation Decision Report, discussed on page 18, lists 26 proposed projects for hazardous waste minimization funding. The following six proposed projects are to develop new source reduction techniques, for which the laboratory has overall responsibility:

- developing purification and reuse technology for pickling bath/electroplating bath,
- reducing blasting grit hazards and types,
- exploring the use of frozen carbon dioxide to strip paint from ship hulls and bilges,
- operational testing of cyanide oxidation system,
- developing non-cyanide electroplating process, and
- removing aircraft paint through innovative systems.

These projects are discussed further in appendix VI.

Elements of a Hazardous Waste Minimization Strategy or Plan

In our report, Hazardous Waste: New Approach Needed to Manage the Resource Conservation and Recovery Act (GAO/RCED-88-115, July 19, 1988), we stated that a long-term strategy for minimizing hazardous waste should include the following elements:

- specific measurable goals and appropriate milestones for achieving the goals,
- specific tasks to be accomplished to meet the goals,
- required resources,
- organizational responsibilities, and
- a system for measuring and reporting performance in accomplishing tasks and goals.

As discussed in other sections of this report, we found that the DOD, through the services, has

- established measurable goals and set a time frame for accomplishing these goals (see pp. 11, 13, and 15),
- initiated programs and plans outlining efforts, including identifying some of the resources needed, on how to go about accomplishing these goals (see pp. 11 through 16), and
- made some organizational changes and studied other changes (see pp. 11 through 16).

However, as explained in chapter 3, DOD has encountered problems in its data collection and reporting concerning the amount and type of hazardous waste being generated, who is generating it, and the results of minimization efforts.

Conclusion

Even though it has taken DOD some time to fully recognize the need for a strong hazardous waste minimization program, DOD and the services have developed strategies or plans and have initiated efforts that should continue to identify opportunities to reduce the generation of hazardous waste. Continued emphasis and support of the program by the OSD and the Offices of the Secretaries of the Air Force, the Army, and the Navy are essential for the program to fully accomplish maximum minimization of hazardous waste.

Reduction Goals Cannot Be Accurately Measured

The services use hazardous waste generation data compiled by their installations for the Defense Environmental Status Report to monitor their hazardous waste generation and report to OSD on waste generation. However, inconsistencies and inaccuracies in the data and the data collection methods make reported generation data unreliable. Furthermore, the reported generation data are not correlated with fluctuations in industrial process volume. Consequently, progress toward meeting the goal of reducing hazardous waste generation by 50 percent in each of the services by the end of 1992 cannot be reliably measured based on the data currently available.

Reported Quantities of Hazardous Wastes Generated Are Unreliable

OSD uses the Defense Environmental Status Report, which provides a summary of data regarding environmental concerns, to monitor, and report to the Congress on, the overall progress of the DOD's hazardous waste minimization program. Hazardous waste generation data are provided in the "Hazardous Waste Activity Summary" section of the report. However, the data reported are often unreliable partly due to inadequate guidance for preparing the summary. Furthermore, the reporting form does not require or provide space for narrative comments explaining how changes in production volume have affected quantities generated.

Data Reliability Problems in the Air Force

The volume of hazardous waste generated is usually recorded on the accompanying manifests[9] or turn-in documents[10] in gallons or pounds. However, the Defense Environmental Status Report requires that wastes generated be reported in kilograms; as a result, Air Force personnel must convert measurements shown on manifests or turn-in documents from gallons or pounds to kilograms.

The Air Force installations we visited were using different ratios to convert their generation data from pounds or gallons to kilograms because they had not been provided with a standard ratio for such conversions. Table 3.1 shows the conversion ratios used at three Air Force installations we visited.

[9]This is a required shipping document, originated and signed by the generator, that contains specific required information. The format is specified by regulation. It must accompany every shipment of hazardous waste. A signed copy must be returned to the generator by the facility receiving the waste.

[10]The Defense Reutilization and Marketing Office accepts accountability for hazardous materials and hazardous waste when a turn-in document has been accepted for such property.

Table 3.1: Hazardous Waste Measurement Conversion Ratios Used at Three Air Force Installations

Installation	Conversion ratios[a]	
	Pounds to gallon	Pounds to kilogram
Langley Air Force Base	8.80	2.20
Randolph Air Force Base	8.34	2.24
Scott Air Force Base	7.80	2.20

[a]The ratios were provided to us by environmental personnel at each installation.

Unless all installations use the same conversion ratio, the Air Force cannot be assured that the generation data furnished by its installations are consistent.

We also found that personnel at Air Force installations we visited made assumptions regarding the weight and composition of the hazardous waste generated, which affects the reliability of the data compiled for the status report. For example, when environmental personnel at the Ogden Air Logistics Center, Utah, estimated the hazardous waste generated in 1985 and 1986, they assumed that all 55-gallon drums of hazardous waste turned in to the Defense Reutilization and Marketing Office (DRMO) contained 47 gallons when they could have contained 55 gallons or 5 gallons. In another example, the Environmental Engineer at Randolph Air Force Base, Texas, assumed that the 55-gallon drums contain only liquids, although the engineer said that the drums might contain liquids, solids, or a combination of the two, thus varying greatly in weight.

Data Reliability Problems in the Army

Army personnel also make assumptions regarding the quantity of waste contained in 55-gallon drums. For example, at Anniston Army Depot, Alabama, when waste was contained in 55-gallon drums, officials always reported 55 gallons of waste, even though they believed some drums probably contained only 10 or 15 gallons.

Also, an October 1987 Army Audit Agency report stated that four Army installations used varying procedures for determining what qualified as a hazardous waste. As a result, the quantities of hazardous waste reported were neither accurate nor consistent. According to the report, the differences were caused primarily by the manner in which the term hazardous waste is defined by the installations and by the guidance for preparing the Defense Environmental Status Report. Examples of these differences are described on the following page.

- At Fort Benning, Georgia, personnel reported all excess or used hazardous material turned into the DRMO as hazardous waste. The installation's environmental office approves turn-in documents before the hazardous material is turned into the DRMO. Copies of the turn-in documents were used as the basis for reporting hazardous waste generated by the installation. However, according to the audit report, the amounts reported may be overstated because some of the materials may have been reutilized, transferred, donated, or sold, rather than disposed of as hazardous waste.
- At Fort Campbell, Kentucky, and Fort Hood, Texas, excess or used hazardous material is turned in directly to DRMO. The environmental office personnel at these installations obtain copies of waste manifests from their respective DRMO and use the manifests as the basis for reporting hazardous waste generated. The audit report states that such procedures overstate the quantities of hazardous waste generated at an installation because the manifests includes waste generated by other activities serviced by the applicable DRMO.
- At the Sunflower Army Ammunition Plant, Kansas, a government-owned, contractor-operated facility, personnel did not consider any excess or used hazardous materials turned in to the DRMO as waste. If the DRMO could not reutilize, transfer, donate, or sell the material and subsequently classified them as wastes, installation personnel considered such waste to be generated by the DRMO and, therefore, did not report the waste. The audit report states that such procedures understate the hazardous waste quantities reported because none of the materials turned in to the DRMO and later classified as waste would be reported.

In a November 1987 report, the Army Audit Agency found discrepancies between inventory documents and actual drum weight at the Sunflower Army Ammunition Plant. The report noted that inventory records showed six 55-gallon drums with an estimated weight of 363 pounds each. At the request of the auditors, the drums were weighed. The actual weights ranged from 191 to 425 pounds. Furthermore, the auditors found that some inventory documents showed "unknown" in the space provided to show type of waste.

Data Reliability Problems in the Navy

Summary data from the Navy Hazardous Waste Annual Report are incorporated into the Defense Environmental Status Report. Each installation that generates, stores, treats, and/or disposes of waste and is subject to local, state, or federal hazardous waste regulations must prepare an annual report.

According to the Naval Energy and Environmental Support Activity's Hazardous Waste Annual Status Report for 1986, hazardous waste generation data submitted by Navy installations are unreliable. In addition, some of the data cannot be traced back to the actual generators of the hazardous waste. According to the report, data reliability problems include variations in the number of generators that report data, improper categorization of hazardous wastes, and submissions that are a combination of generation data from more than one installation. On June 30, 1987, the Naval Energy and Environmental Support Activity reported these areas of concern to the Naval Facilities Engineering Command and made recommendations for improvement. At the time of our review, none of the recommendations had been implemented.

Correlating Waste Stream Volume With Production Variations Will More Accurately Measure Minimization Efforts

Although hazardous waste generation increases or decreases can be caused by production work load increases or decreases, new or expanded production processes, and/or changes in federal or state environmental laws that define hazardous waste, the Defense Environmental Status Report does not require that generation data be correlated with production. Consequently, the services may not be able to distinguish between reductions achieved through their hazardous waste minimization efforts and reductions due to changes in the amount of work done. Changes in production levels can vastly change hazardous waste generation from one year to the next. For example, the amount of hazardous waste a shipyard may generate to clean 10 ships in 1 year will be much greater than if it only cleans 1 ship. If there are no source reduction efforts in place the amount of hazardous materials used to clean each ship will be the same each year.

The lack of correlation between hazardous waste generation data and production levels can hinder the services' ability to distinguish between changes in production levels and the effects of minimization efforts. For example, Morton Thiokol operates a government-owned production facility at the Army's Redstone Arsenal, Alabama, and generates 98 percent of the arsenal's hazardous waste. According to Redstone's Hazardous Waste Minimization Plan, the arsenal's hazardous waste generation increased from 180,243 kilograms in 1985 to 487,820 kilograms in 1987. Waste generation increased, partly because Morton Thiokol's production of weapons materials increased 83 percent since 1985.

Major commands within each service have made efforts to distinguish between hazardous waste reduction achieved through minimization efforts and reductions occurring for other reasons, such as production

variations. The Air Force Logistics Command and the Army Materiel Command require that their installations provide a narrative explanation describing the reasons for volume fluctuations. According to an Industrial Engineer at the Naval Sea Systems Command, the Command attempted to correlate production variations with hazardous waste generation by dividing the generation quantities by direct labor staff hours. However, the official stated that shipyards neither hired nor terminated personnel due to increased or decreased production work loads; therefore, this approach was discontinued.

We discussed the results of our review regarding the reliability of hazardous waste generation data with an official from the Office of Assistant Secretary of the Army and officials from Air Force Headquarters and Navy Headquarters. The officials acknowledged that hazardous waste generation data reported by their installations have been unreliable.

Conclusion

The services are attempting to reduce their hazardous waste generation levels by 50 percent by 1992, but they will have difficulty monitoring their progress in meeting their goals because their generation data are unreliable. Methods for measuring and/or reporting waste generation vary among and within the services, and some installations are estimating amounts and/or types of waste generated. Furthermore, reports of hazardous wastes generated do not contain information regarding production increases or decreases or other factors that affect quantities generated, thus preventing a meaningful assessment of minimization efforts.

Recommendation

To provide the services with accurate, consistent, and comparable hazardous waste generation data for monitoring minimization efforts and progress toward meeting waste reduction goals, we recommend that the Secretary of Defense establish a standard methodology for collecting and reporting hazardous waste generation data within DOD, which should include data on significant changes in production.

Services' Hazardous Waste Generation Data

Command	1985 Tons generated	1985 Percent	1986 Tons generated	1986 Percent	1987 Tons generated	1987 Percent
Air Force						
Commands visited						
Air Force Systems Command	197.35	0.33	446.43	0.46	1,149.60	0.001
Air Training Command	605.00	1.00	660.47	0.69	869.60	0.001
Military Airlift Command	3,426.37	5.66	3,086.36	3.22	3,480.80	0.003
Strategic Air Command	1,789.94	2.96	2,374.09	2.47	2,759.00	0.002
Tactical Air Command	1,779.16	2.94	577.14	0.60	3,101.50	0.002
Air Force Logistics Command	51,875.54	85.77	87,882.98	91.56	1,134,071.60	99.990
Subtotal	**59,673.36**	**98.66**	**95,027.47**	**99.00**	**1,145,432.10**	**99.999**
Other commands	812.16	1.34	958.83	1.00	1,208.70	0.001
Total	**60,485.52**	**100.00**	**95,986.30**	**100.00**	**1,146,640.80[a]**	**100.000**
Army						
Commands visited						
Forces Command	812.03	0.76	2,764.06	1.99	7,478.38	11.34
Training Command	2,882.59	2.68	2,340.90	1.69	1,287.97	1.95
Army Materiel Command	103,770.54	96.51	133,502.20	96.18	56,645.10	85.89
Subtotal	**107,465.16**	**99.95**	**138,607.16**	**99.86**	**65,411.45**	**99.18**
Other commands	59.05	0.05	190.34	0.14	542.26	0.82
Total	**107,524.21**	**100.00**	**138,797.50**	**100.00**	**65,953.71**	**100.00**
Navy						
Commands visited						
Space and Warfare Systems Command	[b]	0.00	72.95	0.04	44.75	0.03
Naval Supply Command	332.80	0.12	2,307.18	1.26	1,068.16	0.61
Pacific Fleet	8,182.69	3.01	12,439.31	6.78	105,674.89	60.31
Naval Air Systems Command	37,382.68	13.78	30,165.33	16.46	6,013.75	3.43
Naval Sea Systems Command	50,834.64	18.73	56,404.00	30.78	51,627.20	29.46
Naval Facilities Engineering Command	90,553.95	33.37	63,135.00	34.45	640.34	0.36
Subtotal	**187,286.76**	**69.01**	**164,523.77**	**89.77**	**165,069.09**	**94.20**
Other commands	84,088.07	30.99	18,742.84	10.23	10,155.53	5.80
Total	**271,374.83**	**100.00**	**183,266.61**	**100.00**	**175,224.62**	**100.00**

Note: Our discussion of inconsistencies and inaccuracies in the reported generation data (see ch. 3) should be considered when reviewing these data.

[a]Data furnished by the Air Force for 1987 reflects gross generations, which includes reclaimed recycled, and reused chemicals and wastewater that is subsequently treated and removed prior to disposal.

[b]The Space and Warfare Systems Command was not established until 1986.

Organizations Contacted

Department of Defense

Office of the Secretary of Defense, Directorate of Environmental Policy, Alexandria, Virginia

Air Force

Headquarters, U.S. Air Force, Bolling Air Force Base, Washington, D.C.
Headquarters, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio
Ogden Air Logistics Center, Hill Air Force Base, Utah
San Antonio Air Logistics Center, Kelly Air Force Base, Texas
Headquarters, Air Force Systems Command, Andrews Air Force Base, Washington, D.C.
Headquarters, Air Training Command, Randolph Air Force Base, Texas
12th Flying Training Wing, Randolph Air Force Base, Texas
Headquarters, Military Airlift Command, Scott Air Force Base, Illinois
375th Aeromedical Airlift Wing, Scott Air Force Base, Illinois
Headquarters, Strategic Air Command, Offutt Air Force Base, Nebraska
55th Strategic Reconnaissance Wing, Offutt Air Force Base, Nebraska
Headquarters, Tactical Air Command, Langley Air Force Base, Virginia
1st Tactical Fighter Wing, Langley Air Force Base, Virginia
67th Tactical Reconnaissance Wing, Bergstrom Air Force Base, Texas
Air Force Engineering and Services Center, Tyndall Air Force Base, Florida

Army

Headquarters, Department of the Army, Washington, D.C.
Headquarters, Army Materiel Command, Alexandria, Virginia
Headquarters, Army Depot System Command, Chambersburg, Pennsylvania
Headquarters, Army Missile Command, Redstone Arsenal, Alabama
Anniston Army Depot, Anniston, Alabama
Corpus Christi Army Depot, Corpus Christi, Texas
Red River Army Depot, Texarkana, Texas
Headquarters, Army Forces Command, Fort McPherson, Georgia (telephone contact)
101st Airborne Division (Air Assault), Fort Campbell, Kentucky
24th Infantry Division, Fort Stewart, Georgia
Headquarters, Army Training and Doctrine Command, Fort Monroe, Virginia (telephone contact)
Army Environmental Hygiene Agency, Aberdeen Proving Grounds, Maryland

Army Toxic and Hazardous Materials Agency, Aberdeen Proving Grounds, Maryland

Navy

Office of the Chief of Naval Operations, Washington, D.C.
Headquarters, Naval Air Systems Command, Washington, D.C.
Naval Aviation Depot, Alameda, California
Naval Aviation Depot, Norfolk, Virginia
Naval Aviation Depot, North Island, San Diego, California
Headquarters, Naval Facilities Engineering Command, Alexandria, Virginia
Navy Public Works Center, San Francisco Bay, Oakland, California
Navy Public Works Center, San Diego, California
Naval Environmental and Engineering Support Activity, Port Hueneme, California
Atlantic Division Naval Facilities Engineering Command, Norfolk, Virginia
Western Division Naval Facilities Engineering Command, San Bruno, California
Naval Civil Engineering Laboratory, Port Hueneme, California
Naval Safety Center, Norfolk, Virginia
Headquarters, Naval Sea Systems Command, Washington, D.C.
Long Beach Naval Shipyard, Long Beach, California
Pearl Harbor Naval Shipyard, Pearl Harbor, Hawaii
Headquarters, Naval Supply Systems Command, Washington, D.C.
Naval Supply Center, San Diego, California
Headquarters, Space and Naval Warfare Systems Command, Washington, D.C.
Naval Ocean Systems Center, San Diego, California
Headquarters, Pacific Fleet, Pearl Harbor, Hawaii
Naval Air Station, Alameda, California
Naval Air Station, San Diego, California
David Taylor Naval Ship Research and Development Center, Annapolis, Maryland

Source Reduction Process Changes Implemented[1] by the Services

Air Force

Air Force Logistics Command	Ogden Air Logistics Center, Hill Air Force Base	
	• ion vapor deposition • plastic media blasting • eliminate Methyl-Ethyl-Ketone	
	San Antonio Air Logistics Center, Kelly Air Force Base	
	• strip nickel-cadmium parts before blasting • plastic media blasting[2] • reduce amount of calibrating fluid used by modifying test stand for gas turbine engines	
Air Training Command	Randolph Air Force Base	
	• none	
Military Airlift Command	Scott Air Force Base	
	• none	
Strategic Air Command	Offutt Air Force Base	
	• none	
Tactical Air Command	Bergstrom Air Force Base	
	• banned Methyl-Ethyl-Ketone • PD-680 type I • trichloroethylene	
	Langley Air Force Base	
	• none	

[1]A process is considered implemented when at least one unit has been installed and is operational.

[2]For small aircraft parts only.

Army

Army Materiel Command

Anniston Army Depot

- paint separating centrifuge[3]
- in-line still to recover trichloroethylene
- in-line reclamation of cadmium
- holding tanks for chemicals while cleaning sludge from vats[4]

Corpus Christi Army Depot

- in-line recovery and reuse of cadmium
- disposable paint can liners[5]
- replace solvent less frequently
- in-line filter systems for plating shops[6]

Navy

Naval Air Systems Command

Naval Aviation Depot, Norfolk

- plastic media blasting
- hard chrome plating
- ion vapor deposition

Naval Aviation Depot, Alameda

- airless paint sprayer
- plastic media blasting
- in-line solvent recycling

[3]An instrument that reduces the amount of hazardous waste generated.

[4]This process reduces amount of chemicals disposed.

[5]These reduce the amount of thinner used for cleaning.

[6]These extend the life of chemicals.

Minimization Techniques Defined

Cadmium Recovery System	An on-line recovery system that is a distillation process, allowing the rinsewater to be reused and the cadmium to be returned to the plating tank.
Chromium Recovery System	An on-line recovery system that treats the rinsewater by ion exchange, returning the chromium to the plating tank and the cleaned water to the rinse tank.
Ion Vapor Deposition	A process that deposits an aluminum corrosion protective coating onto engine parts that were previously plated with cadmium.
Plasma Spray Coating	An automated process that reduces the amount of chromium waste generated by applying plasma coatings to engine components that were previously plated with chromium.
Plastic Media Blasting (also Plastic Bead Blasting)	A prototype paint removal process that uses tiny plastic media to remove paint from aircraft and component surfaces instead of chemical strippers.
Water Jet Foam Removal	A new high-pressure water jet method to remove foam from aircraft wing panels. Foam was previously removed using approximately 55 gallons of Methyl-Ethyl-Ketone per aircraft.

Substitutions Implemented

Command	Original material	Substitute material
Air Force		
Air Force Logistics Command		
Ogden Air Logistics Center	Toxic primers	Water-based primers
San Antonio Air Logistics Center	Cyanide strippers	Noncyanide strippers
	High volatile organic compound epoxy primer	Low volatile organic compound water-borne primer
	Nickel/cadmium plating	Sermetal plating
	Perchloroethylene	Nonhazardous PD-680
	Perchloroethylene	1,1,1 Trichloroethane
	Perchloroethylene	Biodegradable solvent
	Coolant containing phenol	Nonhazardous coolant
Air Training Command		
Randolph Air Force Base	Trichloroethylene	PD-680
	Phenolic-based paint	Non-phenolic-based paint
Military Airlift Command		
Scott Air Force Base	None	
Strategic Air Command		
Offutt Air Force Base	None	
Tactical Air Command		
Bergstrom Air Force Base	PD-680 Type I	Safe T Solvent
	Trichloroethylene	Solvent 140; PD-680 Type II
Langley Air Force Base	None	
Army		
Army Materiel Command		
Corpus Christi Army Depot	Phenolic paint stripper	Less hazardous stripper
	Paint containing lead and/or chromate	Lead and chromate-free paint
Anniston Army Depot	Petroleum-based solvent	Nonhazardous steam cleaning compound
	Paint containing lead and chromate	Lead and chromate free paint
	Primer containing lead and chromate	Lead and chromate free primer
Redstone Arsenal	Trichloroethylene	PD-680
	Methylene chloride	1,1,1 Trichloroethane
Forces Command		
Fort Stewart	PD-680 Type I	PD-680 Type II
	Product Sol 913	Citrikleen
Navy		
Naval Air Systems Command		
Naval Aviation Depots		
Norfolk	Zinc chromate	Lead-free primer
Alameda	PD-680	Citrikleen
	Chevron base "C" hydrocarbon oil	Trimosol - recyclable machine coolant
Naval Seas Systems Command		
Shipyard, Pearl Harbor	Chemicals for cleaning bilges/tanks	Citrikleen

Services' Source Reduction Projects

Description of projects	Milestones		
Air Force Engineering and Services Center			
Ion vapor deposition of aluminum	August 1988	September 1989	September 1990
Replaces the cadmium electroplating operation with IVD of aluminum. By changing the processes, cadmium—which produces a hazardous, toxic waste—is eliminated in the electroplating shops, and consequently from paint stripping operations using blast materials. A major source of cyanide is eliminated simultaneously, since most cadmium and nickel-cadmium baths use cyanide also.	Draft report	Phase II Purchase of equipment and research and development	Phase III Full scale demonstration
Biodegradable solvents and cleaners to replace halogenated and hydrocarbon solvents	March 1988	September 1989	September 1990
Replaces the halogenated and hydrocarbon and cleaners used in electroplating shops with biodegradable substitutes. The solvents and cleaners will then be treated by the waste treatment plant rather than barreled up and shipped to a hazardous waste disposal site.	Draft report	Phase II Determine suitable substitutes (testing)	Phase III Full scale demonstration
Noncyanide strippers to replace cyanide strippers	September 1988	September 1989	September 1990
Replace the cyanide stripping operations used in the electroplating shop with noncyanide substitutes.	Phase I Final report	Phase II Testing and development of processes	Phase III Demonstration of technology
Solvent capacity field test method	April 1989	June 1989	October 1989
Purpose is to develop a test for field personnel to use to maximize a metal cleaning solvent's life prior to disposal or recycle/reuse.	Field test evaluation	Upgrade test kits and manuals	Final technology report
Army Toxic and Hazardous Materials Agency			
Alternative chemical paint strippers	January 1988	June 1988	No date given
The purpose of this effort is to identify, test and field alternate chemical paint strippers which will reduce the output of total toxic organics from Army painting facilities.	Phase I Identify paint stripper laboratory testing	Phase II Pilot scale testing	Phase III Full scale testing
Plastic media blasting and implementation support	June 1988	September 1988	Fiscal years 1988 and 1989 (as necessary)
The purpose is to compare plastic media blasting with chemical stripping and sandblasting, specifically for communication shelters, and to compare their environmental impacts. Further, at specific installations, this project will address technical implementation problems with plastic media blasting, and provide R&D support during initial implementation.	Complete testing	Final pilot test report	Assist depots with implementation

(continued)

Description of projects	Milestones		
Naval Civil Engineering Laboratory			
Development of purification and reuse technology for pickling bath/ electroplating bath	Fiscal year 1988	Fiscal year 1989	Fiscal year 1990
The objective is to develop an innovative and cost-effective purification method in order to prolong bath lives and improve recycling value.	Initial feasibility report	Final feasibility report	User data package
Reducing blasting grit hazards and types	Fiscal year 1988	Fiscal year 1989	
The objective is to evaluate ways to reduce the hazards and number of types of blasting grit. Two options are changing from a hazardous grit (copper/nickel slag) to a nonhazardous grit (sand) and recycling the grit to remove the contamination.	Prepare test plan Developmental evaluation	Developmental evaluation Prepare implementation plan	
Exploring the use of frozen carbon dioxide to strip paint from ship hulls and bilges		Fiscal year 1991	Fiscal year 1992
The objective is to evaluate the use of frozen carbon dioxide pellets to strip paint from ship hulls and bilges. The program will ultimately lead to projects economics and feasibility; equipment requirements; procedures for blasting hulls and bilges; and a plan to implement the process.		Initial data survey Prepare test plan Developmental evaluation	Developmental evaluation
Operational testing of cyanide oxidation system	June 1988		
This effort will provide operational testing and evaluation of an electrolytic system that provides metal recovery and cyanide oxidation for source minimization of cyanide-laden plating wastewaters.	Submit operational test report		
Development of noncyanide electroplating process	Fiscal year 1988	Fiscal year 1989	Fiscal year 1990
The objective is to develop a process that will reduce or eliminate toxic waste from the electroplating process. This effort will explore and develop new non-cyanide and non-acid electroplating processes and will investigate other alternatives to direct current plating for high efficiency, quality, and durability.	Laboratory development	Alternative techniques	Shop tests and report
Innovative systems for aircraft paint removal	Fiscal year 1988		
The objective is to perform a technology assessment of emerging techniques for removing aircraft paint. The project's efforts aim at the study of alternative emerging techniques that might also be considered with plastic media blasting as suitable hazardous waste minimization candidates for aircraft depainting.	Technology assessment		

Major Contributors to This Report

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Los Angeles Regional Office	D. Stephen Kauffman, Site Senior

Glossary

Disposal	The discharge, deposit, injection, dumping, spilling, leaking, or placing of any hazardous waste into or on any land or water so that such hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwater.
Hazardous Waste	A solid waste that exhibits the characteristics of ignitability, corrosivity, extraction procedure toxicity, and reactivity, or appears on any of EPA's lists of hazardous waste. EPA defines solid waste in 40 C.F.R. section 261.2. (A solid waste can be a solid, liquid, or gas.)
Manifest (Uniform Hazardous Waste Manifest)	A required shipping document, originated and signed by the generator, which contains specific required information. Its format is rigidly specified by regulation. It must accompany every shipment of hazardous waste. A signed copy must be returned to the generator by the facility receiving the waste.
Source Reduction	The reduction or elimination of waste generation at the source, usually within a process. Source reduction measures can include some types of treatment processes, but they also include process modifications, feedstock substitution or improvements in feedstock purity, various housekeeping and management practices, increases in the efficiency of machinery, and even recycling within a process. It implies any action that reduces the amount of waste exiting from a process.
Treatment	Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so that it will be neutralized or recover energy or material resources from the waste or to render such waste nonhazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery or storage; or reduced in volume.
Waste Minimization	The reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, stored or disposed. It includes any source reduction or recycling activity undertaken by a generator that results in either (1) the reduction of total volume or quantity of hazardous waste, or (2) the reduction of toxicity of hazardous waste, or both, so long as

the reduction is consistent with the goal of minimizing present and future threats to human health and the environment.