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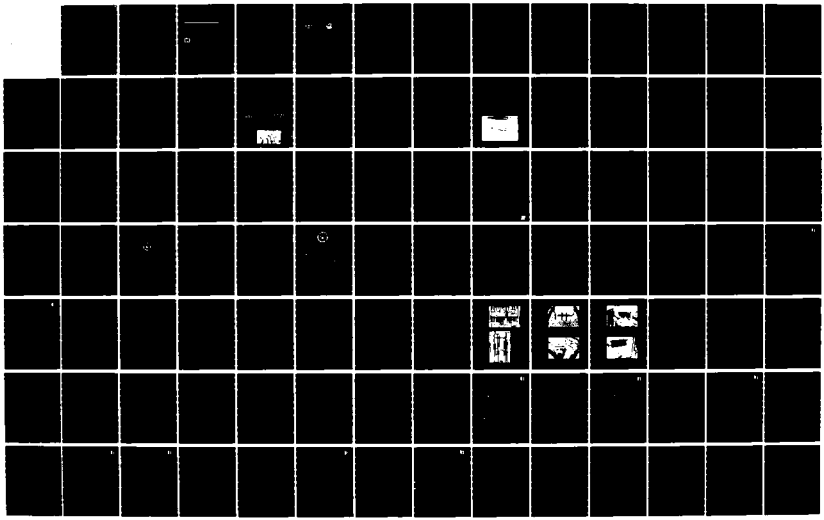

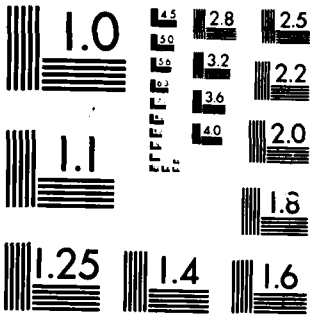

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This report is the third for this waste reduction project. It summarizes the results of the project, presents reviews of the workshops, and provides a source of materials prepared for the workshops in the appendices. This report concentrates on the Projects of Excellence.

The three cases selected as Projects of Excellence were:

- Plastic Media Paint Stripping at Hill Air Force Base, Ogden, Utah
- Innovative Hard Chrome Plating at Pensacola Naval Air Rework Facility, Pensacola, Florida
- Controlled Vehicle Washracks and Scheduled Maintenance Facilities at Fort Lewis Army Post, Tacoma, Washington

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INDUSTRIAL PROCESSES TO REDUCE GENERATION OF HAZARDOUS WASTE AT DOD FACILITIES

PHASE 3 REPORT

APPENDIX B – WORKSHOP MANUAL
Innovative Hard Chrome Plating
Pensacola Naval Air Rework Facility,
Pensacola, Florida

prepared for the
DOD ENVIRONMENTAL LEADERSHIP PROJECT
Washington, D.C.

and
U.S. ARMY CORPS OF ENGINEERS
Huntsville, Alabama

CH2M HILL
and
PEER CONSULTANTS, Inc.

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NOTICE

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Alexandria, Virginia 22314

This report was prepared by CH2M HILL, Inc., Reston, Virginia, and PEER Consultants, Inc., Rockville, Maryland, under Contract Number DAC A87-84-C-0076, dated August 17, 1984, for the DOD Environmental Leadership Project (DELP) and the U.S. Army Corps of Engineers (COE). CH2M HILL was the prime contractor. PEER was responsible for the preparation and presentation of training workshops at the sites of the Projects of Excellence. Dr. Richard Boubel was the Project Officer for DELP, and Mr. Stan Lee was the COE Project Officer. Dr. Thomas E. Higgins was Project Manager for CH2M HILL, and Dr. Brian P. J. Higgins was Project Manager for PEER. Major contributions were made to this project by Drew P. Desher, Randall Peterson, R. Benson Fergus, J. Kendall Cable, Thomas R. Card, Brian R. Marshall, Daniel Bostrom, and Reid Dennis, of CH2M HILL, and Mary Savage of PEER.

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PROJECT OF EXCELLENCE

INNOVATIVE HARD CHROME PLATING

PENSACOLA NAVAL AIR REWORK FACILITY

Phase 3 Workshop:

INDUSTRIAL PROCESSES TO REDUCE GENERATION OF HAZARDOUS WASTE AT DOD FACILITIES

Prepared for the

DEPARTMENT OF DEFENSE ENVIRONMENTAL LEADERSHIP PROJECT

WASHINGTON, DC

and

U.S. ARMY CORPS OF ENGINEERS

HUNTSVILLE, ALABAMA

Contract DAC A87-84-C-0076

By

CH2M HILL

RESTON, VIRGINIA

and

PEER CONSULTANTS, INC.

ROCKVILLE, MARYLAND

CONTENTS

Agenda

Workshop Response Survey

Participants

Participating Organizations

Workshop Location Maps

1.0 Introduction

2.0 Project Description

3.0 Alternative Process Modifications

4.0 Project Requirements

5.0 Production Benefits

6.0 Occupational and Environmental Considerations

7.0 Demonstrations and Tours

Bibliography

Appendix

1.0 Policy Documents Concerning DoD Hazardous Waste
2.0 Selected Project References
3.0 Manufacturers' Literature

DISCLAIMER

Mention of specific items of equipment, trade names, consultants, or industries does not constitute an endorsement by the U.S. Department of Defense. Names and addresses are provided only as a convenience for readers of these workshop materials.

PROJECT OF EXCELLENCE
PENSACOLA NAVAL AIR REWORK FACILITY

INNOVATIVE HARD CHROME PLATING
SEPTEMBER 11-12, 1985

AGENDA

Wednesday, September 11, 1985

Location: Building 604, Conference Room (See attached maps)

8:30 AM Welcome and Introduction

Welcome: CPT Robert D. Duff, Commanding Officer, NARF-Pensacola

Moderator: Brian Higgins, PEER Consultants

Participants introduce themselves - name, organization, and responsibilities

9:00 AM Projects of Excellence Background and Purpose

Speakers: Richard Boubel, Defense Environmental Leadership Project

Thomas Higgins, CH2M HILL

Coffee Break

10:00 AM Hard Chrome Plating Project Development and Description

Speaker: Charles Carpenter, Naval Civil Engineering Laboratory

11:15 AM Chrome Plating Chemistry Considerations

Speaker: Gary Whitfield, Pensacola NARF

11:45 AM Discussion: Questions and Answers, Experience at Other Navy Installations

Speaker: Greg Piner, Cherry Point NARF

All Participants

12:30 PM Lunch Break

AGENDA (Continued)

Wednesday, September 11, 1985

1:30 PM **Reassemble in Conference Room**

Videotape: **Plastic Blasting Versus Chemical Paint Removal** (U.S. Technology Corp., 1985, 15 minutes)

1:45 PM **Tour and Demonstration of Chrome Plating Facilities**

Location	Guides and Demonstrators
Masking and Racking Shop	Dave Marriott
Chrome Plating Shop	Charles Carpenter
Satellite Laboratory	Gary Whitfield
Foundry	Bob Alexander

4:30 PM **Adjourn for the Day**

Thursday, September 12, 1985

Location: Building 604, Conference Room

8:30 AM **Project Requirements/Implementation**

Speaker: Charles Carpenter, NCEL

Film. **Innovative Hard Chrome Plating at Louisville Naval Ordinance Station** (NCEL, 1985, 16 minutes)

Coffee Break

10:00 AM **Environmental Concerns and Benefits**

Speaker: Frank Stuart, Pensacola NARF

10:30 AM **Wastewater Impacts**

Speaker: Ed Pike, Pensacola NAS

11:00 AM **Summary**

Speaker: Brian Higgins, PEER

11:30 AM **Project Funding and Future Directions**

Speaker: Richard Boubel, DELP

AGENDA (Continued)

Thursday, September 12, 1985

12:00 PM Lunch Break

1:15 PM Reassemble in Conference Room

Videotape: Centralized Vehicle Wash Racks and Scheduled Maintenance Facilities (U.S. Army Construction Engineering Research Laboratory, 1984, 15 minutes)

1:30 PM Hands-On Demonstration of Innovative Hard Chrome Plating

Masking, Racking and Plating Shops

3:00 PM Tours (Optional)

Other Plating Lines	Dave Marriott
Machine Shop	Tom Swindle
Hazardous Material Control Facility	Frank Stuart
Wastewater Treatment Plant	Ed Pike, Elbert Ervin

4:30 PM Training Program Adjourns

PROJECT OF EXCELLENCE **INNOVATIVE HARD CHROME PLATING**

PENSACOLA NAVAL AIR REWORK FACILITY **SEPTEMBER 11-12, 1985**

WORKSHOP RESPONSE SURVEY (tear out)

Why did you come to the workshop - what did you hope to learn?

_____

_____

_____

Which parts of the program were of most interest to you?

_____

_____

What additional topics should have been covered?

_____

_____

What problems do you foresee in developing the capability for innovative hard chrome plating at your installation?

_____

_____

_____

Are there other process modifications with the potential to improve productivity and/or reduce waste generation which you hope to see implemented?

_____

_____

_____

What methods of information/technology transfer do you think would have the greatest chance for success in helping to spread process improvements and new technologies?

_____

_____

Other Comments (Continue on Back) _____

_____

Name _____

Organization _____

_____

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The Department of Defense has undertaken a major environmental program initiative called the Defense Environmental Leadership Project. A Project Office has been staffed to study long-term environmental issues that have important cost and policy implications. The Project will examine both technical and policy issues in order to significantly upgrade DOD's environmental perspective and performance. DELPO is responsible for the development and funding of this project on industrial processes to reduce generation of hazardous waste at DOD facilities.

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NAVAL CIVIL ENGINEERING LABORATORY (NCEL)

Naval Facilities Engineering Command (NAVFAC) is responsible for construction and maintenance of the Navy's shore facilities. NCEL is NAVFAC's laboratory and performs RDT&E for shore facilities, energy and environmental systems, amphibious programs and permanent underwater construction. In FY 83 the Environmental Protection Division of NCEL was tasked by NAVFAC to develop technologies for reduction of hazardous wastewater generation at Naval electroplating facilities. NCEL implemented a rigorous RDT&E program in accordance with NAVFAC Instruction 3900.7. NCEL published a Technology Assessment (TA) depicting the state-of-the-art with respect to technologies that had applicability to meeting environmental regulatory constraints. Then NCEL published a program management plan for RDT&E that meshed conclusions drawn from the TA with information taken from site surveys of Navy plating shops. This was put out as the Initiation Design Report (IDR) which presented a prioritized plan of recommended projects for RDT&E. Innovative Hard Chrome Plating was selected first among the other projects because of the enormous benefits to be derived from implementing the process. Pensacola was chosen as the first test site, largely because of the contacts developed during previous work done at the NARF by NCEL.

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PENSACOLA NAVAL AIR REWORK FACILITY (NARF)

The Naval Air Rework Facility (NARF) at Pensacola is a government-owned, government-operated (GOGO) facility which employs approximately 4000 people. The primary mission of the facility is to recondition H-3 and H-53 helicopters and A-4 jet airplanes. Reconditioning consists of disassembly of the aircraft and components, paint stripping, removal of dirt, grease, and corrosion products, remanufacturing or replacement of parts, reassembly, and application of protective coatings (plating and painting). Worn parts that are infeasible to replace new are remanufactured by overplating with chromium (hard chrome plating) followed by machining back to original specifications. In response to the difficulties with the current hard chrome plating process, the Naval Civil Engineering Laboratory (NCEL) at Port Hueneme, California, adapted an innovative chromium plating system for use at Navy plating shops. Three of seven plating baths at Pensacola have been converted to the new process as a demonstration of this technology. For numerous reasons, the Defense Environmental Leadership Project has selected the Innovative Hard Chrome Plating Process at Pensacola NARF as the Project of Excellence for the U.S. Navy.

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NAVAL AIR REWORK FACILITY (NARF)

The Naval Air Rework Facility (NARF) at Pensacola is a depot level maintenance activity with the mission of performing a complete range of rework operations on designated aircraft and components. It also performs associated engineering services in support of assigned aircraft and components, (rotary wing: H-53, H-3, H-2, H-1, CH-53E, SH-60B, fixed wing: A-4, T-39, T-2, T-28, T-34B, engines: J-85, J-60, T-53, T-700) and provides technical services on aircraft maintenance and logistics problems. The Facility performs other levels of aircraft maintenance upon special request or assignment.

The Naval Air Rework Facility is the Navy's largest industrial facility in Florida, and the second largest industrial facility and employer in Northwest Florida with a staffing of over 4,000 civilian and military personnel.

The NARF occupies 54 buildings aboard the Naval Air Station, located on 329 acres of land with a combined total of 1.5 million square feet of covered floor space. Plant equipment is valued at $58 million dollars and facility acquisition cost of $36.2 million with a replacement cost of $112.3 million.

Workload for the NARF is divided into several main categories of aircraft rework, which in addition to Standard Depot Level Maintenance, includes modification, conversion, crash damage and minor damage. The facility also has the capability to rework nearly 8,000 different items in the component rework program, manufacturing of parts and assembliies.

Aircraft workload assignment includes A-4s, and H-3 and H-53 helicopters for the Navy, Marine Corps and the Air Force. The Navy's SH-60B is slated for 1986.

The facility combines artisans' many years of experience with modern equipment and facility to turn out over 200 reworked aircraft and 48,000 aeronautical components annually. Another 500 plus aircraft are repaired through the minor repair program, and field teams travel to ships and stations throughout the free world to repair the Navy's aircraft.

The NARF has its own heliport through the exclusive use of Chevalier Field to accommodate the large number of helicopters reworked here.

CH2M HILL

CH2M HILL is a consulting engineering firm with over 2,500 employees in more than 40 domestic and foreign offices. The firm specializes in water and waste management and in all types of civil engineering, transportation, industry, energy, and agricultural projects. CH2M HILL provides hazardous waste investigation and remediation services to Federal, State, and local governments, to the military services, and to private industry. CH2M HILL is prime contractor to DELP for this project on industrial processes to reduce generation of hazardous waste at DOD facilities.

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PEER CONSULTANTS, INC.

PEER Consultants, Inc., is a civil, chemical, and environmental engineering firm which provides comprehensive professional services in environmental sciences and engineering, water and wastewater systems, solid and hazardous waste management, infrastructure analysis, and information and technology transfer. PEER offices are located in Rockville, Maryland, Washington, DC, Philadelphia, Pennsylvania, and Gary, Indiana. As subcontractor to CH2M HILL, PEER Consultants is responsible for developing and conducting a two-day training program for each of three Projects of Excellence as part of this project on industrial processes to reduce generation of hazardous waste at DOD facilities.

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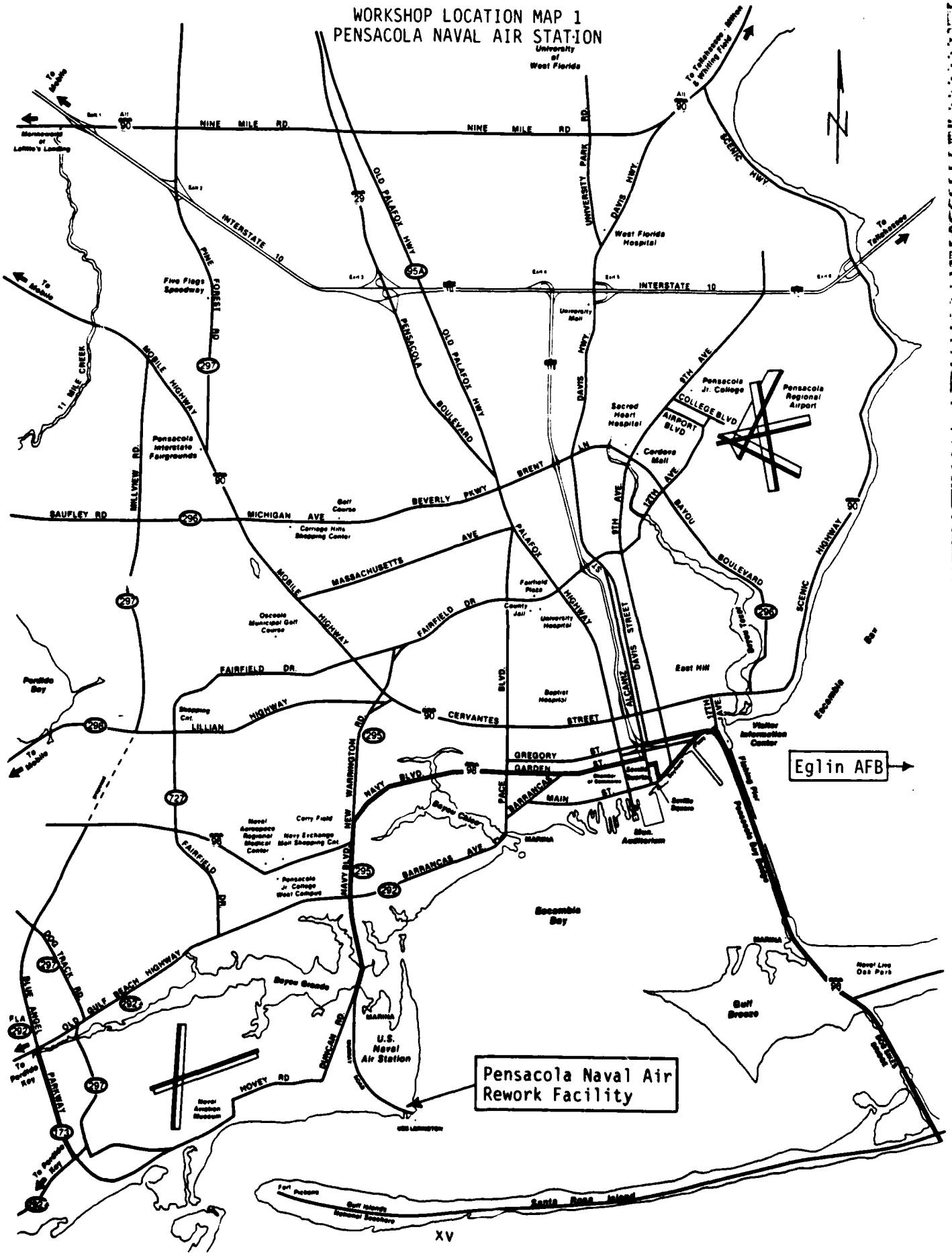
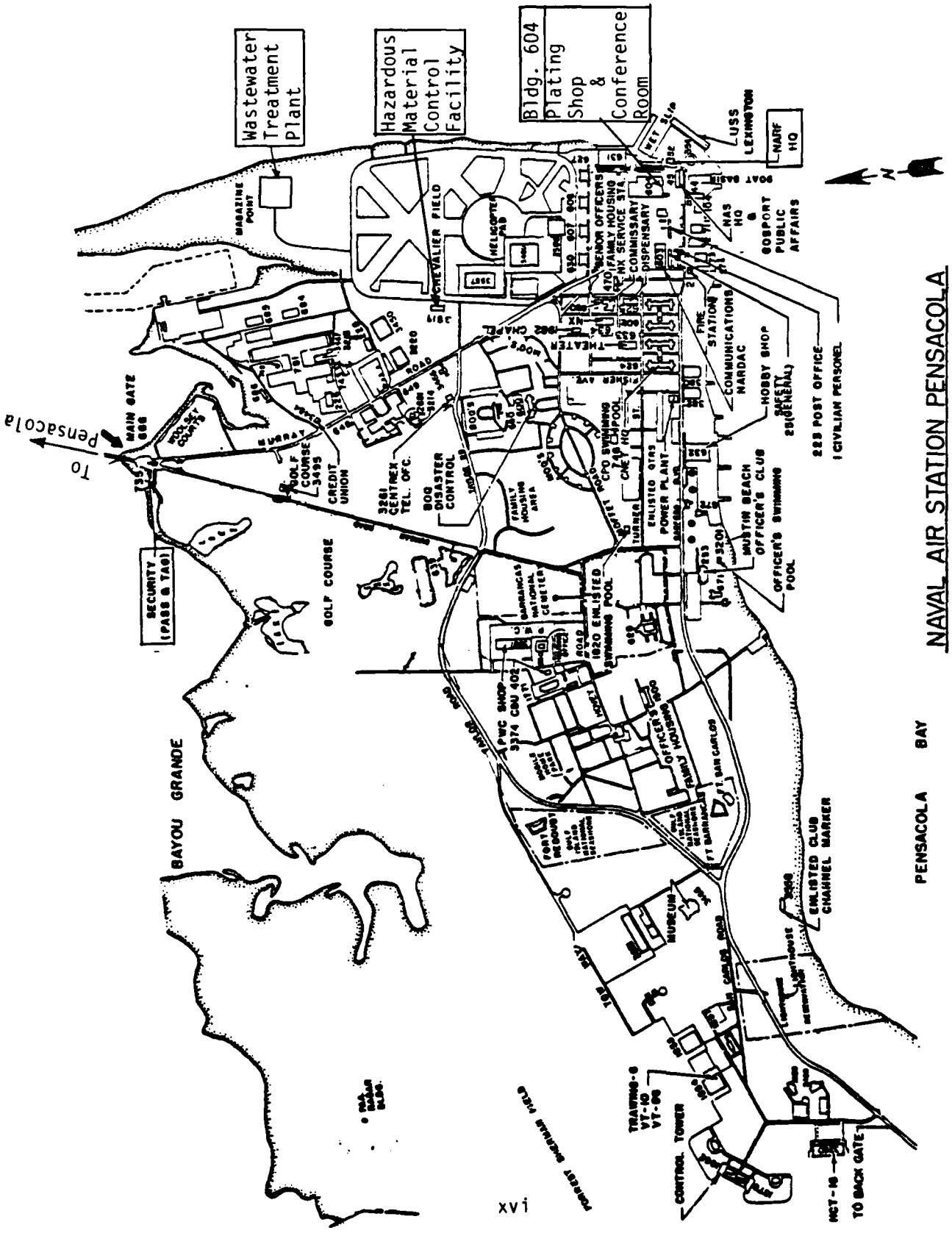
WORKSHOP LOCATION MAP 1
PENSACOLA NAVAL AIR STATION



WORKSHOP LOCATION MAP 2

PENSACOLA NAVAL AIR STATION



1.0 INTRODUCTION

1.1 Welcome

1.2 Background
- 1.2.1 Environmental Laws and Regulations
- 1.2.2 The Resource Conservation and Recovery Act
- 1.2.3 Federal Compliance With Pollution Control Standards
- 1.2.4 DoD Policies Regarding Hazardous Waste

1.3 The Defense Environmental Leadership Project

1.4 Project Goals and Procedures
- 1.4.1 Phase 1: 40 Case Studies
  - Features of Successful Process Modifications
  - Phase 1 Evaluation Results
- 1.4.2 Phase 2: 18 Case Studies
- 1.4.3 Phase 3: 3 Projects of Excellence

1.5 General Recommendations for Successful Process Modifications

Presentation by Richard Boubel, Project Officer, DELP
Defense Environmental Leadership Project (DELP)
Productivity Enhancing Capital Investments (PECI) Program

1.0 INTRODUCTION

1.1 Welcome

Welcome to **Pensacola Naval Air Rework Facility** for a **Project of Excellence Workshop** on **Innovative Hard Chrome Plating** sponsored by the **Department of Defense Environmental Leadership Project.** The purpose of this program is to thoroughly inform selected Navy decision-makers about a significant hard chrome plating process modification which has tremendous potential for:

- Increasing productivity
- Increasing quality control
- Reducing health risks to workers
- Reducing the generation of hazardous wastes, and
- Saving money.

The overall purpose of this training program is to assure adoption of practical, cost and energy efficient, industrial process modifications to reduce hazardous waste generation at DoD facilities.

This two-day workshop will focus on the following aspects of this Project of Excellence:

- Background and Purpose
- Project Description
- Alternative Technologies
- Project Requirements
- Production Benefits
- Environmental Benefits
- Demonstrations and Tours

This package of written materials is given to each participant for reading, note-taking, and future reference. The front part of these materials contains the Agenda, Response Survey, List of Participants, Description of

Participating Organizations, and Location Maps for the workshop. Please fill in the Response Survey and return it at the end of the workshop.

Each section of this handout corresponds to one or more of the scheduled workshop sessions, demonstrations, and tours. Various audio-visual aids, such as slides, exhibits, and a videotape, will also be used. The program is structured to proceed from an overview of the project to a detailed description of project requirements and benefits and a hands-on demonstration. Sessions consist of sit-down discussions in the mornings and on-site demonstrations and tours in the afternoon.

The program is intended to be informal and flexible so that maximum interest and information can be generated and transferred. All participants are encouraged to ask questions and to contribute relevant observations from their own experience for the benefit of the whole group.

Further information on any aspect of the program can be obtained from the appropriate participants and participating organizations. Names, addresses, and telephone number are listed in the front part of the training materials. All participants are encouraged to send information concerning their past, present, and future experience with measures to reduce hazardous waste generation, both successful and unsuccessful, to the Defense Environmental Leadership Project, for everyone's mutual benefit.

1.2 Background

1.2.1 Environmental Laws and Regulations

During the past 20 years the United states has experienced increased awareness of the impacts of people and technology on the natural and social environment.

In the National Environmental Policy Act of 1969, Congress stated that:

> "It is the continuing policy of the Federal Government . . . to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

Since 1969, Congress has passed and amended numerous laws to protect human health and the environment. Major environmental legislation includes:

1. The Clean Water Act (CWA),
2. The Clean Air Act (CAA),
3. The Toxic Substances Control Act (TSCA),
4. The Resource Conservation and Recovery Act (RCRA), and
5. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund").

The U.S. Environmental Protection Agency (EPA) is primarily responsible for developing regulations to implement and enforce these laws. EPA regulations appear under Title 40 of the Code of Federal Regulations. Many proposals for new and revised regulations appear in the Federal Register as laws change and as understanding of environmental and regulatory processes increases. State and local governments frequently adopt their own laws and regulations for environmental protection.

Many Federal, State, and local regulations require that those who generate wastes or release pollutants to the environment obtain permits to do so. Individuals, businesses, and public agencies are responsible for complying with environmental laws, regulations, and permit conditions which pertain to them. They should comply in order to protect the environment and the health and welfare of society.

1.2.2 The Resource Conservation and Recovery Act

Section 1003 of the Resource Conservation and Recovery Act (RCRA) of 1976 states that: "The objectives of this Act are to promote the protection of health and the environment and to conserve valuable material and energy resources." Subtitle C of RCRA directed the EPA to develop and implement a national program to manage hazardous waste. In response to RCRA, EPA has established:

1. Criteria for the identification and listing of hazardous waste;
2. Regulations for generators and transporters of hazardous waste; and
3. Regulations and permit requirements for facilities which treat, store, or dispose of hazardous waste.

The regulations require extensive labeling, recordkeeping, and reporting practices to control hazardous waste "from cradle to grave."

Once hazardous waste is generated, it is usually difficult and costly to manage. Management methods include recycling, treatment, and disposal. Recycling and treatment often result in some residual hazardous waste which still requires disposal. Disposal methods include landfilling, underground placement, and incineration. Much hazardous waste is currently landfilled, but secure landfills which meet EPA requirements for hazardous waste disposal are few in number, difficult to site, and costly to operate. In addition, there are many concerns about the long-term impacts and risks associated with each method of hazardous waste disposal.

The Hazardous and Solid Waste Amendments of 1984 make RCRA more widely applicable and more stringent in many respects (See Appendix 1.1 of these training materials). For instance, the new provisions include:

1. Bans on placement of bulk liquid hazardous waste in landfills, and on certain other disposal practices;
2. Requirements for double-liners and leachate collection systems at surface impoundments and landfills;

3. Additional requirements for monitoring groundwater and taking corrective actions where needed;

4. Restrictions on a facility's permit life;

5. Authority to add conditions to a permit beyond those provided for in the regulations; and

6. Requirements for generators and owners or operators of treatment, storage and disposal facilities to certify that they have instituted a waste minimization program.

As the management of hazardous waste becomes even more difficult and costly, measures to reduce or entirely eliminate the generation of hazardous waste become more attractive.

1.2.3 Federal Compliance With Pollution Control Standards

Executive Order 12088 (October 13, 1978) states that:

> "The head of each Executive agency is reponsible for ensuring that all necessary actions are taken for the prevention, control, and abatement of environmental pollution with respect to Federal facilities and activites under the control of the agency. The head of each Executive agency is responsible for compliance with applicable pollution control standards, including those established pursuant to, but not limited to, the following" (See Appendix 1.2):
>
> 1. Toxic Substances Control Act,
> 2. Federal Water Pollution Control Act,
> 3. Clean Air Act,
> 4. Noise Control Act, and
> 5. Solid Waste Disposal Act, as amended (this includes the Resource Conservation and Recovery Act of 1976 and the Hazardous and Solid Waste Amendments of 1984).

EO 12088 requires that each Executive agency cooperate with the EPA Administrator and with State, interstate, and local agencies in the prevention, control, and abatement of environmental pollution. It states that:

> "Whenever the Administrator or the appropriate State, interstate, or local agency notifies an Executive agency that it is in violation of an applicable pollution control standard, the

> Executive agency shall promptly consult with the notifying agency and provide for its approval a plan to achieve and maintain compliance with the applicable pollution control standard. This plan shall include an implementation schedule for coming into compliance as soon as practicable."
>
> "Exemptions from applicable pollution control standards may only be granted . . . if the President makes the required appropriate statutory determination: that such an exemption is necessary (a) in the interest of national security, or (b) in the paramount interest of the United States."

EO 12088 applies to all facilities and activities under the control of the Department of Defense. Exemptions are not expected to be granted except during mobilization or time of war.

1.2.4 DoD Policies Regarding Hazardous Waste

In May of 1980, the Office of the Assistant Secretary of Defense issued Defense Environmental Quality Program Policy Memorandum DEQPPM 80-5 to provide DoD policy guidance on the disposal of hazardous materials. The Defense Logistics Agency (DLA) was designated the responsible agency within DoD for worldwide disposal of all hazardous materials, except for those categories of materials specifically designated for DoD component disposal. DEQPPM 80-5 (Appendix 1.3) and Chapter XXI of DoD 4160.21-M (Appendix 1.5) assign DoD components and installations with the responsibility to "Where feasible, minimize quantities of hazardous waste through resource recovery, recycling, source separation, and acquisition policies."

In August of 1980, DoD policy memorandum DEQPPM 80-8 affirmed that DoD policy is:

> "To limit the generation of hazardous waste through alternative procurement and operational procedures that are attractive environmentally yet are fiscally competitive, (and) . . . to reutilize, reclaim, or recycle resources where practical and thus conserve on total raw material usage." (Appendix 1.4)

In carrying out the intent of these policies, numerous studies have been performed at DoD facilities which recommended modifications to industrial processes to reduce the generation of hazardous wastes at the source, rather than treating the wastes at end-of-pipe treatment facilities. Many of these studies recommended process modifications with excellent cost/benefit ratios. Several of these have been successfully implemented. However, others have either not been implemented or were improperly applied.

1.3 The Defense Environmental Leadership Project

Military installations and programs have often had significant impacts on the environment because of their location, size, and mission. In order to encourage leadership in environmental protection the Department of Defense has undertaken a major environmental program called the Defense Environmental Leadership Project (DELP). A Project Office has been established under the Environmental Policy Directorate of the Office of the Secretary of Defense to study long-term environmental issues that have important cost and policy implications. Project staff are examining both technical and policy issues in order to significantly upgrade DoD's environmental perspective and performance.

In addition to its many other activities, DELP has developed and funded a three-phased project, of which this workshop is a part of Phase 3, to encourage the development and implementation of industrial process modifications which reduce hazardous waste generation at U.S. Army, Navy, and Air Force facilities. The goal of another DELP project is to develop an incentive program so that commanders who adopt environmental protection measures which save government money can retain the money for other activities. DELP is also developing methods to more realistically determine the total costs of DoD hazardous waste treatment, storage and disposal activities.

1.4 Project Goals and Procedures

DELP has been conducting this comprehensive three-phased project since mid-1984. A major goal of the project is to develop an in-depth analysis of both successful and unsuccessful attempts to reduce hazardous waste. Project procedures include:

1. Analysis of sites which have been previously studied for reduction of hazardous wastes by either process modifications or change to alternative processes. Sites include those where recommended modifications have been successfully implemented, as well as those which showed potential benefits, but where no action or inadequate action was taken.

2. Identification of management techniques that cause needed changes to be implemented.

3. Integration of successful techniques into operational procedures that will assure future adoption of practical, cost and energy efficient, industrial process modifications to reduce hazardous waste generation.

The analysis concentrated on a few processes that generate the greatest proportion of DoD hazardous waste. The Defense Department operates industrial facilities to clean, repair, and recondition a wide variety of military equipment, including airplanes, helicopters, ships, wheeled and tracked vehicles, and other weapons systems and equipment. Metal finishing operations are performed on military equipment and their components at more than 100 DoD industrial facilities. Metal finishing operations generate most of DoD's hazardous waste. These operations include:

1. Paint stripping,
2. Solvent cleaning,
3. Metal plating, and
4. Painting

Solvent wastes and toxic metal wastes from these processes are the principal hazardous wastes at DoD facilities.

This analysis of process modifications is being conducted under the assumption that the technology to reduce hazardous waste generation is already in existence. This particular DELP project was not intended to fund technology research, development, or implementation. However, project deliverables, including reports, training materials, and three workshops, are structured to promote technology transfer and to encourage wider use of successful process modifications.

1.4.1 Phase 1: 40 Case Studies

During Phase 1 of the project, 40 cases of industrial process modifications at Army, Navy, and Air Force installations were evaluated, and 18 cases were recommended for further study during Phase 2. As shown in Table 1.1, process modifications involving paint stripping, painting, metal plating, and solvents represented most of the 40 cases. Additional cases involved explosives manufacturing, jet engine test cells, fire fighting equipment, fuel tank cleaning, and purchase and use specifications. Cases were evaluated on the basis of costs, energy consumption, technical practicality, management, incentives, and program monitoring and auditing. The primary factor in evaluating the cases was not whether they had been successful, but whether they were useful as examples of how such processes could be modified.

Many times, the success or lack of success of the modification can be attributed not to the technology, but rather to the management, training, and incentive programs that were developed and put into place along with the technology. The Phase 1 report (CH2M HILL, February 1985) identifies managerial techniques that stimulate acceptance and successful implementation of the selected process modifications.

Table 1.1 Type and Number of Process Modifications Evaluated in Phase 1.

Type of Operation	Number of Modifications Evaluated			
	Army	Navy	Air Force	Total
Paint Stripping	1	2	1	4
Painting	-	3	2	5
Metal Plating	3	9	1	13
Recycle of Solvents and Other Organic Fluids	1	6	3	10
Explosives Manufacturing	4	-	-	4
Jet Engine Test Cell	-	-	1	1
Fire Fighting Training	-	1	-	1
Fuel Tank Cleaning	-	1	-	1
Purchase & Use Specifications	-	1	-	1
Total	9	23	8	40

Features of Successful Process Modifications

Industrial modifications were generally found to be successful; however, some modifications failed and others could not be adequately evaluated.

While there are specific circumstances and reasons behind the success or lack of success of each modification attempted, two characteristics have been integral parts of each of the successful process modifications and at least one of these elements has been missing from the modifications that have been less than successful. Very simply stated, in process modifications that were successfully implemented, the end user was sufficiently motivated to make the change and the technologies were "elegant in their simplicity." Factors which have motivated personnel included improved production rate or quality, reduced overall costs, decreased manpower requirements, and decreased quantity of hazardous wastes to be disposed of. Technologies that were "elegant in their simplicity" were easy to operate and maintain, reliable, and cost effective. Successfully implemented process modifications combined effective technology and motivated personnel to significantly reduce hazardous waste production by substantially changing the process, substituting raw materials, or recovering and reusing waste by-products.

In general, a number of common features distinguished successful process modifications from those that were not. These features are outlined below:

1. Production people were enthusiastically and actively involved in implementing successful process modifications. This usually required that some incentive be offered by the modification, such as reduced manpower requirements or simplification of the process. The change could not harm product quality, and preferably was an improvement over existing processes.

2. A "champion," who strongly believed in the modification, ramrodded the project, and overcame developmental problems and the inertia that protects existing processes (especially those that function, although they may produce undesirable wastes).

3. Care was taken to tailor the modification to the individual facility. During design and installation, many operations personnel were included to obtain their input and to inspire them to adopt the process change.

4. Support was provided at a sufficiently high level in the chain of command to influence production and environmental policy decisions. Frequently, waste disposal and environmental protection had been viewed as service functions, subservient to the mission of the facility, which was usually production-oriented. Successful modifications usually required the reallocation of resources from production functions to environmental protection. Allocation of manpower slots for environmental protection was particularly difficult to obtain.

5. The technologies tended to require "evolutionary rather than revolutionary" changes. That is, off-the-shelf equipment was adapted to a new application, and special or complex equipment was avoided.

6. Successful modifications were straightforward and simple to operate, thus requiring minimal training for personnel unfamiliar with the technology involved.

7. Process reliability had to be high so as not to adversely affect production. Maintenance requirements were minimal.

8. At facilities where modifications were successful, true costs of hazardous waste disposal were appreciated by management, and were considered in the decision to implement the modifications. At DoD facilities, the Defense Property Disposal Office (DPDO) takes hazardous waste, which must be disposed of off the installation, without charge. This has resulted in a disincentive to production people to reduce their generation of hazardous wastes, since costs of waste disposal are not charged to production activities. At some installations, industrial treatment facilities have been sized to handle the existing waste flow. This has resulted in a disincentive to reduce waste production.

Phase 1 Evaluation Results

Table 1.2 (Table 13.1 from the CH2M HILL Phase 1 Report) shows the assessment of each case, and indicates the 18 cases recommended for further study in Phase 2. Cases were favored in which modifications were seriously attempted, had a widespread application, and had the potential of effecting a significant reduction in hazardous waste generation. Cases recommended for further study in Phase 2 of the project are designated with an asterisk (*).

In all but two cases, the cases earning the highest score under an assessment model were recommended for further study. The two cases earning high scores, but not recommended for further study (Case No. 24, Solvent Recovery at Kelly AFB, and Case No. 22, Dry Media Paint Stripping, Alameda NARF), both failed to offer sufficient information to warrant further evaluation.

Some process modifications were not implemented for immediately obvious and overwhelming reasons, such as lack of money or manpower. For these cases, little additional useful information would be obtainable for further evaluation. Cases were favored in which the modification was seriously attempted, resulting in the production of reports or other information suitable for further analysis.

Some of the cases involved wastes that would not be classified as hazardous under EPA regulations. Since the purpose of this project is to evaluate process modifications to reduce generation of hazardous wastes, these cases were considered to be less useful than those that dealt with hazardous wastes.

An assessment model was prepared to help evaluate cases for consideration for Phase 2 of the project. This model contained the following five criteria:

1. Concrete Example: Was there a modification proposed, and is sufficient information available (i.e. existing operation, reports, conversations with personnel) to perform a detailed study of the modification?

CASE NO.	FACILITY, MODIFICATION	EVALUATION RESULTS (1) CRITERIA (1) A	B	C	D	E	STUDY VALUE	(2)	NOTES (3)	(4)	REPORT SECTION
1	Hill AFB, Dry Paint Stripping	1.0	1.0	1.0	1.0	1.0	10.0	S		*	3.4.1
4	Robins AFB, Solvent Recycle	1.0	1.0	1.0	1.0	1.0	10.0	S		*	6.4.1
10	Pensacola NARF, Spray Rinse	1.0	1.0	1.0	1.0	1.0	10.0	S		*	5.4.4
26	Pensacola NARF, Dry Paint Strip	1.0	1.0	1.0	1.0	1.0	10.0	S		*	3.4.3
5	Tyndall AFB, Solvent Recycle	0.7	1.0	1.0	1.0	1.0	9.4	U	b	*	6.4.2
18	Anniston Army Depot, Plating	1.0	1.0	0.7	1.0	1.0	9.4	S		*	5.4.7
8	Norfolk NSY, Solvent Recycle	1.0	0.5	1.0	1.0	1.0	9.0	S		*	6.4.4
24	Kelly AFB, Solvent Recycle	0.5	1.0	1.0	1.0	1.0	9.0	N	g		6.4.5
7	Norfolk NARF, Heptane Recycle	1.0	0.7	0.7	1.0	1.0	8.8	U	a, c	*	6.4.3
22	Alameda NARF, Dry Paint Strip	0.3	1.0	1.0	1.0	1.0	8.6	N	k		3.4.2
23	Watervliet Army Arsenal, Modern Plating	0.5	1.0	1.0	1.0	0.7	8.4	S		*	5.4.10
6	Lockheed(USAF), CD Plating	1.0	0.5	0.7	1.0	1.0	8.4	S		*	5.4.1
16	Tobyhanna AAP, Waste Treatment	1.0	0.5	0.7	1.0	1.0	8.4	S		*	5.4.6
27	Pensacola NARF, Water Primer	1.0	0.5	0.7	1.0	1.0	8.4	S		*	4.4.3
39	Anniston Army Depot, Solvent Recycle	1.0	0.5	0.7	1.0	1.0	8.4	S		*	6.4.9
33	NARF's IVD of Aluminum	1.0	0.7	0.7	1.0	0.7	8.2	S		*	5.4.13
2	Hughes (USAF), Powder Coating	1.0	0.5	0.5	1.0	1.0	8.0	S		*	4.4.1
3	Lockheed (USAF), Painting	0.7	0.3	1.0	1.0	1.0	8.0	U	a	*	4.4.2
40	Norfolk NSY and NARF, Shelf Life	0.5	1.0	1.0	0.5	1.0	8.0	U	b	*	11.4.1
12	Charleston NSY, LICON Unit	1.0	0.5	0.7	1.0	0.7	7.8	U	c, d, e, f	*	5.4.3
9	Pensacola NARF, LICON Unit	1.0	0.5	0.7	1.0	0.7	7.8	U	c, d, e, f		5.4.2
14	Radford AAP, Pink Water	1.0	0.7	0.5	1.0	0.3	7.0	S			7.4.3
29	Pensacola NARF, Solvent Recycle	0.3	0.5	0.7	1.0	1.0	7.0	U	m		6.4.6
34	Navy, Electrostatic Paint	0.5	0.5	0.5	1.0	0.7	6.4	U	e		4.4.3
30	Pensacola NARF, Machine Coolant	1.0	0.3	0.3	1.0	0.5	6.2	U	e, l		6.4.10
13	Radford AAP, NO_x Control	1.0	1.0	0.5	0.0	0.3	5.6	U	d, h		7.4.1
15	Milan AAP, Pink Water	0.7	0.5	0.3	1.0	0.3	5.6	S			7.4.4
20	Alameda NARF, Rinse Controls	0.3	0.5	0.3	1.0	0.7	5.6	U	e, j		5.4.9
25	Holston AAP, NO_x Treatment	1.0	1.0	0.5	0.0	0.3	5.6	U	d, h		7.4.2
38	Navy, Fuel Tank Cleaning	0.5	0.5	0.5	0.3	1.0	5.6	U	e		10.4.1
28	Pensacola NARF, Epoxy Paint	0.3	0.5	0.3	1.0	0.5	5.2	U	f, d		4.4.3
31	Mare Island NSY,Plating	0.3	0.5	0.3	1.0	0.5	5.2	S			5.4.11
19	Alameda NARF, CN Rinse Changes	1.0	0.0	0.0	1.0	0.3	4.6	S			5.4.8
35	NAS's Fire Fighting	1.0	0.3	0.3	0.0	0.7	4.6	S			9.4.1
36	Charleston NSY, Refrigerant	1.0	0.5	0.3	0.0	0.3	4.2	S			6.4.7
17	Anniston Army Depot, Wet Paint Strip	0.0	0.0	0.0	1.0	1.0	4.0	N	i		3.4.4
21	NARF Dry Jet Engine Test	1.0	0.0	0.3	0.0	0.5	3.6	S			8.4.1
32	NARF's Water Over $MeCl_2$	0.0	0.0	0.0	1.0	0.5	3.0	N	i		5.4.12
37	Norfolk NSY, Refrigerant Recycle	0.3	0.5	0.3	0.0	0.3	2.8	U	c		6.4.8
11	Pensacola NARF, Cond. Recovery	0.5	0.0	0.0	0.0	0.5	2.0	N	g		5.4.5

FOOTNOTES TO TABLE 13.1

(1) Key to evaluation of modifications

Each modification was assigned a score for each of the five criteria applied in evaluating a given modification. The criteria applied, and the five scores possible for each criteria, are shown below. The total score was then doubled to come up with the study value assigned

Criteria		Weighting Value 1.0	0.7	0.5	0.3	0.0
A	Concrete Example	Yes		Questionable		No
B	Waste Reduction	Major		Moderate		Minor
C	Waste Generation	Major		Moderate		Minor
D	EPA Hazwaste	Yes		Sometimes		No
E	Potential Use	Widespread		Limited		Unique

(2) S Process modification was judged successful in that it accomplished its goal, was cost-effective and sustainable.

U Process modification was judged not successful for reasons delineated under "Notes"

N Process modification was not yet implemented, or there was not sufficient information available to evaluate the modification.

(3) NOTES (Reasons for Lack of Success)

a Negative impact on product quality.
b Lack of authority by those attempting to implement the modification.
c Lack of manpower
d Poor reliability or maintainability.
e Inappropriate technology application.
f Required skilled operators.
g Process evaluation in progress, insufficient information.
h Process consumables no longer commercially available
i No process modification was known to have been proposed
j Lack of space to locate the required equipment.
k Not implemented, pending demonstration results at other facilities.
l Physical properties of the material to be recycled kept changing.
m Operation was discontinued due to lack of technical support and incentives to reduce hazardous wastes.

(4) * Recommended for additional study during Phase 2 of the project based on study value and availability of information to evaluate

TABLE 1.2 Phase 1 Evaluation of 40 Case Studies

Source: CH2M HILL, April 1985.

TABLE 13.1

EVALUATION OF CASE STUDIES

2. Waste Reduction: To what extent would the proposed modification, if successful, affect a significant reduction in waste generation at the facility?

3. Waste Generation: At the average facility using the industrial process, how much waste is produced that would be affected by the proposed modification?

4. EPA Hazardous Waste: Would the affected waste be classified as a hazardous waste under EPA regulations? (For a detailed description of EPA hazardous waste regulations and definitions, see 40 CFR Part 261 -- Identification and Listing of Hazardous Waste.)

5. Potential Use: How widely is the process used in the Armed Services? Would the process modification have widespread application?

Notice that the five criteria do not judge the success (or lack thereof) of a given modification. The five criteria were used in Phase 1 to determine which cases would be most valuable for further study in Phase 2. They were also used in Phase 2 to select three Projects of Excellence for the Phase 3 workshops.

The evaluation of whether or not a process modification was successful was separated from the determination of its value as an example for further analysis. To determine if a modification was successfully applied, it was determined whether or not the modification had been implemented as proposed, proved cost-effective, and was sustainable or capable of being carried on indefinitely. Modifications that met these criteria were classified as successful (S). Those process modifications found not to be successful (U) failed for a variety of reasons, which are explained in footnotes (a through m) to Table 1.2. Those modifications for which insufficient information was available, or for which implementation was too early in progress to evaluate, are designated with an N; and the rationale for this designation is also explained in footnotes to Table 1.2.

The 18 cases recommended for further evaluation included 13 that were successful and 5 that were not. By service, there were 3 Army, 6 Air Force and 9 Navy cases, approximately proportional to the distribution of the original 40 cases.

By industrial process, 7 of the cases involved modifications to plating operations, 5 were for modifications to painting or paint stripping, 5 were for modifications to recover solvent, and 1 was to modify purchase and use specifications to reduce disposal of items whose shelf life had expired. Selection of these cases fulfills the objective of the contract to "...focus on a few processes that generate the greatest proportion of DoD hazardous wastes..."

Among the 18 cases, there were numerous candidates for the three "Projects of Excellence" to be selected during Phase 2 of the project.

1.4.2 Phase 2: 18 Case Studies

During Phase 2 of the project, 18 case studies were further evaluated and three Projects of Excellence were selected. Since it was extremely difficult to obtain information about Case No. 23 (Modern Plating System at Watervliet Army Arsenal) and Case No. 40 (Purchase and Use Specifications), they were replaced with two additional Army case studies at the beginning of Phase 2. These process modifications are the Centralized Vehicle Wash Racks and Scheduled Maintenance Facilities at Fort Lewis and Fort Polk (Case Nos. 41 and 42).

The 18 case studies were ranked according to their study value and application success as shown in Table 1.3 (Table 6-1 from the CH2M HILL Phase 2 Report). The three top-ranked cases were selected for Phase 3.

TABLE 1.3 Phase 2 Evaluation of 18 Case Studies

TABLE 6-1 EVALUATION OF CASE STUDIES

REPORT SECTION	FACILITY, MODIFICATION	STUDY VALUE A	B	C	D	E	STUDY SCORE	APPLICATION SUCCESS F	G	H	I	J	K	L	M	N	O	SUCCESS SCORE	TOTAL SCORE
3.4.1	HILL AFB, DRY PAINT STRIPPING	1.0	1.0	1.0	1.0	1.0	10.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	9.5	19.5
4.4.3	PENSACOLA NARF, SPRAY RINSE	1.0	1.0	1.0	1.0	1.0	10.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	9.5	19.5
5.4.2	FORT LEWIS ARMY, VEHICLE WASHRACKS	1.0	1.0	1.0	0.5	1.0	9.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	9.5	18.5
3.4.6	ROBINS AFB, SOLVENT RECYCLE	1.0	1.0	1.0	1.0	1.0	10.0	0.5	0.5	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.5	8.0	18.0
3.4.2	PENSACOLA NARF, DRY PAINT STRIPPING	0.7	1.0	1.0	1.0	1.0	9.4	1.0	1.0	1.0	1.0	0.5	0.5	1.0	0.5	1.0	1.0	8.5	17.9
5.4.1	FORT POLK ARMY, VEHICLE WASHRACKS	0.7	1.0	1.0	0.5	1.0	8.4	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	9.0	17.4
3.4.7	NORFOLK NSY, SOLVENT RECYCLE	1.0	0.5	1.0	1.0	1.0	9.0	0.5	0.5	1.0	0.0	1.0	1.0	1.0	1.0	1.0	0.5	7.5	16.5
4.4.5	ANNISTON ARMY DEPOT, PLATING	0.7	1.0	0.7	1.0	1.0	8.8	0.5	0.5	1.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0	7.0	15.8
3.4.3	PENSACOLA NARF, WATER PRIMER	1.0	0.5	0.7	1.0	1.0	8.4	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	7.0	15.4
3.4.5	HUGHES (USAF), POWDER COATING	1.0	0.5	0.5	1.0	1.0	8.0	1.0	1.0	1.0	0.0	0.5	0.5	0.5	1.0	0.5	1.0	7.0	15.0
4.4.2	LOCKHEED (USAF), Cd PLATING	1.0	0.5	0.7	1.0	1.0	8.4	0.5	0.5	0.0	0.5	0.5	0.5	1.0	1.0	1.0	1.0	6.5	14.9
3.4.10	ANNISTON ARMY DEPOT, SOLVENT RECYCLE	1.0	0.5	0.7	1.0	1.0	8.4	0.0	0.5	1.0	0.0	1.0	1.0	1.0	0.5	0.5	0.5	6.0	14.4
3.4.4	LOCKHEED(USAF), PAINTING	0.7	0.3	1.0	1.0	1.0	8.0	0.5	0.5	1.0	0.0	0.5	0.5	1.0	0.5	0.5	1.0	6.0	14.0
3.4.8	TYNDALL AFB, SOLVENT RECYCLE	0.7	1.0	1.0	1.0	1.0	9.4	0.5	0.5	0.5	0.0	0.5	0.5	0.5	0.5	0.5	0.0	4.0	13.4
4.4.6	TOBYHANNA ARMY DEPOT, WASTE TREATMENT	1.0	0.5	0.7	1.0	1.0	8.4	0.5	0.5	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	3.5	11.9
3.4.9	NORFOLK NARF, HEPTANE RECYCLE	1.0	0.7	0.7	1.0	1.0	8.8	0.5	0.0	0.0	0.0	0.5	0.0	0.5	0.5	0.5	0.0	2.5	11.3
4.4.1	NORTH ISLAND NARF, IVD OF ALUMINUM	1.0	0.7	0.7	1.0	0.7	8.2	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.5	10.7
4.4.4	CHARLESTON NSY, LICON CHROME RECOVERY	1.0	0.5	0.7	1.0	0.7	7.8	0.0	0.0	0.5	0.0	0.0	0.0	0.0	1.0	1.0	0.0	2.5	10.3

NOTE: Each modification was assigned a score for each of fifteen criteria. The criteria applied and the scores possible for each criterion are shown below. Five of the criteria are to determine the example value of the case, or potential for reducing hazardous waste, if successfully applied. Double the sum of these values is used to compute the "Study Score." The second ten criteria were used to evaluate the success of the *modification and potential for successful application at* other DOD facilities.

	WEIGHTING VALUE		
STUDY VALUE	1.0	0.5	0.0
A CONCRETE EXAMPLE	YES	QUESTIONABLE	NO
B WASTE REDUCTION	MAJOR	MODERATE	MINOR
C WASTE GENERATION	MAJOR	MODERATE	MINOR
D EPA HAZWASTE	YES	SOMETIMES	NO
E POTENTIAL USE	WIDESPREAD	LIMITED	UNIQUE
APPLICATION SUCCESS			
F ENERGY USE	LOWER	SAME	HIGHER
G MANPOWER	LOWER	SAME	HIGHER
H MATERIAL COSTS	LOWER	SAME	HIGHER
I CAPITAL COSTS	LOWER	SAME	HIGHER
J MAINTAINABILITY	EASY	MODERATE	HARD
K RELIABILITY	HIGH	MODERATE	LOW
L SIMPLICITY	SIMPLE	MODERATE	COMPLEX
M STAFF ENTHUSIASM	CHAMPION	MODERATE	INDIFFERENT
N MANAGEMENT	SUPPORTIVE	MODERATE	INDIFFERENT
O PRODUCT IMPACT	FAVORABLE	NONE	NEGATIVE

Source: CH2M HILL, July 1985.

1.4.3 Phase 3: 3 Projects of Excellence

As a result of all the evaluations the following three case studies were selected as the most appropriate to fulfill the overall goals of this project:

1. **Plastic Media Paint Stripping at Hill Air Force Base, Ogden, Utah.**
2. **Innovative Hard Chrome Plating at Pensacola Naval Air Rework Facility, Pensacola, Florida.**
3. **Centralized Vehicle Wash Racks and Scheduled Maintenance Facilities at Fort Lewis, Washington.**

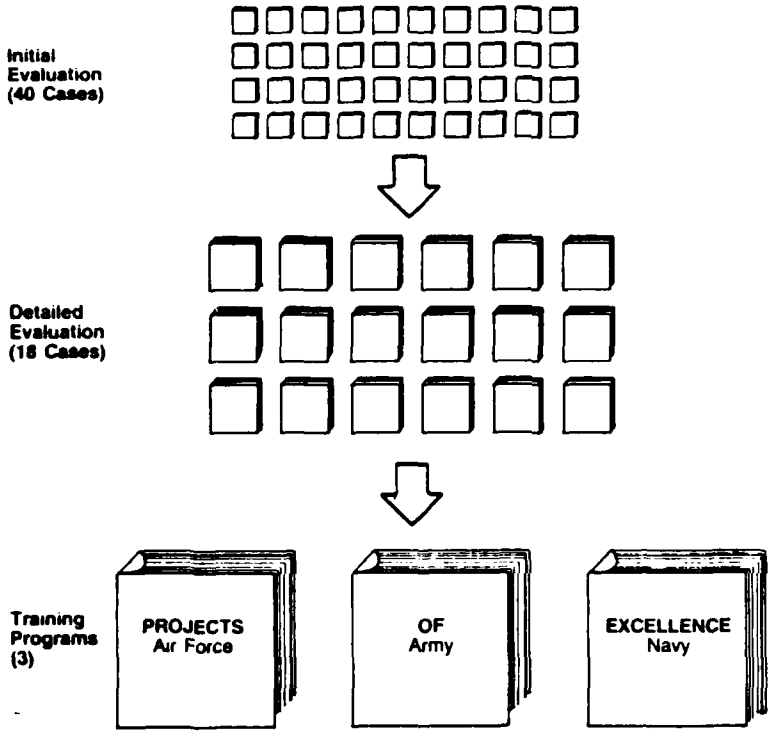
Plastic media paint striping at Hill Air Force Base was selected for the following reasons:

1. Widespread DoD adoption has the potential of reducing the costs of operation by at least $100,000,000 per year, a significant internal incentive to production and management people to implement this change.
2. Adoption of the process would eliminate one of the major liquid hazardous waste sources in the armed services.
3. Its applicability is widespread, potentially applicable at every military installation.
4. The process is easy to operate and involves adaptation of conventional technology.
5. From a production standpoint, manpower requirements are significantly reduced, product quality is improved, and production costs are significantly decreased.

The zero discharge chromium plating system, developed at Pensacola NARF by the Naval Civil Engineering Laboratory (NCEL) at Port Hueneme, likewise combines the incentives of production improvement with reduced hazardous waste production. The process is also widely applicable. From a production standpoint, rejection rates are drastically reduced, plating rates are increased, and fewer plating baths are required to plate the same number of parts. In addition, frequency of plating bath dumps has been reduced and industrial wastewater treatment has been simplified.

INDUSTRIAL PROCESSES

To Reduce Generation of Hazardous Wastes At DOD Facilities



Case Distribution

Category	Phase 1 (40)	Phase 2 (18)	POE (3)
Paint Stripping	4	2	1
Solvent Cleaning	10	7	1
Plating	13	6	1
Painting	5	3	—
	32	18	3

Technology Elegant in its Simplicity

- Plastic Media Paint Stripping
- Solvent Recovery Stills
- Vehicle Wash & Maintenance
- Spray Rinse System

The central vehicle washracks and vehicle maintenance facilities at Fort Lewis, Washington, were selected principally for their segregation of exterior vehicle washing from vehicle maintenance and engine compartment cleaning. Conventional cleaning with cold water, solvents, and detergents on open pads resulted in a significant contamination of stormwater. The modification uses off-the-shelf high pressure hot water cleaning equipment for engine compartment cleaning, eliminating the use of solvents and greatly reducing the volume of waste requiring treatment. The overall system has also greatly reduced the manpower requirements for vehicle cleaning. Significant cost savings are projected compared to the previous operation.

During Phase 3, two-day workshops are being developed and given at each of the three sites. The workshops are designed for decision-makers in each of the three services, including managers, engineers, and operators who are responsible for similar military industrial processes at other facilities. The goal of the training programs is to give firsthand knowledge of highly successful process modifications and an understanding of why they have been successful, so that participants will be even better equipped to take the lead in adopting similar process modifications at their own facilities.

1.5 General Recommendations for Successful Process Modifications

Based on the case study analysis in Phases 1 and 2 of this report, the following recommendations were made for enhancing the likelihood of success for future process modifications:

1. Identify the potential advantages and disadvantages of including the costs of hazardous waste disposal in production budgets so that they will be used in production decisions.

2. Investigate the possibility of providing incentives for hazardous waste reduction efforts (e.g., returning money not spent on disposal to the base recreation and welfare fund).

3. Include production people in the design effort; since they will be left to operate the modified process, they need to feel that it is theirs.

4. Ensure that environmental effects are considered as important as production when conflicts between the two arise. It may be desirable to make environmental rating one of the evaluation criteria for the base commander.

5. Ensure that adequate funding is provided to support wider adoption of proven process modifications.

6. Ensure that appropriate adaptations are made to all technologies (even off-the-shelf systems) before transferring them to facilities where they have not been tested; thus, each technology will be "tailored" to the individual facility.

7. In view of the typically high turnover rate among operations personnel, ensure that a sufficient number of personnel are trained to provide back-up operation when necessary.

8. Ensure that the data collected to predict costs and benefits of a particular technology are accurate, valid, and sufficient.

9. Ensure that design personnel devote sufficient time, after equipment installation, to inspecting the system for proper operation and maintenance.

10. In considering locations for future demonstration studies, select only facilities where the responsible personnel are enthusiastic about the study.

11. In conducting future demonstration studies, ensure that sufficient manpower is assigned and that the personnel are adequately trained, well supervised, and not fully commmitted to other projects.

12. Whenever possible, make adaptations to off-the-shelf equipment with a proven record of reliability rather than selecting specialized or complicated equipment.

Again, welcome to Pensacola Naval Air Rework Facility for the Project of Excellence Workshop on Innovative Hard Chrome Plating. The remaining sections of these training materials discuss numerous technical, environmental, and economic aspects of this highly successful project to reduce hazardous waste generation from hard chrome plating operations at DoD facilities.

Presented by Richard Boubel, Project Officer, DELP

DEFENSE ENVIRONMENTAL LEADERSHIP PROJECT

INAUGURATED JANUARY 1984

REPORTS TO THE DIRECTOR OF ENVIRONMENTAL POLICY, OASD

PURPOSE

- o TO IMPROVE COMPLIANCE
- o TO REDUCE WASTE

PRESS RELEASE

DEFENSE ENVIRONMENTAL LEADERSHIP PROJECT

Environmental protection is a multi-billion dollar DoD effort. Non-compliance with environmental laws and regulations will adversely impact DoD operations, resources and Congressional support. DoD is the largest federal generator of hazardous wastes, and the public, news media and Congress view environmental protection from hazardous wastes as a high national priority. Environmental protection cannot be avoided or ignored. The nuclear power industry, for example, used the best engineering, planning and economic talent available. The one area overlooked, environmental protection, ultimately crippled the industry.

The environmental leadership project was initiated to provide DoD a needed resource for long-range planning and policy development. The project has undertaken 18 tasks which can be grouped broadly under "compliance" and "waste stream reduction". Compliance is necessary to avoid crippling our installations and production base, and waste stream reduction will reduce disposal costs and future disposal-related problems.

The leadership project approach of planning to avoid problems will ensure least cost compliance. Resources not required for environmental protection are freed for other Defense programs. Effective planning and management are used to identify and solve problems before they become more costly. Environmental protection need not be complex and costly, if handled properly.

The project team is dealing with some tough environmental issues -- problems like groundwater protection, solvent recovery, regional hazardous waste treatment, hazardous waste storage construction criteria, environmental audits, and low-level radioactive waste disposal. These and future issues will improve significantly DoD's national leadership position in environmental protection and avoid the pitfall of non-compliance.

INDUSTRIAL PROCESS MODIFICATION TO REDUCE HAZARDOUS WASTE GENERATION

- o PHASE I - STUDY OF EXISTING INFORMATION
- o PHASE II - IN-DEPTH ANALYSIS OF A FEW DOD INDUSTRIAL PROCESSES
- o PHASE III - SELECT ONE PROCESS FROM EACH SERVICE AS A DEMONSTRATION PROJECT OF EXCELLENCE

DOD NEEDS AN INCENTIVES PROGRAM FOR HAZARDOUS WASTE REDUCTION/RECYCLING

- o TO PROVIDE UP-FRONT MONEY FOR WASTE REDUCTION PROJECTS.
- o TO RETURN BENEFITS TO THE INSTALLATION COMMANDER.

FUNCTIONAL DESCRIPTION OF THE ENVIRONMENTAL, PRODUCTIVITY ENHANCING CAPITAL INVESTMENT (PECI) PROGRAM

THE DEPARTMENT OF DEFENSE

PRODUCTIVITY ENHANCING CAPITAL INVESTMENTS

PROGRAM STATUS REPORT

PREPARED BY

THE DEFENSE PRODUCTIVITY PROGRAM OFFICE

FOR THE

ASSISTANT SECRETARY OF DEFENSE

FOR

MANPOWER, INSTALLATIONS AND LOGISTICS

MARCH 1984

EXECUTIVE SUMMARY

The Department of Defense (DoD) is pleased to report, once again, on the status and achievements of the DoD Productivity Enhancing Capital Investment (PECI) Program. In addition to providing specific information on this program, this report will describe the relationship of the PECI Program to many other DoD productivity initiatives, ranging from established programs for employing modern industrial and management engineering techniques to the Department's relatively new emphasis on work force motivation and efficiency reviews.

The Department is very proud of its efforts. Since the initiation of the PECI Program in 1977, a broad range of avenues for productivity improvement have been investigated and pursued. Many have become institutionalized in DoD management practices. Others are promoted as "self-help" tools whereby managers can cope with the demands of increasing technology and constrained or diminished resources. The Department recognizes that if it is to be effective in maintaining a strong and ready Defense force, it has a commensurate responsibility to do this in the most efficient manner -- a process which means getting the greatest return from the dollar and manpower resources provided by the American taxpayer. DoD's PECI Program is a very necessary effort to this end with a demonstrable impact.

Initially started as a means of capitalizing on small dollar quick return investment opportunities, the PECI Program has since evolved into a broad strategy for productivity improvement. As presently structured, it involves three distinct but directly related funding strategies -- the Productivity Enhancing Incentive Fund (PEIF) for small dollar quick return equipment projects; the Productivity Investment Fund (PIF) which focuses on larger long-term investments with a payback period of four years or less; and Component Sponsored Investment (CSI) funding which complements the OSD-sponsored PIF but is more flexible to react to goals and priorities of the individual Military Service or Defense Agency. Projects financed through each of these funds are selected competitively on the basis of their economic merit and an assessment of their technical and operational potential.

Together these three funding strategies have invested a total of $605 million over the past four years to acquire modern technologies and facilities. The savings from these investments are expected to total over $3.0 billion by 1990, through either direct reductions in Defense budget requests or by allowing DoD managers to plow back savings and thereby accomplish increased missions or attack critical backlogs within fixed resource limitations. Equally as important, these PECI funds have become a cornerstone in many of the Department's other productivity initiatives by

providing ready and dedicated financing for opportunities identified through the Commercial Activities, Efficiency Review and Work Force Motivation Program. PECIs have also served as an avenue to foster infusion of high technology projects into the Defense operational mainstream. Funds have been provided for such wide-ranging projects as DoD's Logistics Applications of Automated Marking and Reading Symbols (LOGMARS) project involving the use of machine readable bar coding in logistics activities and the installation of technologies developed through the Manufacturing Technology Program in the repair of sophisticated weapons systems. Modern equipment has also been procured for the Defense laboratories, enabling them to greatly improve the testing of new materials and systems at significantly lower costs.

Statistics on the PECI Program are impressive. Visible support by top DoD management, a sharp focus on high-payoff investments, and an ultra-conservative level of funding have resulted in a continuing increase in the expected level of returns from PECIs. Savings to investment ratios for the fast payback PEIF investments have grown from approximately $10 to $1 for Fiscal Year (FY) 1977 investments to $13 to $1 for FY 1983 investments. Many of the individual investment projects return about $15 for each dollar invested during their average nine year life span. The larger PIF investments, because of their longer expected life, have shown a much greater growth in expected savings. First funded in 1981, the savings to investment ratios have dramatically increased from 6 to 1 in that year to 14 to 1 for projects included in the FY 1984 Budget request. Projects now in the FY 1985 Budget reflect a ratio of 22 to 1, with an expected internal rate of return of over 80 percent.

In addition to the tangible benefits from PECIs, which include expected manpower savings of over 17,500 spaces, these investments have also produced a variety of intangible benefits such as improved work methods and conditions, increased ability to cope with complex and mounting workloads, and motivation for innovative productivity enhancing actions.

The program complements DoD's Asset Capitalization Program (ACP) in industrially funded activities and planned modernization efforts across the Department. More importantly, it recognizes and acknowledges the fact that the Department's greatest asset is the initiative shown by its people. PECI has received the full support of Defense management at all levels. With its present maturity, it is deserving of the support of the Congress for it represents concrete evidence of DoD's ability to achieve tangible economies through a judicious investment policy.

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2.0 PROCESS DESCRIPTION

2.1 Description of Metal Plating

2.2 Innovative Hard Chrome Plating at Pensacola

Industrial Process Description
Process Modification Description
Process Modification Experience
Future Direction and Other Information

Engineering Support for Development of the Innovative Hard Chrome Plating Process

Description of L.I. Dimmick Corp., Prime Contractor to NCEL
References
Table of Contents: Developmental Test Report
Table of Contents: User Data Package

Presentation by Greg Piner, Cherry Point NARF

Presentation by Gary Whitfield, Pensacola NARF

2.0 PROCESS DESCRIPTION

2.1 Description of Metal Plating

Plating is the deposition of a thin layer of metal on the surface of a basis metal for the purposes of changing the properties of the basis metal. These modifications may be to improve the appearance (decorative plating), to increase resistance to corrosion, or improve hardness, durability, solderability, or frictional characteristics of the basis metal. Plating is a subset of metal finishing, which includes painting and operations that modify the properties of the basis metal (e.g., anodizing of aluminum).

The principal metals plated at military facilities are chromium, cadmium, nickel, and zinc.

Chromium is used principally in the remanufacturing of worn parts whose replacement with new parts would be infeasible because of their unique design. Remanufacturing consists of machining the worn part or stripping a portion of the old plate, overplating with a thick layer of chromium (hard chrome plating), and machining back to original specifications. The remanufactured parts are often of better quality than the original parts due to the thick chromium plate. Parts are typically plated for longer than 24 hours, to achieve the required thickness of chromium.

Nickel, cadmium, and zinc are plated to provide a corrosion protection finish to parts. These coatings are significantly thinner than hard chrome plates, and are applied in minutes, rather than the hours or days required for hard chrome plating. Nickel is applied to new parts for corrosion and wear resistance as well as for rebuilding worn parts. A thin nickel plate is sometimes applied prior to hard chrome plating.

Sacrificial cadmium and zinc coatings are normally applied to protect the basis metal, typically iron or steel. A thin surface coating is normally applied to provide corrosion protection, improve wear or erosion resistance, reduce friction, or for decorative purposes. Since cadmium is significantly more expensive and toxic than zinc, it is used as a protective electroplate only in those circumstances in which its special properties are required.

Cadmium is often selected over zinc as a protective coating in military applications for the following reasons: (1) it is more easily soldered than zinc; (2) its corrosion products do not swell and are not bulky, unlike the "white rust" formed by zinc, and hence do not interfere with functional moving parts; (3) cadmium plating is easier to

control than zinc plating; and (4) cadmium is somewhat superior to zinc in corrosion protection in marine (salt) environments. Parts that are to be cadmium plated typically are cleaned of grease, oil, dust, and rust by undergoing solvent vapor degreasing, alkaline cleaning, and acid pickling. Once a part is cleaned, it is cadmium plated and then heated to remove hydrogen (to prevent hydrogen embrittlement).

2.2 Innovative Hard Chromium Plating at Pensacola NARF Industrial Process Description

The Naval Air Rework Facility (NARF) at Pensacola is a government-owned, government-operated (GOGO) facility employing approximately 4,000 people. The primary mission of the facility is to recondition H-3 and H-53 helicopters and A-4 jet aircraft. Reconditioning consists of disassembly of the aircraft and components, paint stripping, removal of dirt, grease, and corrosion products, remanufacture or replacement of parts, reassembly, and application of protective coatings (plating and painting). Worn parts that would be infeasible to replace new are remanufactured by overplating with chromium (hard chrome plating), followed by machining back to original specifications.

The most common electroplating process found at NARFs, Naval Shipyards (NSY), and Naval Air Stations (NAS) is hard chromium plating. Hard chromium plating methods employed at naval facilities have remained essentially unchanged for more than 20 years despite advancements in plating technology and concerns with environmental pollution. Areas on worn parts which do not require a chromium build-up are masked with wax, aluminum foil, lacquer, or tape. After masking, the parts are fastened to racks and suspended in the plating bath. These racks are then secured to the cathode bus bar using C-clamps, providing physical support for the part and completing the electrical circuit. Heavy lead anode bars are then hung from the anode bus bar and positioned around the racked part. Since the lead anodes are 8 feet long and weigh over 50 pounds each, they cannot be easily removed by one man and so are often left sitting in the plating solution when not in use. This results in the anodes slowly becoming passive and ineffective.

After plating, parts must be rinsed to remove plating solution dragged out of the bath on the parts. Continuous flow rinse tanks are usually used to clean plated parts. Rinse flows range from 3 to 12 gpm, resulting in a cost of $7,000 to $28,000 per year per rinse tank at Pensacola, based on 24 hr/d, 260 d/yr operation, a freshwater cost of $0.34/1000 gal, and a wastewater treatment cost of $5.81/1000 gal.

Hard chrome plating facilities require large production areas since only one or two large parts can be plated at the same time in a single tank and plating times often exceed 24 hours. The period between receipt of a part at the plating shop and delivery to the machine shop is often a week or more. Since these parts are often critical items to the repair of an aircraft, time for maintenance can be significantly extended by plating delays.

Hard chromium plating is considered the most demanding of all plating processes since it requires close supervision and a high degree of quality control. Most parts require a uniform build-up of chrome so that they can be accurately ground and polished to their required dimensions. Unfortunately, platers using current Navy plating methods have had trouble meeting these specifications or quality requirements. Conventional Navy hard chrome plating often results in uneven plating deposits since the anodes cannot be arranged to provide a uniform current density at the surface of parts. Rejection rates have been as high as 40 percent. Parts which are rejected are stripped and returned for replating, resulting in an increased workload for the plating and machine shops and delays in delivery of the remanufactured part.

Plating baths become contaminated with metal ions leached from parts, plating tanks, racks, and anodes, and conversion of hexavalent to trivalent chromium. These impurities can blemish a plated surface, resulting in a reduction of plating efficiency and quality. Once baths are deemed unsuitable for use, they are bled into the industrial waste system. Due to a buildup of impurities, plating baths at Pensacola have been dumped about every two years. Approximately three times a year, plating baths have been accidently discharged to the sewer since these plating tanks were not equipped with high level alarms. The cost of treating plating wastewater and replacing the plating solution with new material is high.

Process Modification Description

In response to the difficulties with the current hard chromium plating process, the Naval Civil Engineering Laboratory (NCEL) at Port Hueneme, California adapted an innovative chromium plating system for use at Navy plating shops (Carpenter, October 1984). The "new" plating process uses technology that was developed over 50 years ago in the Cleveland area; hence the term "Cleveland Process" or "Reversible Rack 2 Bus Bar System." Three of the seven plating baths at Pensacola were converted to the Cleveland process by NCEL as a demonstration of this technology. Approximately 50 percent of hard chrome plating at Pensacola is now performed using this innovative system. Although the

plating method varies considerably from conventional procedures, plating efficiencies greatly improved and the resulting end product meets all military specifications.

Modifications from standard Navy hard chromium plating practice were:

1. Use of conforming anodes and reversible racks to suspend parts instead of the Navy practice of clamping parts on a third cathodic bus bar and using common lead anodes

2. Control by voltage (4.5 volts) rather than by amperage

3. Use of a recirculating spray rinse system (Figure 2-1)

4. Operation at higher temperatures (140°F versus 130°F)

5. Use of a continuous bath purification system to remove contaminating cations from the plating solution (Figure 2-2)

Photographs of the components of this innovative chrome plating system are shown as Figures 2-3 through 2-8 at the end of this discussion.

Use of conforming anodes has produced a more even current density for the Cleveland process, resulting in a more uniform deposit, improved product quality, and an increased plating rate. The reversible racks require considerably less room in the plating tank than the conventional system of clamping anodes and parts to three bus bars. Also, in controlling the process by voltage, rather than by amperage, control of the process is greatly simplified and multiple parts can be plated in the same tank simultaneously.

To assure good adhesion of a new plate to the existing surface, parts are often subjected to a reverse current to etch or roughen the existing surface. The conventional Navy process requires an expensive switching mechanism to reverse polarity of the bus bars for etching; all of the parts in a tank can either be plated or etched at any one time, but both operations cannot be performed concurrently. In contrast, the Cleveland process uses reversible racks that can be picked up and placed in the other direction to reverse current for etching. With this method, some parts in a tank can be plated while others are being etched. As a result, 16 to 20 parts of different sizes and shapes could

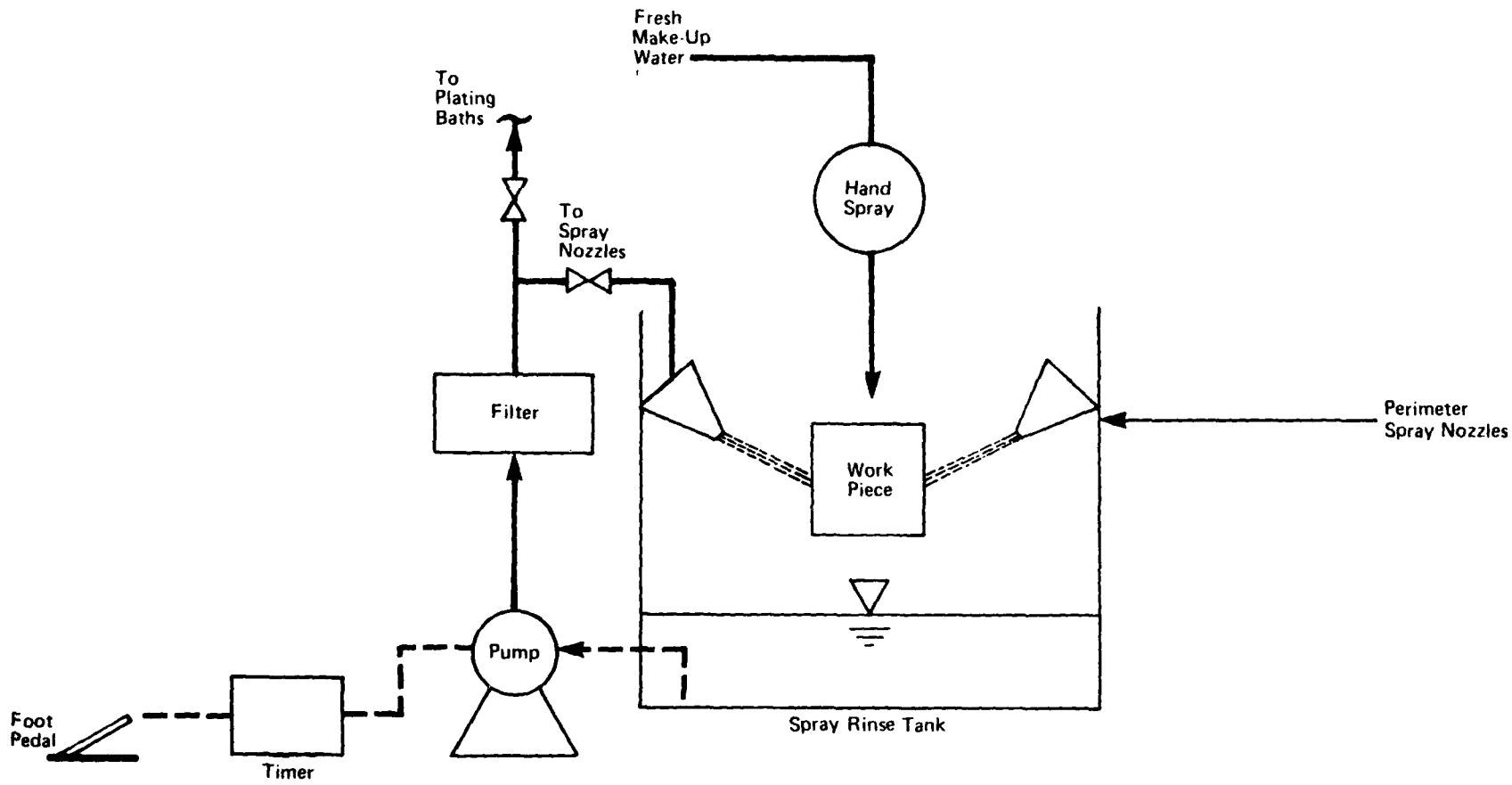

Figure 2-1. Spray rinse system.

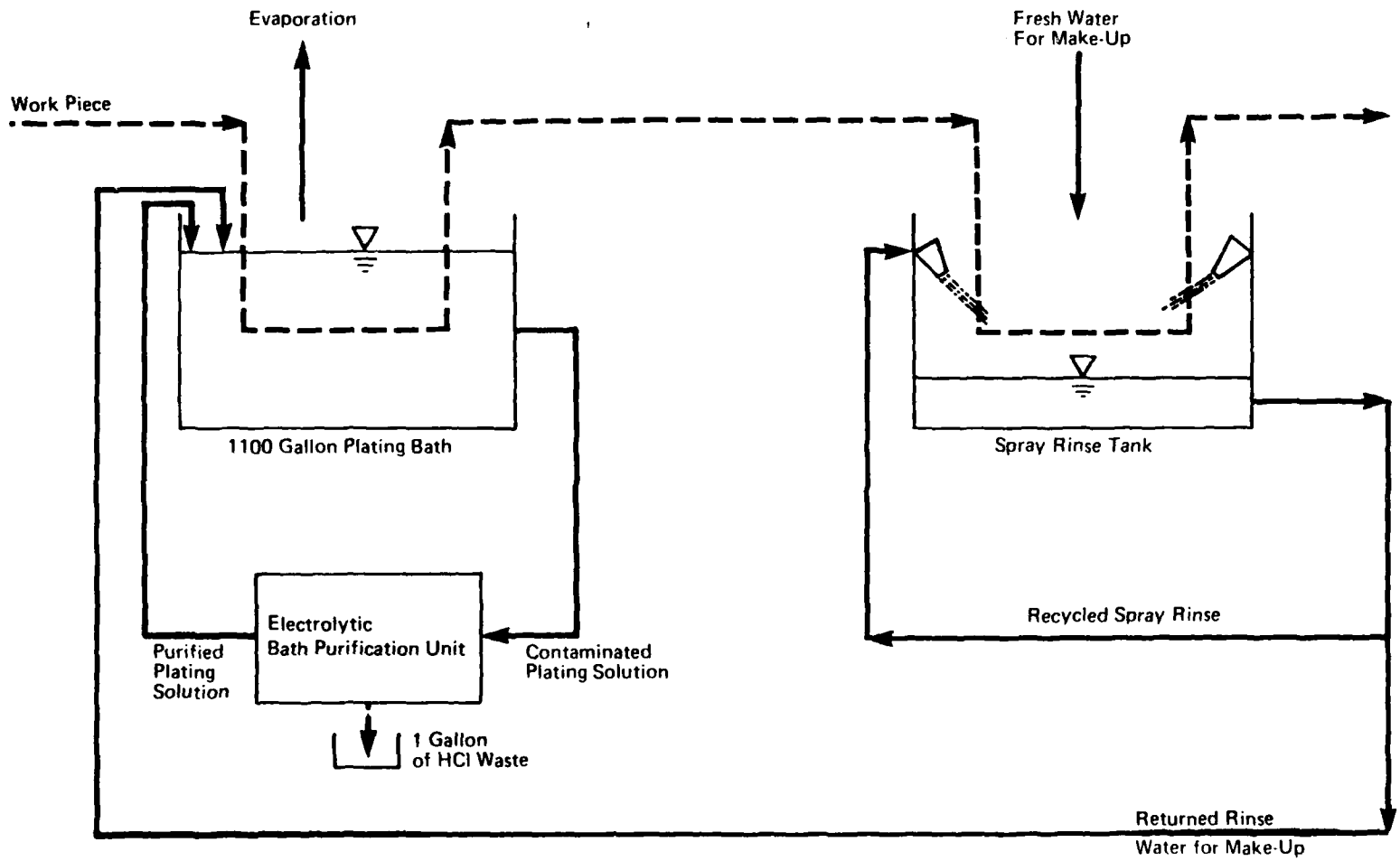

Figure 2-2. Zero discharge hard chromium plating system.

typically be plated simultaneously in one tank, with the Cleveland process, compared to only 6 to 8 in the conventional Navy system.

To reduce the amount of rinsewater used, a prototype spray rinse system was installed in an existing rinse tank. A foot-activated pump recirculates rinsewater through eight high velocity spray nozzles located around the perimeter of the rinse tank. Clean rinsewater is also available via a hand-held sprayer. After repeated use, a portion of the rinsewater is pumped through a cloth filter into the plating tank to replace water lost to evaporation. Operation of the plating bath at a higher temperature has resulted in a higher evaporation rate than in conventional chromium plating as well as an increased plating rate. Because these changes have resulted in a spray rinse system makeup that is less than evaporative losses, the result is a "zero discharge" plating system

Without drag-out to aid in removal of contaminants from the bath, a cleanup process was desirable to reduce the need for plating bath dumps. A "CatNapper-10" treatment system, manufactured by Innova Technology, Inc., of Clearwater, Florida, was installed to continuously remove metal cations from the chromium plating bath. According to the vendor, the "CatNapper" system utilizes a cathode contained within a membrane module to selectively precipitate contaminating metal cations from the plating solution and oxidize trivalent chromium to its hexavalent form. Hexavalent chromium remains on the anode side of the membrane, and is returned to the plating bath. Since impurities are removed from the plating baths, the CatNapper is supposed to extend the life of the bath and reduce the need to increase chrome concentrations or plating voltage. By extending the life of a bath (and thus decreasing the frequency of bath dumps), the CatNapper could indirectly reduce the volume of hazardous waste produced by the plating shop.

Process Modification Experience

Pensacola installed the first demonstration unit, which showed that the Cleveland process could be modified for use at military installations. The Cleveland process is reported to be more "forgiving" than the conventional Navy process. The chromic acid concentration can vary significantly from the standard concentration of 36 oz/gal (e.g., 16 to 40 oz/gal) without a detrimental effect on plating quality.

The conforming anodes in the Cleveland system are attached to the rack and hence are removed with the part, which improves efficiency, and reduces passivation effects, common when conventional anodes are left in the plating tank. Most

conforming anode and rack assemblies (approximately 75 percent) weigh less than 50 pounds and can be handled by a single operator.

Conforming anodes and racks must be fabricated at the facility for each type of part to be plated. First, gridded mats are formed from lead. The mats are then bent to form cylinders. To form large anodes, several cylinders are joined together. Anodes are produced in various diameters and lengths so that they can conform to the size of various parts. The part is then placed inside the anode cylinder and both the anode and the part are attached to the rack. The racks consist of copper cathode bars, aluminum side clamps, and soft steel bolts.

Large parts, such as landing gears, continue to be plated by the conventional process. For large parts, the weight of the total apparatus (rack, conforming anode, and part) would make plating difficult without the use of cranes and so the conventional process is appropriate in these cases. It is also not practical to specially fabricate anodes for unique, large parts which rarely require plating.

Wax is the most commonly used masking material for hard chrome plating. However, since wax melts at 160°F, platers must be careful during plating since bath temperatures of the Cleveland process are kept at 140-145°. To avoid the possibility of melting the wax, many plating shops have switched to masking parts with aluminum foil. They have found that it is generally more economical to install and remove foil, especially if only a small area requires masking. Wax is used on parts which are intricately shaped or have large areas that are not to be chrome plated. Lacquer is sometimes used to mask small parts.

One limitation of the Cleveland process is that it cannot be used for parts chrome plated over a nickel strike. After a part is flash plated with nickel, it must be immediately plated with chromium. With the Cleveland process, too much time is required to remount parts (that have been nickel-plated) to the reversing racks. This represents approximately 15-20 percent of parts that are chrome plated at Pensacola.

NCEL personnel believe that most parts do not require an initial nickel strike. Nickel flash plating is specified for some parts to provide corrosion protection of the underlying basis metal. However, this military specification was written for parts that were originally plated with a decorative chrome layer, in which only a thin deposit (less than 10 millionths of an inch) of chrome covers a part. The specification was inadvertently applied

to hard chrome plating. Due to the thickness of chrome plate required on worn parts, the nickel plate provides no additional protection against corrosion and wear. Gary Whitfield, who is a chemist at Pensacola, and personnel at NCEL have been trying to revise the current military specification so that parts which are hard chrome plated would not require a nickel strike. Laboratory tests are being performed at NCEL to verify that nickel plating is not necessary for parts that are to be hard chrome plated. If they are successful in modifying the specification, all parts could be chrome plated by the Cleveland process.

A partial list of the costs of implementing the Cleveland process at Pensacola is presented in Table 2-1. Costs for manufacturing of racks and conforming anodes, engineering, testing, and training were unavailable.

The process modifications resulted in an initial increase in the average plating rate from 0.002 to 0.004 inch per hour. There was also a significant increase in production because the rack design enabled a significantly greater number of parts to be plated concurrently. As many as 40-50 small parts have been plated in one tank with the Cleveland process. Combining the effects of increased plating speed and plating rack design resulted in a sixfold increase in production.

By the end of 1984, however, the average plating rate had decreased from 0.004 to 0.003 inch per hour. Plating rates became so erratic that platers could no longer predict how long it would take to coat a specific part. Plating personnel expressed the belief that this recent decrease in plating rates was due to build-up of dirt and oxide film on racks, conforming anodes, and tanks. They speculated that a change in bath chemistry may have also contributed to the problem. Charles Carpenter from NCEL expressed his opinion that the reduction in plating rates was due to improper operation and maintenance of the process modifications. He stated that operators often were not maintaining the control voltage at 4.5 volts throughout the plating process. Platers may also have been placing the conforming anodes further than the recommended 2 inches from parts, resulting in a reduction in plating rates.

A high personnel turnover rate at Pensacola has contributed greatly to the problems, because only four platers had been trained on the new system when the process modification was first implemented. These platers attended a week-long course in Cleveland taught by C. Peger of Hard Chrome Plating Consultants Ltd., followed by an additional week of hands-on training at Pensacola. Since this initial training, two of the trained operators have transferred to other departments. Operation and maintenance of the plating

Table 2-1
CAPITAL COSTS, INNOVATIVE CHROMIUM PLATING SYSTEM
(Carpenter, October 1984)

Item	Preliminary Estimate	Actual Cost
Convert 3 Plating Tanks		
Equipment, Materials	--	$5,950
Labor	--	--
Subtotal	$7,000	$5,950
Bath Purification System		
CatNapper & Rectifier	--	$8,900
Misc. Equipment	--	$1,460
Labor	--	$1,000
Subtotal	$8,000	$11,360
Spray Rinse System		
Equipment	--	$2,140
Labor	--	$1,800
Subtotal	$8,000	$3,940
TOTAL INSTALLED COST	$23,000	$21,250

Note: Dash indicates cost data not available.

shop is made difficult because trained personnel often transfer to higher grade positions in other departments when they become available. The remaining platers have received no formal training and learned about the process modification indirectly from the other platers. In the last year, as many as 50 personnel from three shifts have rotated in and out of the plating shop. Plating personnel seem eager to receive training on the Cleveland process.

NCEL implemented the Cleveland process at Pensacola as a demonstration of the technology. At that time, NCEL did not realize the importance of training all personnel involved with hard chrome plating. Since the prototype installation, NCEL has installed the Cleveland process in three other Navy plating shops. Personnel at the other facilities have received in-depth training on the Cleveland process. In response to the problems encountered at Pensacola, NCEL has budgeted additional funds to train Pensacola platers in the summer of 1985. It is believed that this additional

training and subsequent proper operation and maintenance of the Cleveland process will result in an improvement in production and product quality.

The recirculating spray rinse system and bath purification unit have not been properly maintained because some personnel consider the equipment to be a temporary prototype system. The reversible racks and conforming anodes have been better accepted and consequently have been better maintained. About 4-6 hours per week are spent repairing and remanufacturing anodes and racks.

The compositions of plating baths are monitored by a chemist and a technician at the NARF. Once a week, samples are analyzed to determine the chromic acid and sulfate concentrations. The baths are maintained at a chromic acid to sulfate ratio of 80-90 to 1. Problems develop when this ratio exceeds 100-110 to 1. Once every 3 weeks, the baths are analyzed for trivalent chromium concentrations. The chemist controls all chemical additions to the plating baths.

Facilities Engineering at Pensacola reported that they considered the spray rinse system an improvement over the previous countercourrent rinse system. During the initial 4-month test period (March-June 1984), water use was reduced from 350,000 gallons per month per bath for countercurrent rinsing to about 1,200 gallons per month of freshwater used for spray rinsing. Since this was less than the evaporation rate from the plating bath, all of the spray rinsewater was used for plating bath makeup, resulting in "zero discharge."

Not convinced that the spray rinse was adequately removing drag-out from parts, platers recently installed a dead rinse tank (i.e., no inflow or outflow) to the chromium plating line for use after a part is rinsed in the spray tank. Although NCEL personnel showed that the spray rinse system was effective in removing drag-out, the platers remained reluctant to eliminate this dead rinse tank. Some platers do not bother to rinse parts with the recirculating spray rinsewater but instead use fresh water from the hand-held spray gun and the dead rinse tank for cleaning.

The contents of the dead rinse tank (approximately 500 gallons) are dumped to the industrial sewer once a week. An additional 10,000 gallons per month of fresh water is currently being discharged to the sewer due to a leak in the freshwater spray rinse gun. Because of these deviations from proper operation, the goal of zero discharge is no longer being achieved by the innovative chromium plating system. By reverting to cleaning parts exclusively with the spray rinse system and properly maintaining the rinse equipment, zero discharge could again be achieved.

The spray rinse system has produced total savings of approximately $25,000 per year per bath, principally due to reduced industrial wastewater treatment costs. Of this savings, $128 per year is attributable to recovering 108.7 pounds of chromic acid.

The CatNapper system was found to be ineffective in removing impurities from the chromium plating bath during an initial trial run. The system was plagued by failure of the teflon membrane modules, caused by a change of material by a supplier. The membranes were reconditioned and placed back into service. NCEL plans to replace the membranes in the summer of 1985 because they believe the membranes are not functioning properly. NCEL planned further testing of the CatNapper system during March 1985, but these tests were canceled due to failure of the recirculating pump. NCEL estimated that it would take 2 to 3 months for the pump to be replaced. Until then, the CatNapper is scheduled to be out of service. NCEL plans to perform additional testing once the CatNapper is put back in service, to determine the metal impurity removal rate. NCEL also plans to investigate the limits of contamination that can be tolerated in a hard chrome plating bath before plating quality becomes unacceptable.

The manufacturer recommended that the ten membrane modules be cleaned once a week and stated that the cation precipitates could be easily scraped off the membranes or dissolved in hydrochloric acid (17 percent solution). NCEL found that it was difficult to physically scrape the impurities from the membranes; therefore, the membrane modules have been removed from the unit and cleaned by immersion in 1 to 2 gallons of hydrochloric acid.

Future Direction and Other Information

The plating shop at Pensacola NARF is scheduled to be completely renovated to improve both production and safety. It is anticipated that permanent spray rinse systems and bath purification units will be installed in the new hard chromium plating lines. An undetermined number of the remaining four hard chrome plating tanks will be converted from the existing conventional process to the Cleveland process.

Following the successful demonstration of the prototype test installation at Pensacola NARF, NCEL has installed the Cleveland hard chrome process at Louisville Naval Ordnance Center, Puget Sound NARF, and Pearl Harbor Naval Shipyard. The system was also installed at the Cherry Point NARF without NCEL's financial or technical assistance. There are plans to have the innovative plating system installed in all 16 of the Navy's hard chrome plating shops by 1988, and

approximately $1.5 million has been allocated for that purpose. Army personnel attended a 2-day training session at Pensacola NARF in February of 1985 to learn the principles of the Cleveland plating process. The Army now plans to install the innovative plating process in three of its hard chrome shops.

NCEL has tailored the innovative chrome process to fit the space and operator preferences of each individual facility. NCEL has worked closely with each facility's plating personnel to foster acceptance of the process modification and to minimize disruption of normal operations. For example, the plating foreman at Louisville prefers manual operation and control of plating baths. Therefore, NCEL did not install extensive instrumentation and control (I&C) systems, except for high level alarms on the plating tanks. In contrast, at Puget Sound an elaborate I&C system was installed because personnel there were more receptive to automatic control.

CatNappers were installed at Pearl Harbor and Puget Sound. A unit similar to a CatNapper, manufactured by Pfaulder, was installed at Louisville. This device uses unglazed "clay pots" for the anode membranes and a stainless steel cathode. NCEL is evaluating which manufacturer's equipment is more effective at removing contaminating cations.

Although a continuous bath purification system was not installed at Cherry Point, the plating chemist closely maintains the proper bath composition and periodically removes dissolved solids by precipitation. As a result, baths have only needed to be dumped at 5- to 10-year intervals.

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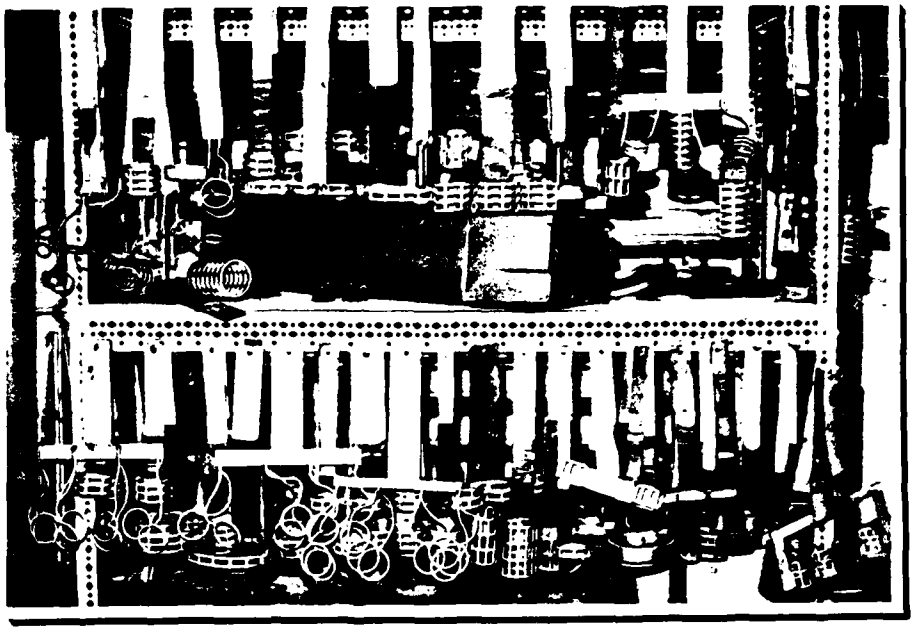

Figure 2-3. Assortment of conforming anodes.

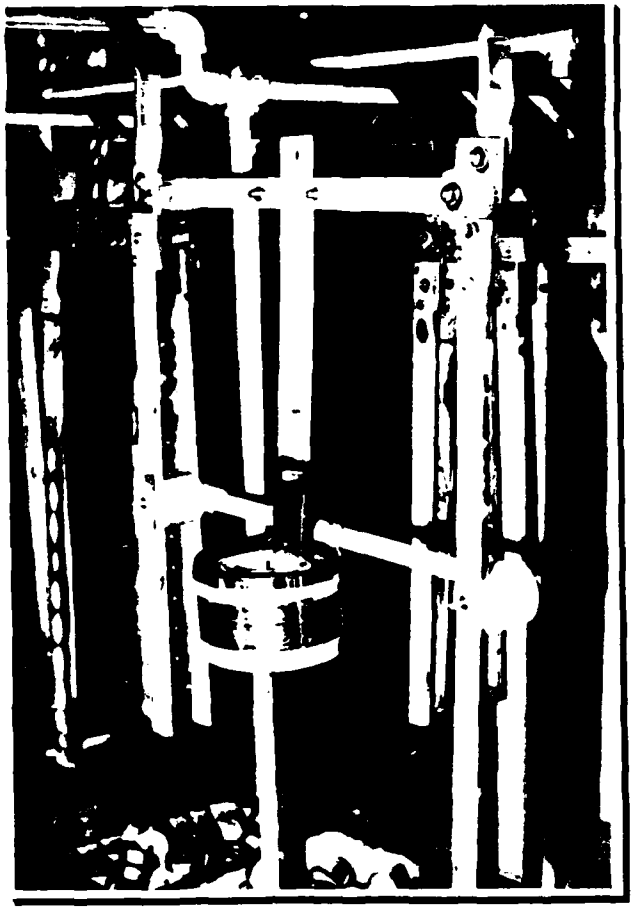

Figure 2-4. Reversible rack with conforming anode.

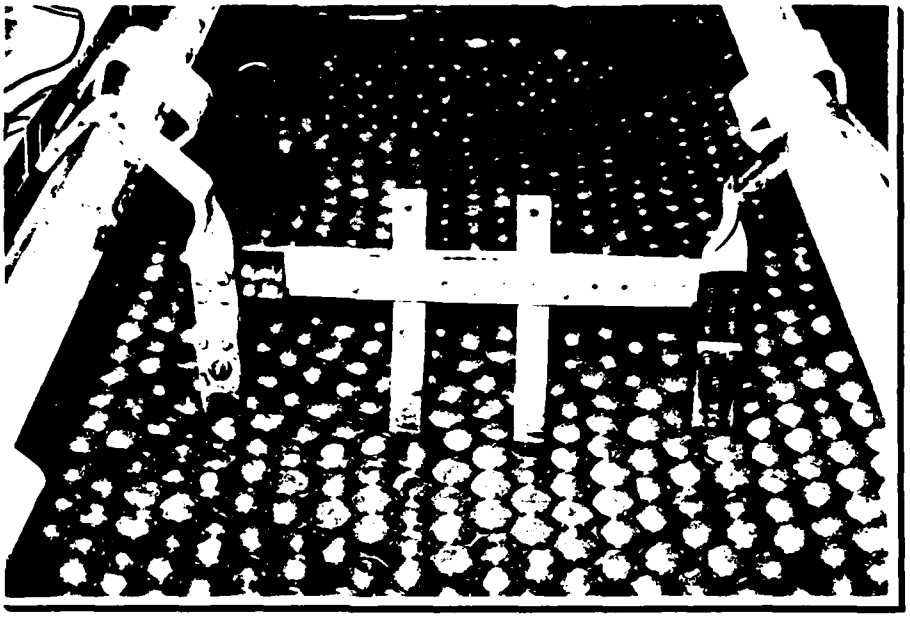

Figure 2-5. Chrome plating bath with 2 bus bars and reversible rack.

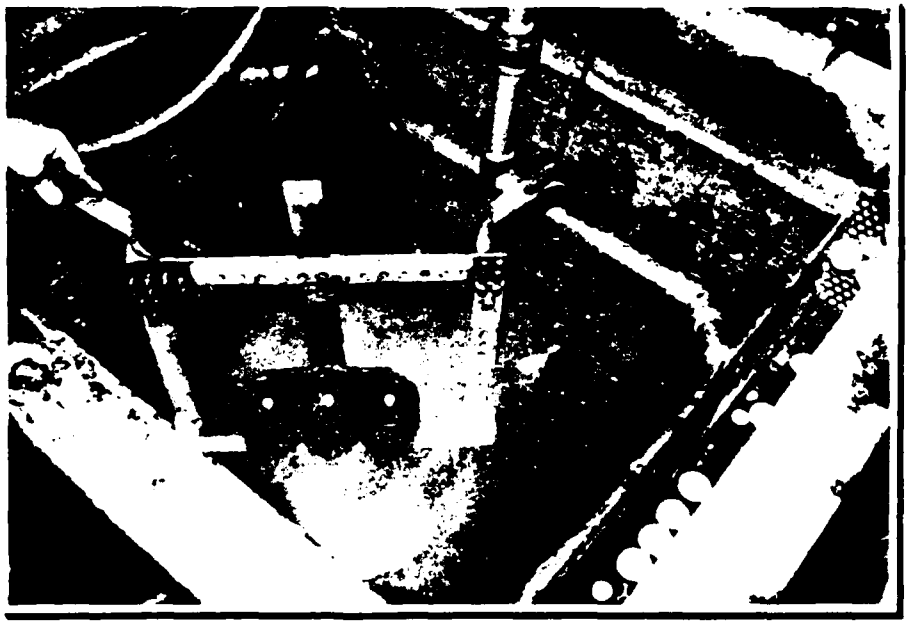

Figure 2-6. Spray rinse of plated part and reversible rack.

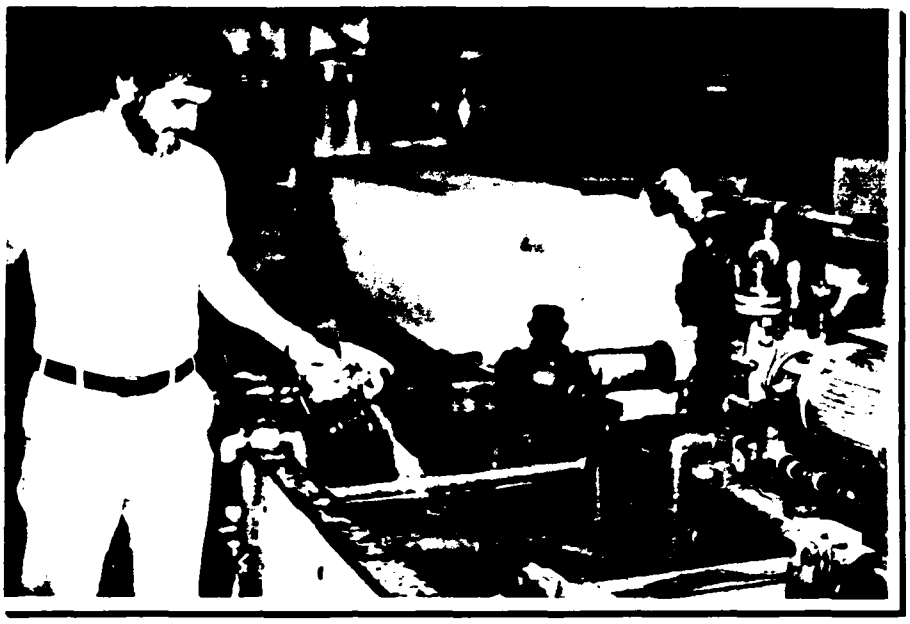

Figure 2-7. Hand spray rinse.

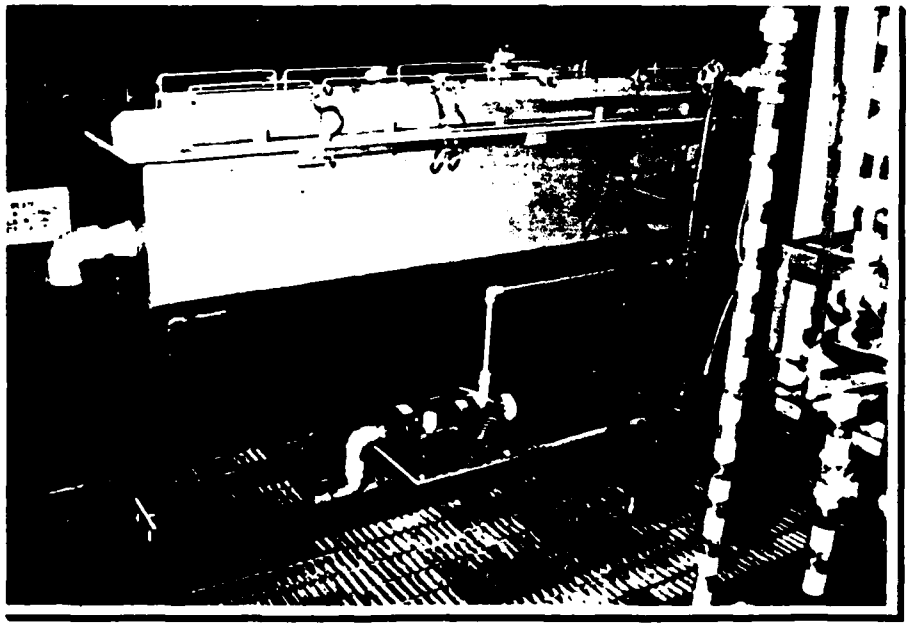

Figure 2-8. "CatNapper 10" electrolytic plating bath purfication system.

ENGINEERING SUPPORT FOR DEVELOPMENT OF INNOVATIVE HARD CHROME PLATING

L. I. DIMMICK CORPORATION (LIDCO)

LIDCO is the consulting engineering firm which, as prime contractor for the Naval Civil Engineering Laboratory (NCEL), was responsible for aspects of the design, installation, start-up, testing, and evaluation of the innovative hard chrome plating (IHCP) system implemented at Louisville NOC, Puget Sound NSY, and Pearl Harbor NSY. The IHCP work was conducted by George C. Cushnie, Jr., a recognized environmental authority in the electroplating industry, and Charles G. Roberts. While formerly with CENTEC Corp., Messrs. Cushnie and Roberts authored the Navy Technology Assessment and Initiation Decision Report, published by NCEL, leading to implementation of the IHCP.

LIDCO's scope of activities includes environmental, energy, production, and computer consulting for both government and industrial clients.

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L. I. Dimmick Corporation
8/85

DEVELOPMENTAL TEST REPORT OF THE

INNOVATIVE HARD CHROME PLATING PROCESS

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Presented by Greg Piner, Cherry Point NARF

HOW TO TELL IF YOU HAVE CHROME PLATING PROBLEMS

1. ASK MACHINE SHOP
2. COUNT REJECTS
3. LOOK AT INCOMING TABLE
4. LOOK AT SHIPPING AREA
5. WHAT KIND OF TURNAROUND TIME
6. COUNT NUMBER OF PARTS IN TANK
7. LOOK AT AMP METER ON RECTIFIER
8. ASK HOW MUCH CHROME PLATE OVER PRINT
9. RINSE DOWN BUS BARS, LOOK FOR STEAM
10. ASK THE PLATERS

THINGS TO REMEMBER WHEN CONVERTING CHROMIUM TANKS

1. SET REALISTIC OBJECTIVES
2. ENSURE ONE PERSON IS RUNNING OPERATION
3. COMMUNICATE
4. ENSURE TOP AND BOTTOM SOLD ON IDEA
5. LEARN ANODE MAKING SKILLS EARLY
6. DON'T EVER UNDERESTIMATE THE ABILITY OF TINY PROBLEMS STOPPING THE ENTIRE OPERATION
7. IF YOU HAVE MORE THAN ONE SHIFT YOUR PROBLEMS SKY ROCKET
8. KEEP WRITTEN RECORDS OF PROGRESS OR LACK OF IT

INNOVATIVE HARD CHROME PLATING INFO FOR H-46 -67 PINS

	Case 1	Case 2
Plated	4 hours	5 hours
Volts	4.4 on parts	4.6 on parts
Amps	600 - 625	700 - 710
Current Density	4.4 amps/in^2	4.9 amps/in^2
Plating Rate	3.75 mils/hr	4.2 mils/hr

Presented by Gary Whitfield, Pensacola NARF

A. The Five Most Important Operating Conditions in Chrome Plating:

1. Bath Composition.

a.

Material	Specification
Chromium Trioxide	O-C-303
Sulfuric Acid 93%	O-S-801

b. Concentrations

NARF/PN

Chemicals	Operating Limits	Ratio
CrO_3	33-36 oz/gal*	80 to 1
$SO_4^{=}$	.42-.45 oz/gal	

*avoirdupois (ounce), 1 oz = 28.35 grams.

2. Chromic Acid to Sulfate Ratio ($CrO_3/SO_4^{=}$)

a. $CrO/SO_4^{=}$ ratio influences both the rate of chrome deposition and the throwing power of the bath.

b. 20 to 54 oz/gal could be used, but the $CrO_3/SO_4^{=}$ ratio will stay at about 80-100 to 1.

c. Lowering the ratio increases the plating speed.

d. Too high a ratio tends to induce burning or graying on the high current density areas.

3. Trivalent Chromium Concentration

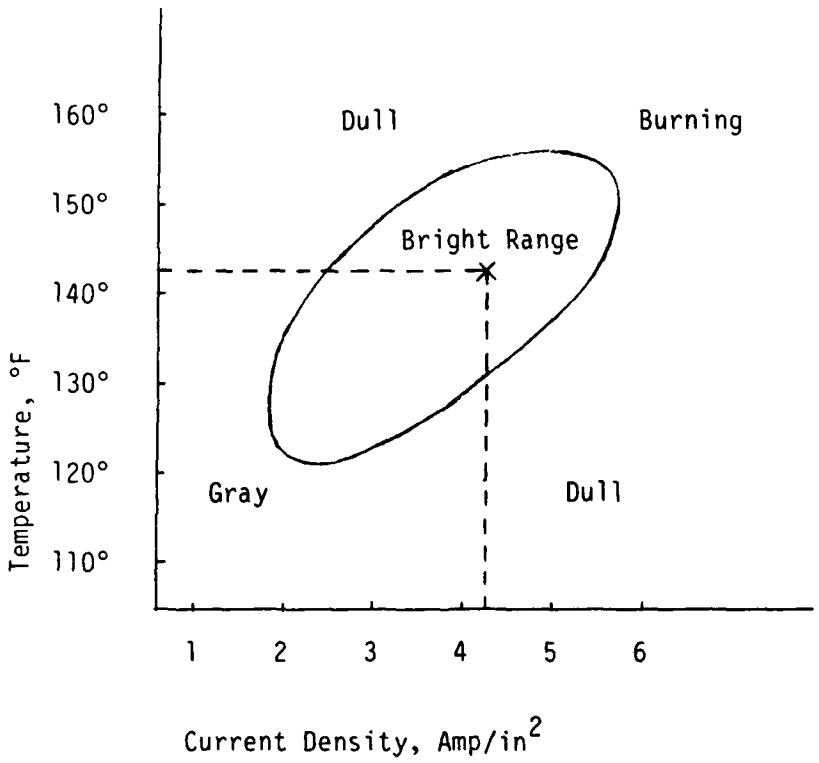
a. Deposition of chrome metal is accompanied by the formation of trivalent chrome (Cr^{3+}), which is continually reoxidized to the hexavalent state (Cr^{6+}) at the anode. Trivalent chrome properly maintained in equilibrium is about 1-2% of the chromic acid concentration.

b. Anode deficiencies or bath contaminants cause the Cr^{3+} concentration to increase. This will result in lower plating speeds, excessive pitting and trees.

c. Anodic oxidation readily restores the chrome to its hexavalent state.

4. Temperature

a. Temperature and current density are dependent on each other.



Plating at 4.5 volts uses about 4-4.5 Amps/in^2 when the bath is operated at 140° to 145° F. Under these conditions the plating is still in the bright range.

5. Current Density

a. Plating at a constant 4.5 Volts, the Amps used will depend on the temperature of the part and the bath. For example:

1. @ 130°F, constant 4.5V, Current density is about 3.8 Amps/in^2

2. @ 140°F, constant 4.5V, Current density is about 4.5 Amps/in^2

b. Plating rates using a constant 4.5V are very dependent on the temperature of the bath, as seen above. Best results using this system require the bath to be at 140 ±1°F.

B. The above operating conditions are true for conventional and reversible rack plating. Most conventional chrome plating baths can be used by the reversible rack method without any modifications. Care must be taken when using mixed catalyst (fluoride or silicofluoride) bath. This type of catalyst bath may etch parts in low current density areas. When the reversible rack method of masking is used, this etching is likely to occur. It is best to use the standard chrome plating bath made of chromium trioxide, sulfuric acid, and water.

3.0 ALTERNATIVE PROCESS MODIFICATIONS

3.1 Housekeeping Practices

3.2 Drag-Out Reduction

3.3 Rinsewater Modifications

- Spray or Fog Rinse
- Still or "Dead" Rinse Tanks
- Rinse Tank Mixing
- Water Supply Control Valve(s)
- Conductivity Controllers or Timers
- Cascade Rinsewater Recycling
- Countercurrent Multiple Rinse Tanks

3.4 Chemical Recovery Systems

- Evaporation
- Reverse Osmosis
- Ion Exchange
- Electrodialysis
- Donnan Dialysis
- Coupled Transport

3.5 Material Substitution

- Non-Cyanide Baths
- Vacuum Deposition of Cadmium
- Ion Vapor Deposition of Aluminum
- Trivalent Chromium Baths

3.0 ALTERNATIVE PROCESS MODIFICATIONS

Several process modifications have been proposed to reduce the generation of hazardous metal plating wastes at their source. These include improved housekeeping practices, reducing drag-out and modifying rinsing, recovering metals from rinsewaters, reduction or elimination of tank dumping, and changing to less hazardous plating materials. Each of these modifications is discussed in detail in this section of the report.

3.1 Housekeeping Practices

Production rates can be increased, product quality can be improved, and hazardous wastes can be decreased by improving housekeeping practices. Although good housekeeping requires little or no capital investment, significant savings in raw material usage and wastewater treatment can be realized. The following list of housekeeping practices, although not all-inclusive, could save plating shops thousands of dollars a year:

1. Repair all leaking tanks, pumps, valves, etc.

2. Inspect tanks and tank liners periodically to avoid failures that may result in bath dumps. Inspect steam coils and heat exchangers to prevent accidental contamination of steam condensate and cooling water or leakage of condensate and cooling water into the plating bath.

3. Install high level alarms on all plating and rinse tanks to avoid accidental bath dumps.

4. Maintain plating racks and anodes to prevent contamination of baths. Remove racks and anodes from baths when not in use.

5. Minimize the volume of water used during cleanup operations.

6. Properly train plating personnel so that they understand the importance of minimizing bath contamination and wastewater discharge.

7. Properly clean and rinse parts prior to plating to minimize contamination of the plating bath. Areas that are not to be plated should be masked or stopped off with tape or wax to limit corrosion from these areas. Parts should be removed from the bath when not being plated.

3.2 Drag-out Reduction

To evaluate the effectiveness of drag-out reduction, existing drag-out must be quantified. For example, the drag-out from barrel plating tanks is usually ten times greater than that removed from baths employing rack plating. The shape and design of the parts, racks, and barrels can also significantly affect drag-out rates.

It is clear that modifications should first be implemented to reduce bath dumps before concentrating on reducing drag-out. A more favorable rate of return is realized by implementing drag-out reduction techniques at decorative chrome, cadmium, and zinc plating lines, where plating times are relatively short and drag-out is significantly greater than in hard chrome plating.

Drag-out can be reduced by decreasing either bath viscosity or surface tension. Viscosity can be reduced by reducing the chemical concentration of the bath or by increasing temperature. Surface tension can be reduced by either adding non-ionic wetting agents or increasing bath temperature. These modifications improve the drainage of plating solutions back into plating baths or reduce the concentation of metal in the drag-out. Lowering the velocity of withdrawal of parts from a bath can drastically reduce the thickness of a drag-out layer, due to surface tension effects.

Drag-out can be captured by the use of drain boards, drip bars, and drip tanks and returned to the bath (Figure 3-1). These simple devices save chemicals, reduce rinse requirements, and prevent unnecessary floor wetting (U.S. Environmental Protection Agency, January 1982). Significant drag-out reduction can be accomplished if platers carefully rack and remove parts so as to minimize entrapment of bath materials on surfaces and in cavities.

Air knives can be used to knock plating films off parts and back into process tanks. This technique is particularly effective in removing ambient temperature solutions from plated parts. Spray rinses are also effective in removing drag-out from parts. The part is held over the plating tank and sprayed with rinsewater. Over 75 percent of plating chemicals drain back to the plating bath. Spray rinsing is best suited for flat parts that are hard chrome plated since evaporation rates in these baths can exceed rinsewater requirements (CENTEC, February 1984).

3.3 Rinsewater Modifications

Reduction in rinsewater flows may not reduce the amount of toxic metals to be disposed of, but it can reduce the volume

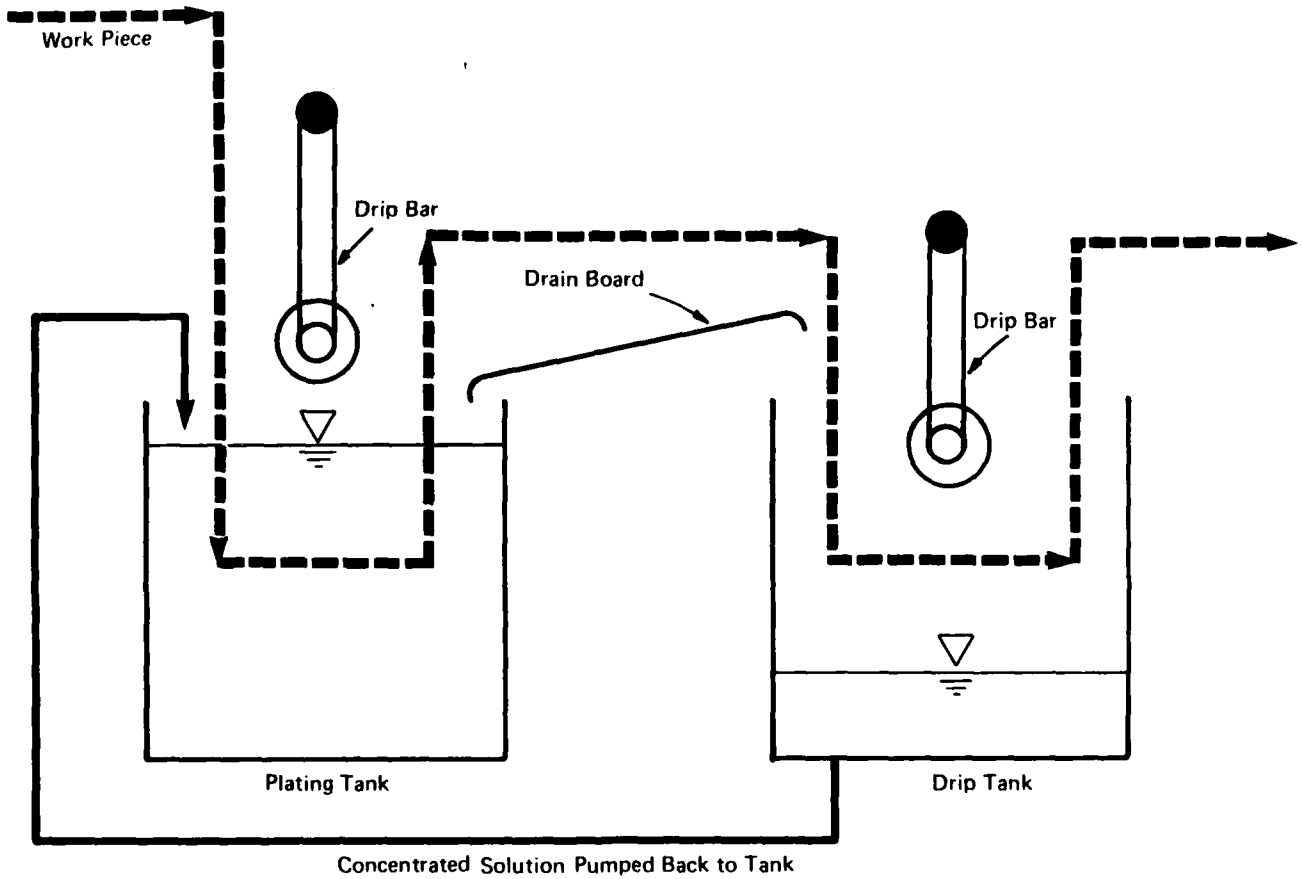


Figure 3–1. Drag-out recovery devices.

of liquid waste that must be processed in industrial wastewater treatment plants. However, concentrations of metals would increase, resulting in possible adverse impacts on treatment. Thus costs of wastewater treatment may not be appreciably reduced, especially if treatability is impaired.

If the rinse flow rates are reduced sufficiently, it is possible to utilize rinsewater to make up for evaporative losses in the plating tanks, resulting in metal recovery and reduced waste discharge. Reducing flows can also increase the efficiencies of metal recovery processes, such as ion exchange, electrodialysis, and reverse osmosis.

The following are descriptions of techniques that have been developed to improve rinse efficiency.

Spray or Fog Rinse

This method can be used to improve the efficiency of rinsewater use. Drainage can be directed back into the process tank if evaporation is sufficient, or into a drag-out tank.

Still or "Dead" Rinse Tanks

These can be used prior to flowing clean water rinse tanks. Water from the drag-out tank or still rinse tank can be returned to the bath to make up for evaporation losses. Increasing plating bath temperatures to increase evaporation may be justified.

Rinse Tank Mixing

This technique can increase the efficiency of water use (Figure 3-2). A submerged influent water line evenly distributes fresh water through the tank and creates a rolling action, enhanced by aeration. Existing facilities can be retrofitted with these modifications using inexpensive PVC piping.

Water Supply Control Valve(s)

In the interest of reducing rinsewater flows to the minimum, these inexpensive devices (approximately $30) regulate the feed rate of fresh water within a narrow variation of flow despite variations in line pressure. These controllers can usually be set to regulate flow within a 1/2-gpm range.

Conductivity Controllers or Timers

These can be used to operate rinsewater control valves, thereby reducing demands on plating personnel. Conductivity control operates on the principle that clean water has a

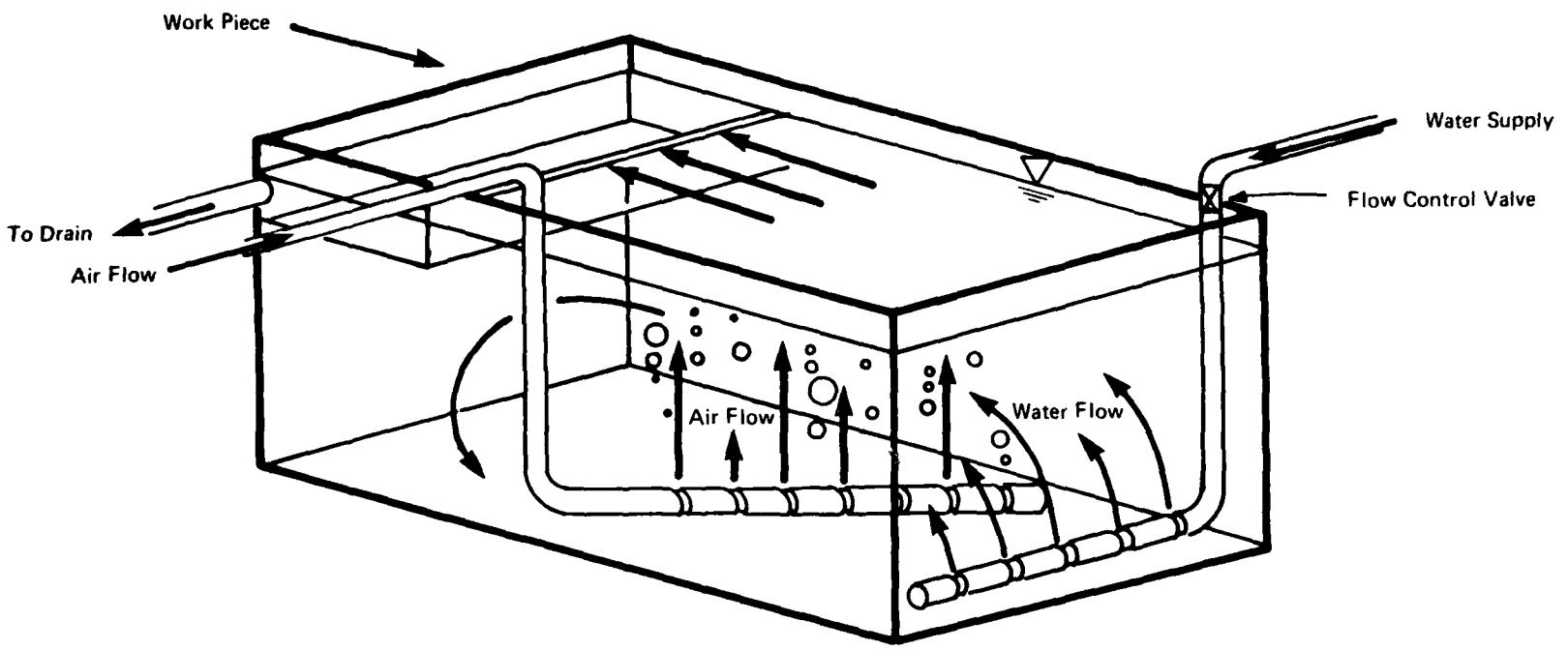


Figure 3–2. Improved rinse tank design.

lower conductivity than water contaminated with plating solutions. Timer controls operate on a preset cycle. Conductivity control is preferable when the amount and type of work varies greatly from day to day. Timers are adequate when production is reasonably uniform. A conductivity probe, controller, and valve reportedly can cost less than $1,000 to purchase and install (U.S. Environmental Protection Agency, June 1979). Conductivity controllers have been installed in many Navy and Air Force plating shops. Unfortunately, these units have not performed well in most installations, resulting from the probes' lack of ruggedness and need for frequent calibration and cleaning. In addition, many controllers are constructed of materials subject to corrosion. Also, selecting the optimum minimum and maximum conductivity setpoints can be difficult. Many platers have overridden or disconnected these conductivity controls due to dissatisfaction with their operation.

Cascade Rinsewater Recycling

In this technique, overflow from one rinse tank is used as the water supply for another compatible rinsing operation. For example, rinsewater effluent from an acid dip tank can be cascaded to an alkaline cleaner rinse tank. Interconnecting rinsing tanks can complicate operations, but the cost savings often exceed the additional operation cost.

Countercurrent Multiple Rinse Tanks

This arrangement can reduce rinse flows by over 95 percent compared to single overflow rinses. Optimum countercurrent rinsing usually employs three tanks operating in series, with parts sequentially immersed in each of the three tanks, countercurrent to the rinse flow (Figure 3-3).

The concentration of plating solution in each successive rinse tank can decrease by a factor of ten. For example, assume that the drag-out concentration of a plating bath contains 40,000 mg/L of dissolved solids, and the final rinse is limited to 40 mg/L. Concentrations of dissolved solids in the three multiple rinse tanks could be controlled to 4,000, 400, and 40 mg/L. For a drag-out rate from the plating bath of 1.0 gal/hr, a countercurrent rinse flow of 10 gal/hr would be sufficient, as compared to 1,000 gal/hr for a single rinse tank.

Many military facilities do not include countercurrent rinsing because the required additional space is often not available, and because of the additional production time since parts must be rinsed at more than one tank. Where space is available, the cost of additional rinse tanks can range from $1,000 to $10,000 per tank, depending upon size, shape, and materials of construction.

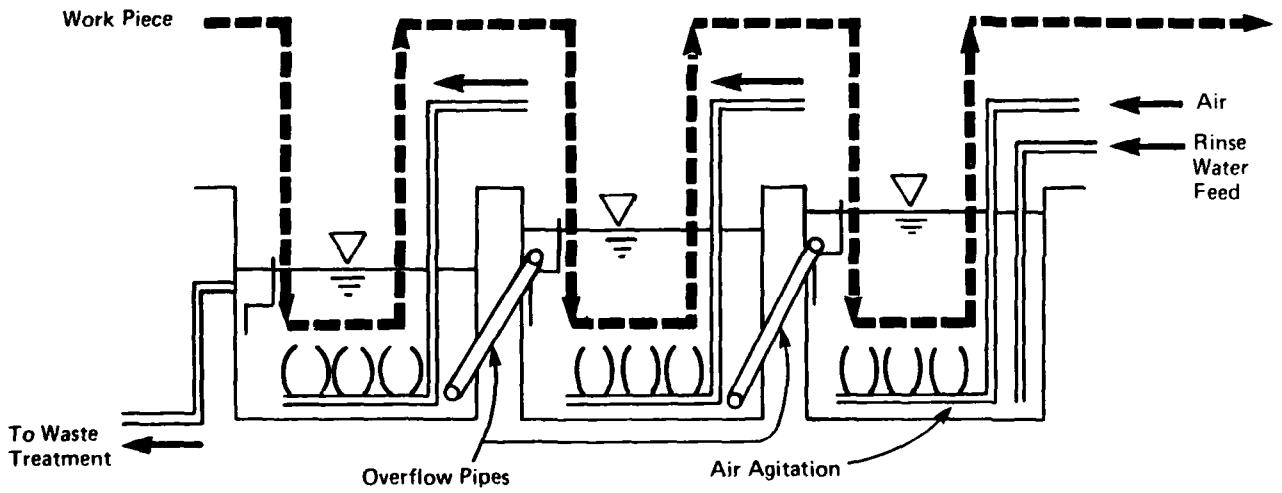


Figure 3–3. Three-stage countercurrent rinse system.

Countercurrent rinse systems can be retrofitted in existing tanks by adding baffles, weirs, pipes, and pumps. Savings vary considerably due to differences in costs of raw water and wastewater treatment. At many facilities, the payback period can be as short as one year. Further savings can be realized when plating solution is recovered by returning the most concentrated rinsewater to the plating bath to make up for evaporative losses. Similar savings can be accomplished by employing a "dead" or "still" rinse, followed by a flowing rinse. The contents of the still rinse are periodically returned to the plating bath to recover the plating chemicals.

3.4 Chemical Recovery Processes

Evaporation, reverse osmosis, ion exchange, electrodialysis, Donnan dialysis, and coupled transport have been used to recover chemicals from rinsewaters. These processes reconcentrate plating solutions from rinsewater and produce a relatively pure water, which is reused for rinsing. Both general and site-specific factors must be evaluated to determine the recovery process which is best suited for a particular plating operation. Factors include: the metal being plated, drag-out rates, rinsewater concentrations and flows, space requirements, manpower requirements, availability of utilities (steam, electricity, etc.), and costs for water and wastewater treatment and sludge disposal.

Evaporation

Evaporation is the oldest method used to recover plating chemicals from rinse streams. In this process, enough rinsewater is boiled off to concentrate the solution sufficiently to be returned to the the plating bath. The steam is then condensed and reused for rinsing. Evaporators are operated under a vacuum to lower the boiling temperature in order to reduce energy consumption and prevent thermal degradation of plating additives.

Because of their high energy use, evaporators are most cost-effective in concentrating rinsewaters that are returned to hot baths, such as those used in chromium plating, where high evaporation rates reduce the concentration required. However, evaporative recovery has been used for ambient temperature nickel baths and various metal cyanide baths. The capital and operating costs of an evaporator can be reduced by employing countercurrent rinsing to produce a low-volume, concentrated rinse stream. One study estimated that chrome plating shops at Naval shipyards could save $17,000 a year (1983 dollars) by employing a countercurrent rinse system in conjunction with evaporative recovery

(Moore, Gardiner & Associates, July 1983). The payback period was estimated to be less than one year.

In order to maintain a "zero discharge" or "closed loop" system, it is necessary to periodically remove impurities from the plating bath (Figure 3-4). Divalent metal impurities such as iron and trivalent chromium need to be removed from chromium plating baths. Nickel baths are usually purified by activated carbon adsorption. Carbonates, the principal impurities in cyanide baths, are normally removed by chemical precipitation (Hartley, May 1978). Suspended solids are removed by cartridge filtration.

The degree of concentration required of the evaporator can be reduced by increasing the evaporation rate from plating baths. Increasing the operating temperature can significantly increase the evaporation rate, but only at the expense of increased heating costs. Use of air agitation in a plating tank can also increase the surface evaporation rate. Evaporation can be increased by removing mist suppression "ping-pong" balls from plating tanks; however, this modification would also increase the loss of metals.

Reverse Osmosis

Reverse osmosis (RO) is a demineralization processs in which water is separated from dissolved metal salts by forcing the water through a semipermeable membrane at high pressures (400 to 800 psig). The basic components of a RO unit are the membrane, a membrane support structure, a containing vessel, and a high-pressure pump. A typical RO recovery process is shown in Figure 3-5. Rinsewaters must be filtered to prevent fouling of the membranes by solid particles. Reverse osmosis units can concentrate most divalent metals (e.g., Ni, Cu, Cd, Zn) from rinsewaters to a 10-20 percent solution. The concentrated solution is fed back to the plating bath to make up for plating and drag-out losses. Activated carbon adsorption is commonly used to remove organic contaminants. The cleaned rinsewater is then reused.

The capital and annual operating costs for a typical RO plating recovery system were reported to be $20,000 and $5,000, respectively (1979 dollars) (Mouchahoir and Muradaz, June 1981). Due to savings associated with plating chemicals, wastewater treatment, and sludge disposal, the payback period of this process modification was reportedly 4.3 years.

According to an EPA study, the main plating application of RO has been for concentration of rinsewaters from slightly acidic nickel plating baths using cellulose acetate membranes (McNulty and Hoover, May 1980). Since 1970, over

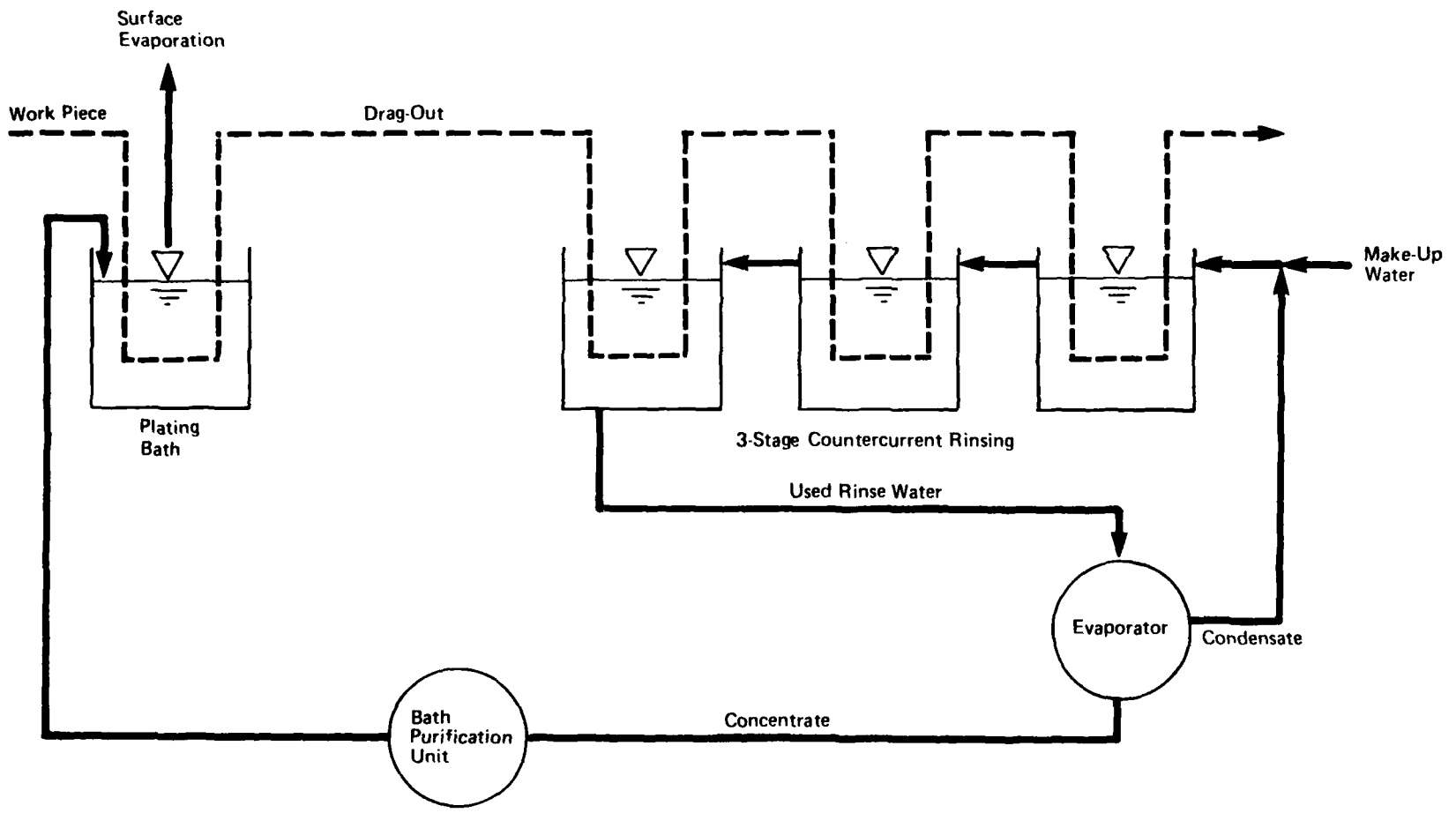


Figure 3–4. Zero discharge evaporation system.

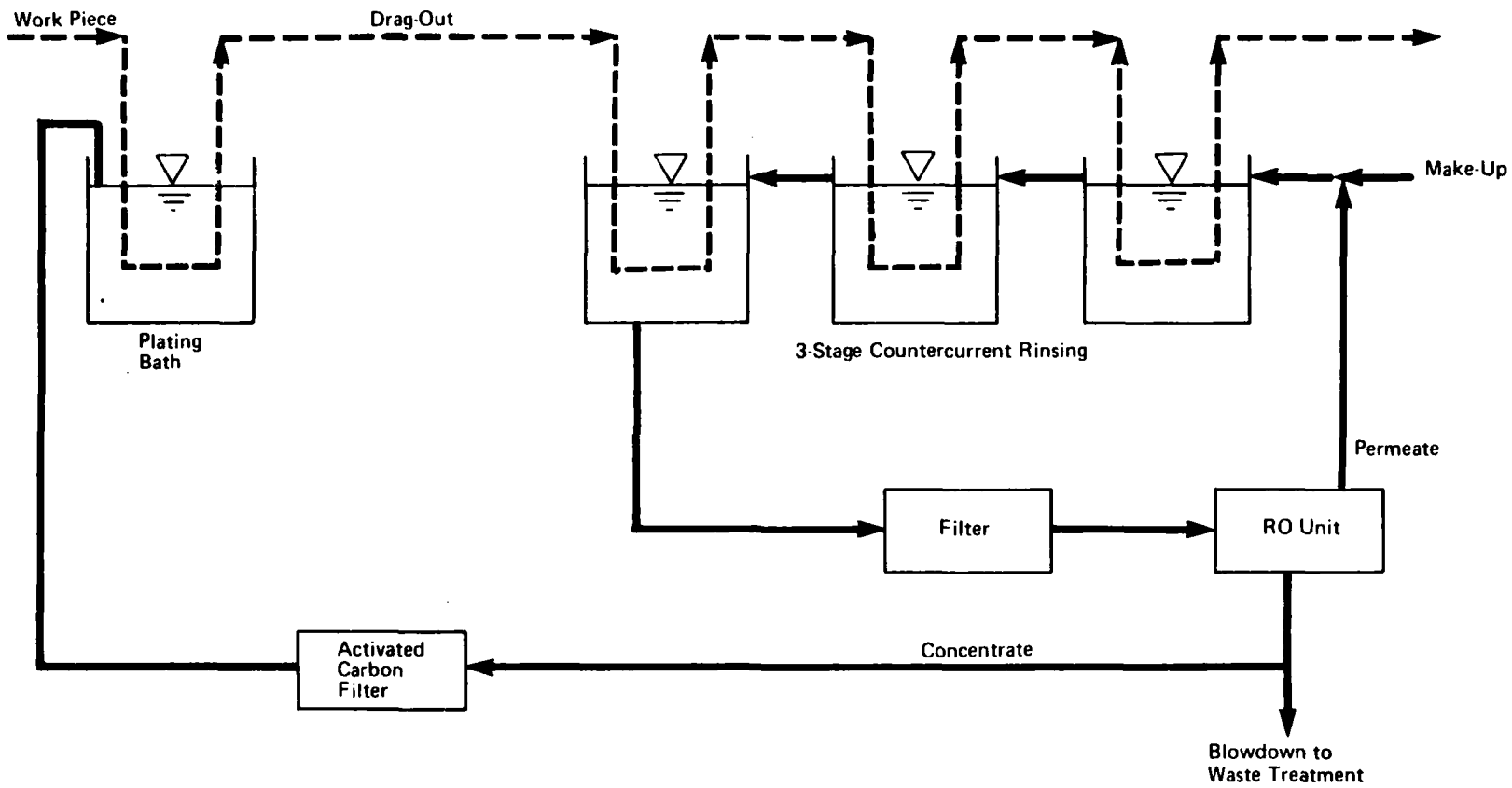


Figure 3–5. Zero discharge reverse osmosis system.

150 RO systems have been installed for nickel plating baths. Recovery efficiencies have been reported to be between 90 to 95 percent with membrane lives ranging from 1 to 3 years (Cartwright, April 1984).

About 20 RO systems have been installed for the recovery of copper sulfate, copper cyanide, zinc sulfate, brass cyanide, and hexavalent chromium. RO use for these baths is limited since RO membranes are attacked by solutions with a high oxidation potential (e.g., chromic acid) or extremes of pH (less than 2.5 or greater than 11). The use of RO for non-nickel baths is expected to increase in the future due to the expected development of membranes which can withstand corrosive and oxidizing environments.

RO use is limited to a moderate degree of concentration. For this reason, it is often coupled with a small evaporator when used to concentrate rinsewaters from ambient temperature baths, such as copper and zinc sulfate. An EPA study evaluated the use of RO and evaporation for the recovery of zinc cyanide from rinsewaters (McNulty and Kubarewicz, July 1981). To reach an adequate concentration for reuse in the ambient temperature plating bath, an evaporator was required to supplement the RO system. Capital costs for the RO system and evaporator were $25,000 and $40,000, respectively, for a total cost of $65,000 (1981 dollars). Operating cost of the complete system was $12,000/year. A $10,000 savings per year in wastewater treatment, water, and makeup chemical costs was insufficient to offset operating and capital recovery costs.

Another EPA study (McNulty, et al., 1979) demonstrated that reverse osmosis was effective in recovering copper cyanide from rinsewater for recycling in a plating bath. However, due to low rinsewater concentrations, short membrane lives, and low wastewater disposal costs, this process was found not to be cost effective.

In summary, reverse osmosis has been shown to be cost effective in concentrating nickel in rinsewaters for reuse in nickel plating baths. However, for ambient temperature plating baths, RO must be supplemented with expensive evaporators in order to concentrate the metals in rinsewater to plating bath strength. The cost effectiveness of an RO metal recovery system depends upon production rate, type and concentration of constituents in the rinsewater, fresh water supply and wastewater disposal costs, and expected useful life of the RO membrane used. Process and operating uncertainties associated with membrane processes that can significantly affect their cost effectiveness include problems with membrane fouling, bath chemical balance, wastewater generation, and operation and maintenance requirements.

Ion Exchange

Ion exchange (IE) utilizes charged sites on a solid matrix (resin) to selectively remove either positively charged ions (cations) or negatively charged ions (anions) from solution. Ions removed from solution are replaced by an equivalent charge of ions displaced from the resin, hence the name ion exchange. Exchanged rinsewater is normally recycled.

Following saturation of the exchange sites, ion exchange resins are usually regenerated by passing acid or base through them, producing a concentrated solution that can be recycled.

In metal plating operations, anionic exchange resins have been used to recover chromic acid from rinsewaters, typically exchanging hydroxide ions for the negatively charged chromic acid anions (Figure 3-6). Anionic resins have also been used to recover cyanide and metal cyanide complexes. Cationic exchange resins have been used to recover metal cations. An IE system typically consists of a wastewater storage tank, prefilters, cation or anion exchanger vessels, and caustic or acid regeneration equipment.

In general, IE systems are suitable for chemical recovery applications where the rinsewater has a relatively dilute concentration of plating chemicals and a relatively low degree of concentration is required for recycle of the concentrate. The recovery of plating chemicals from acid-copper, acid-zinc, nickel, tin, cobalt, and chromium plating baths has been commercially demonstrated. The process has also been used to to recover spent acid cleaning solutions and to purify plating solutions for longer service life.

An EPA study estimated that an IE system being operated 5,000 hours per year would cost $31,000 to install and $6,000 per year to operate (1979 dollars), resulting in a 5.2 year payback period (Mouchahoir and Muradez, June 1981). However, another EPA study estimated that the capital and operating costs (4,000 hours per year) of an IE system would be $23,000 and $34,000, respectively (1980 dollars). The significant operating cost difference was due to significantly different assumptions for regeneration frequency and resin life.

Ion exchange recovery systems are not cost effective when drag-out rates are low. According to an EPA study, a favorable payback period of 2.8 years was estimated for chromic acid recovery from rinsewater where the chromic acid drag-out rate is 3 lb/hr (U.S. Environmental Protection Agency, June 1981). For drag-out rates significantly lower

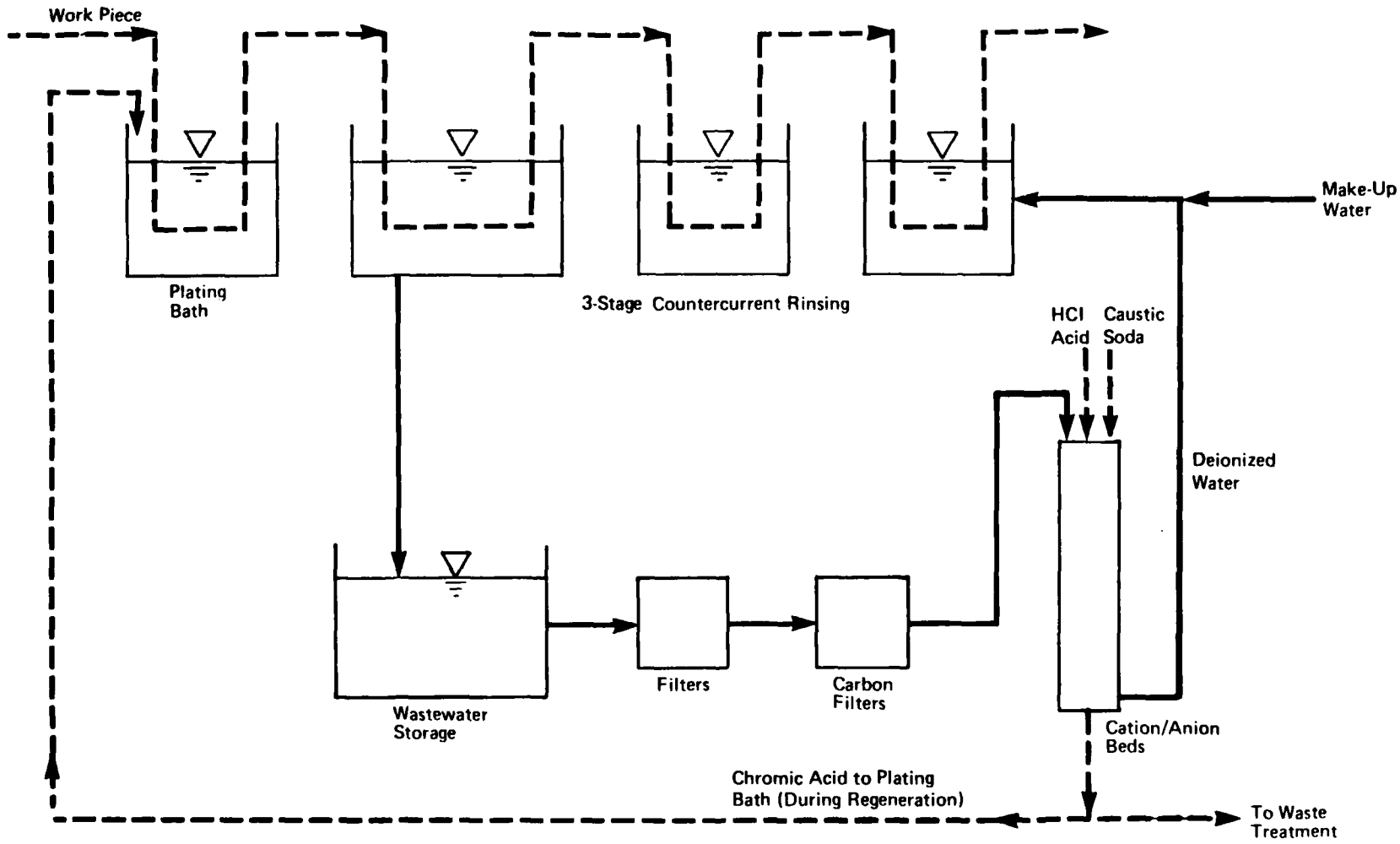


Figure 3–6. Ion Exchange system for chromic acid recovery.

(e.g., those used in hard chrome plating), an ion exchange recovery system is not normally cost effective. IE may also be uneconomical where wastewater treatment and sludge disposal costs are minimal.

A reciprocating flow ion exchanger (RFIE) is the most widely used IE system for the recovery of chemicals from plating rinses. These proprietary skid-mounted units are specially designed to purify plating rinsewaters. The units cost less and require less space than conventional fixed bed systems, and incorporate regenerant chemical reuse techniques to reduce operating cost and yield higher product concentration for recycle. RFIE units have proved effective in three basic applications:

1. Recovery of chromic acid from rinsewaters

2. Recovery of nickel, copper, zinc, tin, and cobalt from rinsewaters

3. Concentration of mixed-metal rinse solution for disposal

Ion exchange has been most successful when recovering chromic acid and nickel from rinsewaters, but problems have been encountered in concentrating mixed-metal solutions. By using the ion exchanged water for rinsing, fresh water consumption can be be reduced by 90 percent. However, waste regenerant brine can be difficult and expensive to treat and dispose of. The environmental and economic benefits of reduced water consumption can often be offset by an increased use of treatment chemicals (Lancy Laboratories, October 1975).

Electrodialysis

Electrodialysis (ED) concentrates or separates ionic species in a water solution through the use of an electric field and semipermeable ion-selective membranes. Applying an electrical potential across a solution causes migration of cations toward the negative electrode and migration of anions toward the positve electrode. ED units are packed with alternating cation and anion membranes. Cation membranes pass only cations, such as copper, nickel, and zinc, whereas anion membranes pass only anions, such as sulfates, chlorides, or cyanides. Alternating cells of concentrated and dilute solutions are formed between the cation and anion membranes. Packaged ED units contain from 10 to 100 cells.

Electrodialysis has been used to recover cationic metals from plating rinsewaters. In a typical application, as depicted in Figure 3-7, rinsewater from a stagnant or "dead"

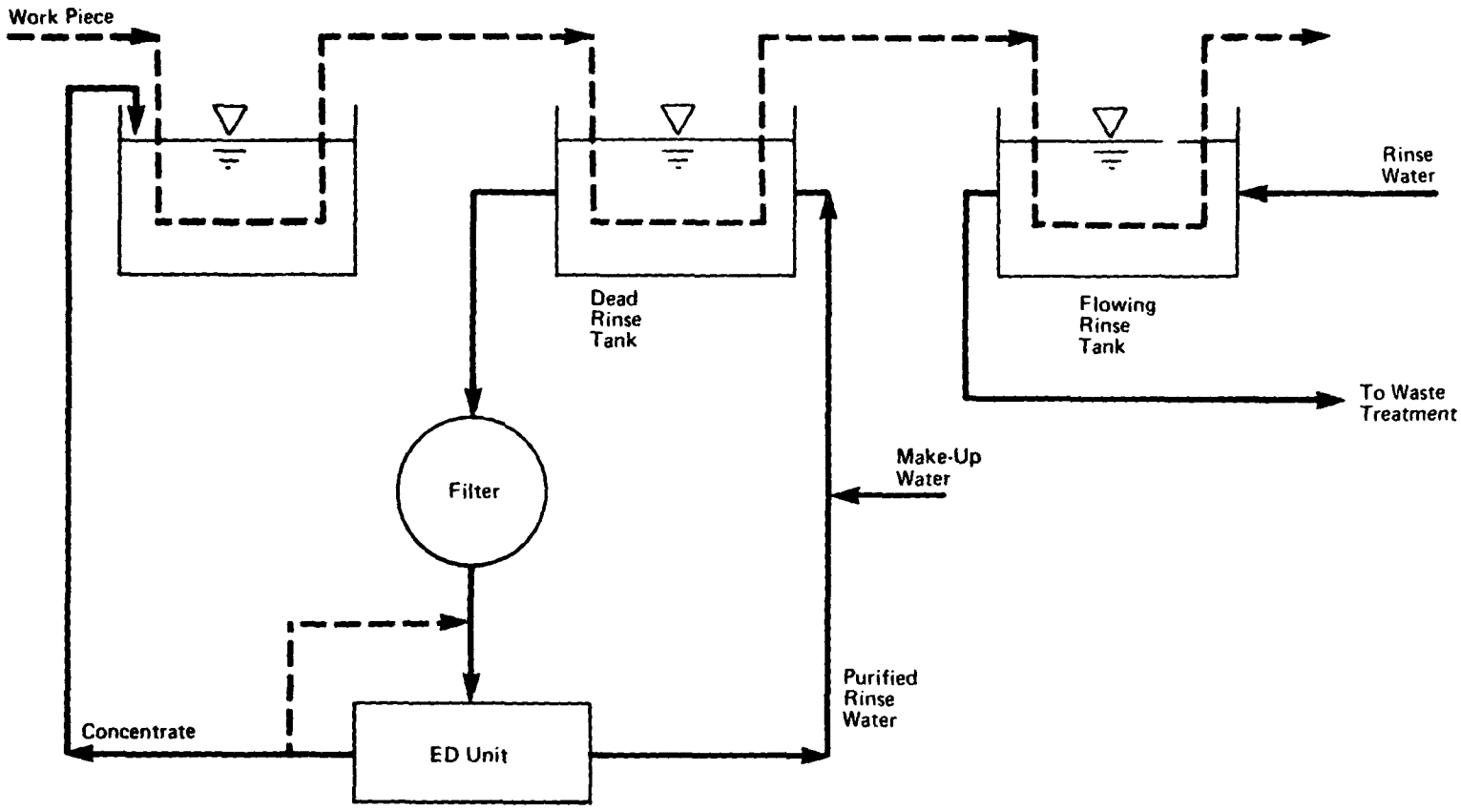


Figure 3–7. Electrodialysis recovery system.

rinse (i.e., no inflow or outflow) tank is continuously fed to an ED unit and concentrated by a factor of ten. The concentrate is then returned to the plating bath. The waters in the dilute cells are combined with makeup water and returned to the dead rinse tank.

Unlike ion exchange and reverse osmosis, the maximum concentration limit of an electrodialysis unit is only limited by the solubility of the compounds in solution. Therefore, ED generally can produce a more concentrated solution than IE and RO, eliminating the need for an evaporative concentrator when used for applications with ambient temperature plating baths. ED units are also reportedly easy and economical to operate, require little space, and operate continuously without requiring regeneration (CENTEC, February 1984).

A disadvantage of ED and RO is that all ionic species are nonselectively removed. Therefore, ionic impurities are returned to the plating bath along with the recovered metal, and organic brighteners, wetting agents, and other nonionized compounds accumulate in the dead rinse tank. Therefore, plating baths must be periodically treated to remove impurities and the dead rinse tanks occasionally disposed of.

If the applied voltage exceeds the hydrogen electrode potential, water will be converted to gaseous hydrogen and hydroxide ions. The subsequent increase in pH can cause precipitation of metal hydroxides that can foul the membranes (Eisenmann, June 1979).

ED package systems cost from $30,000 to $45,000 (1984 dollars). A Navy study estimated a less than one year payback period for an ED recovery system for a cadmium cyanide plating bath operating 4,000 hours per year at drag-out rates of 1.3 lb/day of Cd and 5.1 lb/day of Cn. This evaluation did not include the costs of removing impurities from the baths or maintaining the ED units and replacing the membrane modules (CENTEC, February 1984).

An EPA study evaluated recovery of nickel from rinsewaters using ED (Eisenmann, July 1981). The ED unit was able to recover 95 percent of the nickel salts from the rinsewater and return the concentrated solution to a Watts-type nickel plating tank. The study estimated that $16,000 per year could be saved by employing ED in a nickel plating line which operated 4,000 hr/year. The cost estimate only considered savings in chemical usage, wastewater treatment, and sludge disposal, and did not consider the cost of operating and maintaining the ED system.

Donnan Dialysis

Donnan dialysis is a membrane separation process similar to reverse osmosis and electrodialysis. However, rather than relying on high pressure or electrical current to drive ions through membranes, Donnan dialysis employs a concentration gradient. The recovery process is based on the (Donnan) principle that two solutions separated by a membrane will remain electrically neutral, allowing metal ions (e.g., nickel) to be exchanged from a dilute rinsewater with hydrogen ions in a concentrated sulfuric acid solution. Laboratory tests have shown that metal ions can be concentrated more than tenfold by Donnan dialysis. The acid solution can be returned directly to the plating bath (Hamil, December 1982).

The main advantage of Donnan dialysis over ED or RO is its lower energy use. Unfortunately, the recovery solution acidifies the plating bath and contains cationic impurities. Donnan dialysis has not been commercially applied, since existing membranes have short life expectancies. Extensive research is currently being performed to determine the applicability of recovering metals with Donnan dialysis.

Coupled Transport

In coupled transport, similar to Donnan dialysis, ions are driven across a membrane against a concentration gradient. The membrane is microporous, containing a liquid complexing agent held within the pores. Metals combine with this complexing agent and are removed from a dilute solution. On the other side of the membrane is a solution in which metal solubility is favored over that of the complex. The result is transport of a metal across the membrane against a concentration gradient due to the coupling of these two complexation reactions (Babcock, May 1983).

In field and laboratory tests, coupled transport has been used to recover chrome from decorative chrome plating rinsewaters. Dichromate ions are tied up by an organic amine complexing agent. The complex then diffuses through the membrane. Due to high pH on the other side of the membrane, the complex is broken, leading to the release of chromic acid and regeneration of the amine complex.

According to researchers, coupled transport can be used to save rinsewater and to recover chromium as a pure sodium chromate concentrate. Unlike other recovery processes, the recovered chromium cannot be directly returned to a bath without further processing. However, sodium chromate can be used in the plating shop in cleaning solutions or etchants, or sold for other uses (Babcock, May 1983).

In field tests, coupled transport membranes have had mixed success. While some membrane modules showed no deterioration in performance during a 4-month period, others quickly developed leaks or clogged due to precipitation of iron hydroxide.

The capital and operating costs of a coupled transport membrane system for the recovery of 5,000 lb/year of chromium (as sodium chromate) from decorative chromium plating were estimated to be $10,000 and $6,200/year, respectively (1982 dollars) (Babcock, December 1982). Net annual savings were estimated to be $5,700, with a 2-year payback period. Favorable savings for a hard chromium shop were also predicted. However, coupled transport will not be commercially viable until more long-lived membranes are developed.

3.5 Material Substitution

Non-Cyanide Baths

Traditionally, cadmium, zinc, brass, and precious metals have almost universally been plated from alkaline cyanide baths, due to the superior plate produced from stable metal cyanide complexes. Unfortunately, cyanide baths are costly and dangerous to operate and the wastes generated are difficult and expensive to treat.

In the late sixties and early seventies, considerable research was performed to develop non-cyanide zinc electroplating baths. As a result, several alternative zinc baths were developed. Alternatives include low cyanide baths, non-cyanide alkaline baths, neutral ammonium chloride and potassium baths, and a number of acidic baths containing sulfate, chloride, and fluoborate ions (CENTEC, February 1984).

Low cyanide baths contain approximately 20 percent as much cyanide as conventional cyanide baths and have similar operating characteristics. However, process control is more difficult and cyanide treatment is still required.

Neutral chloride baths use ammonium or potassium ions for complexing the zinc. These baths usually require the addition of proprietary brighteners and chelating agents which form zinc complexes. Unfortunately, these zinc complexes can be difficult to remove in subsequent waste treatment.

Acid sulfate, chloride, and fluoborate baths have become the most popular non-cyanide zinc baths. With the recent development of new additives, acid zinc baths are capable of producing bright deposits that are competitive with alkaline

cyanide baths for general plating applications (CENTEC, February 1984).

Less effort has been expended in developing non-cyanide cadmium baths since the volume of cadmium plating is only 5-10 percent that of zinc plating. Due to increased environmental and safety concerns with operating and disposing of cadmium cyanide baths, alternative proprietary acidic cadmium baths similar to zinc baths have recently been developed to replace cyanide baths.

Most of these acidic baths consist of cadmium oxide, sulfuric acid, distilled water, and anion compounds. Since many old alkaline cadmium cyanide plating tanks are made of bare steel, conversion to these acidic baths may require that the existing tanks be refurbished or replaced. Thus material substitution may require a considerable capital expenditure. However, the savings in eliminating cyanide treatment can make the modification economically attractive (Jorczyk, October 1975).

Parts being plated in non-cyanide cadmium baths can require more thorough cleaning prior to plating than parts plated in cyanide baths. The non-cyanide cadmium baths reportedly have less throwing power and lower cathode efficiency than cyanide baths. Despite the disadvantages, however, some platers prefer the new non-cyanide plating baths because of the reduction in waste treatment complexity. Some have reported that drag-out of cadmium is reduced compared to that experienced with cyanide baths.

Non-cyanide zinc and cadmium baths usually cost more than cyanide baths. However, to properly evaluate the cost effectiveness of the material substitution, the following factors must also be considered: cost of new corrosion-resistant equipment, difference in labor and chemical costs, change in production rate, and savings realized by eliminating cyanide treatment.

In 1983, Charleston Naval Shipyard switched from alkaline cyanide baths to an acidic non-cyanide solution and eliminated the cyanide oxidation process from the waste treatment plant (Cushnie, October 1983).

Vacuum Deposition of Cadmium

Vacuum deposition of cadmium was developed as an alternative to electroplating. Problems with electroplating arise from cadmium cyanide baths due to the toxicities of cadmium and cyanide. Switching to non-cyanide plating baths (discussed above) removes one of these problems. Use of vacuum deposition of cadmium also eliminates the need for cyanide.

Vacuum deposition of cadmium is a line-of-sight process, making it difficult to provide a uniform deposit on an irregularly shaped part. Parts need to be rotated at intervals during processing to produce a more uniform coverage, and adhesion of the deposit to the basis metal is not as strong as that produced by conventional cadmium plating. Also, occupational and environmental hazards can result from the evacuation of cadmium vapors and condensed aerosols. In addition, the vacuum exhaust must be carefully filtered to prevent these cadmium vapors and condensed aerosols from escaping to the work environment.

Ion Vapor Deposition of Aluminum

Due to the many hazards inherent in working with cadmium, and increasingly stringent requirements being placed on disposal of wastes containing even traces of cadmium, there has been considerable incentive to develop a substitute for cadmium coatings for corrosion protection. Aluminum coating is a logical choice as a replacement for cadmium to provide corrosion protection, since aluminum is anodic to steel and provides galvanic protection similar to that afforded by cadmium. In addition, its corrosion products are not bulky or unsightly. Aluminum is also cheaper than cadmium and zinc on a volume basis. Moreover, aluminum can be used up to a temperature of 925°F compared with a maximum of 450°F for cadmium. As a result, there has been considerable interest in the possibility of aluminum plating, with many attempts to develop a successful method. However, the electrode potential of aluminum is too negative for it to be successfully plated from an aqueous solution (Lowenheim , 1978). Aluminum has been deposited on steel by hot dipping or using a metal spray system. These methods do not provide the thin, uniform coating required on aircraft parts, nor do these coatings adhere to substrates as strongly as plated cadmium.

As a logical extension of vacuum deposition of cadmium, ion vapor deposition (IVD) of aluminum was developed by McDonnell Douglas Corporation as a means of replacing cadmium plating on steel aircraft parts (Steube, June 1978; Fannin, 1979; and Muehlberger, November 1983). The IVD system (Ivadizer) consists of a vacuum chamber, a resistance heating aluminum vaporization system, and a high voltage system to ionize the aluminum and impart a negative charge to the parts, resulting in aluminum ions electrodepositing on the parts. Air in the vacuum chamber is replaced by a low pressure inert gas, which is ionized. Interaction of aluminum vapor with the ionized inert gas is required for the aluminum to be ionized and be attracted to the oppositely charged parts and coat them uniformly. Without this ionization and interaction with the inert gas ions, IVD

would be restricted to line-of-sight coating as in vacuum deposition of cadmium.

Advantages cited for IVD of aluminum include a higher useful temperature, improved throwing power, and better adhesion of the aluminum coating compared to cadmium. In addition, parts which are cadmium plated require baking to prevent hydrogen embrittlement; problems have been encountered with oven temperatures not being carefully controlled, resulting in parts being scrapped. Safer working conditions were cited as another advantage of IVD of aluminum. (A few years ago, an individual at North Island was hospitalized following exposure to cadmium while cleaning a VacuCad chamber. Such an occurrence could be avoided with aluminum.)

Trivalent Chromium Baths

Some platers have investigated using trivalent chromium solutions instead of conventional hexavalent chromium solutions. With trivalent chromium rinsewaters, it is unnecessary to add sodium bisulfite or other reducing agents in waste treatment for conversion of hexavalent to trivalent chromium prior to precipitation. Trivalent solutions are typically less concentrated (22 g/L versus 150 g/L for hexavalent solutions), thus lessening the amount of chromium dragged out on parts. Consequently, sludge produced from trivalent baths is about one-seventh the volume from hexavalent baths and is far less toxic (Garner, September 1983).

The main disadvantage of trivalent solutions is that they cost two to three times more than hexavalent solutions. Some researchers have reported that higher production rates and lower rejection rates can be realized with trivalent chromium plating solutions; however, the main advantage of the solution is the lower cost of wastewater treatment and sludge disposal. Before a plating shop converts to trivalent chrome solutions, a detailed study must be performed to determine if the projected savings in waste treatment are greater than the increased operating cost.

Electroless Nickel

The majority of nickel plating is done in an acidic (pH between 1.5 and 4.5), elevated temperature (between 110°F and 150°F) Watts bath which contains nickel sulfate, nickel chloride, and boric acid. An electrical current causes the nickel to be plated on the substrate.

In 1946, an electroless plating process was developed which coated a substrate without the use of an outside source of electrical current. Electroless nickel plating employs the

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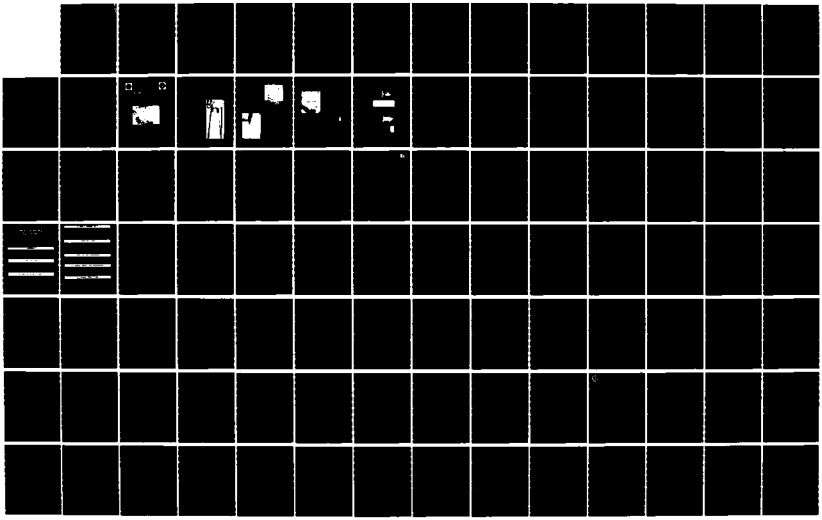

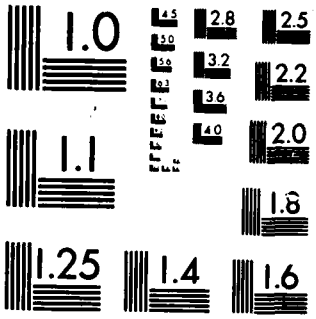

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substrate to catalyze a chemical reduction reaction. However, due to the expense of the chemical reducing agents, electroless plating is not cost effective in applications where conventional electroplating can be used.

The main advantages of electroless nickel plating are that the throwing power is essentialy perfect and the deposits provide greater protection of the substrate since they are less porous (CENTEC, February 1984). In addition, the nickel concentrations of electroless baths are approximately one-eleventh those of conventional Watts nickel baths. Therefore, drag-out quantities and sludge production from an electroless bath are much less than from a conventional bath.

WDR121/041

4.0 *PROJECT REQUIREMENTS*

Engineer Investigation Project Proposal, Improvement of Navy Hard Chrome Process, Naval Civil Engineering Laboratory and Pensacola Naval Air Rework Facility, February 1984.

4.0 PROJECT REQUIREMENTS

IMPROVEMENT OF NAVY HARD CHROME PROCESS

OBJECTIVE OF PROJECT

To provide a report on the effects of the innovative hard chrome plating process, the chrome bath purifier, and timer-controlled spray rinsing on Navy hard chrome operations. The report will cover the effects on processing changes, quality control, production rate, economic benefits and cost analysis, and environment benefits. The report will be used to provide a guideline for improvements Navy-wide to bring Navy hard chrome waste treatment up to Best Available Technology (BAT). The information developed from this project will be included in DM-5 and in the activity's Local Process Specifications.

EXPERIENCE RECORD

The NARF at Pensacola has had several comprehensive studies applying to the plating shop in recent years. A report produced by Aware Engineering, Inc. out of Houston, Tex., was initiated in July 1979. The Aware report obtained their information on chrome from the NARF personnel, available data on hard chrome plating, and limited sampling (three 1-day periods in 3 consecutive months).

The data showed very low chrome content in rinse waters, usually less than 1 ppm with flow rates at approximately 60,000 - 65,000 gal/day. Data on chrome apparently didn't agree with a material balance as deducted from chrome usage per year and the Aware statement, "The raw waste load data was not included in the average for cyanide and chromium concentrations since the values are extremely high compared to all the other data indicating an abnormal operating condition." The report also indicated that neither R.O. nor evaporation would be cost effective in chrome recovery but recommended water controllers to reduce water usage. The report also recommended countercurrent rinses.

The report by AB_2MT Consultants, Inc. along with M.H. Dent, titled Electroplating Process Evaluation at The Naval Air Rework Facility, Naval Air Station, Pensacola, Fla., also concerned itself with the hard chrome plating process. This report recommended changes to the rinse system, ventilation systems, and plating procedures in hard chrome plating to reduce water usage and wastewater production, and to apply Best Available Technology. The report discussed recovery methods for chrome recovery, as well as discussion of the "LICON" evaporator discussed later. The report was based on materials supplied by the NARF personnel, manufacturers of recovery equipment and from data from civilian hard chrome practices. No sampling of actual conditions was included in this report, and much of the data is not applicable to Navy hard chrome plating.

The NCEL study of April - June 1983 which was an evaluation of the LICON evaporator unit installed at the NARF for recovery of chromic acid involved 3 months of continuous monitoring and sampling. This study revealed information which invalidated the basis for installation of the LICON unit. This study showed that the concentrations of chromic acid

in the rise water was far too low for a chrome recovery operation. The contractors apparently could not appreciate the significant different between Navy hard chrome plating and commercial plating. This study also recommended water reduction techniques and process changes that are in line with Navy hard chrome practices.

The Centec Corporation Initiation Decision Report of October 1983 on treatment of electroplating wastes is a report dealing with Navy plating. It recommends methods of water reduction for chrome plating, treatment technologies, and their application to Navy plating. This study also reports exceptionally low levels of chrome contamination in rinse waters from Navy facilities. This study was based on a week of data in each facility studied.

The NCEL and Centec reports mentioned above, and the experience of the environmental, production, and plating personnel at the NARF in Pensacola, point up the large differences in Navy hard chrome operations as compared to commercial and industrial chrome plating. These differences include the following:

- low metals in rinse waters
- low production rates (4 - 5 pieces/day)
- much longer bath immersion times (days versus minutes)
- quality-control problems due the limitations on state-of-the-art chrome plating compared to Navy requirements
- contamination of plating bath due to low drag-out rates require baths to be dumped as waste

These major differences require a complete reevaluation of Navy hard chrome plating systems. Conclusions are as follows:

- A new chrome plating system with a higher degree of compatible to Navy requirements is needed.
- A process for continuously cleaning plating baths should be employed.
- A system for reduction of rinse water and recovery of metals suitable to Navy operational requirements should be employed.

SUGGESTED PROGRAM

Recent studies by NCEL at the NARF plating facility in Pensacola, Fla., found that Navy hard chrome plating needs to be upgraded to meet Navy requirements. Problems now associated with Navy hard chrome plating that can be eliminated or reduced include low productivity per tank, quality control problems, and environmental problems associated with tank dumps and rinse water. The objective of this proposal is to update

a Navy chrome plating line and measure productivity, quality, environmental considerations, and cost benefits associated with the changes. Three major changes are proposed as follows: (1) reversible rack two bus bar chrome plating, and (2) CAT-napper plating solution purifier, and (3) timer-spray rinses.

Reversible Rack Two Bus Bar Hard Chrome Plating

It is proposed to convert one of the four hard chrome plating lines at NARF Pensacola, Fla., to this innovative hard chrome technique. This involves contracting a consultant to reconfigure the chrome plating rack, instruct the NARF personnel on changes needed for the process, and to instruct the platers in the new technique. Data will be collected on production rates, quality control, and rinse waters treatment costs compared to an adjacent line using the present Navy plating procedures. It is expected that this change will greatly increase production rates, cut the number of tanks required and eliminate the wasting of rinse water. Also, product quality, which has at times been a problem at the NARF with over a 40% rejection rate, should be greatly improved. Finally, waste water treatment from the hard chrome lines would be eliminated. This process eliminates the wasting of rinse waters by rinsing over the plating bath. This provides for evaporation make up. Ventilation by-products are also returned to the plating tank.

Data collection will be in terms of plating control forms normally filled out by platers. These data will be compared to determine the results. Meters will be installed to measure water consumption and power consumption in order to have an accurate comparison.

NOTE: This process is currently used by private companies performing military work and has been approved for these military applications.

CAT-napper Chrome Bath Purifier

It is proposed to install a "CAT-napper" into an existing hard chrome bath to remove the impurities that result in the loss of chrome by frequently "dumping" the chrome bath. Dumping the bath is costly in both chemicals and disposal. Baths are usually dumped due to cation buildup. CAT-napper removes these cations and uses very little manpower, maintenance, and energy. We propose to compare the reduced cost of this bath to its neighbor (without a CAT-napper) at equivalent production rates.

Timer Spray Rinse Control

It is proposed to modify a countercurrent rinse system now operating at NARF Pensacola, Fla., on a chrome plating line. The "first" rinse tank will be fitted with a spray-type rinse system with built-in timer control. The "second" tank in the countercurrent system would be converted into a dead rinse tank in order to measure the effect of the spray rinse. The "third" or final rinse will be a running rinse to insure a complete rinse while we are testing.

Cost at NARF Pensacola for rinse water treatment is $5.40/1,000 gal added to the price of the water ($0.66/1,000 gal). This results in a cost of over $6.00/1,000 gal of water used. Many thousand of gallons of water are used each day. It is proposed to eliminate this rinse water discharge by using a spray rinse with a timed spray period. When a part is lowered into the rinse tank, the rinse button is pushed. The part is rinsed, and the water automatically shuts off. This rinse water will be collected in the bottom of this rinse tank. After the water reaches a predetermined quantity it will be filtered back into the plating tank for evaporation make up, thus saving valuable chemicals and a great deal of expense for its treatment. This part will be further rinsed in the dead rinse tank as a test of the spray rinse effectiveness.

The data collected will be the amount of water used, effectiveness of the rinse (sampling dead rinse), compatibility with evaporation losses, and effect on productivity. This will require both water and electrical meters.

SUMMARY

The suggested approach to the solution is to apply state-of-the-art techniques to the Pensacola hard chrome section. As stated above we plan to instigate the training in and use of the reversible rack, two bus bar plating system. Records of production, etc., would be monitored for 3 months prior to, and 3 months after, installation of the new chrome process. Careful records of water consumption, waste discharge, electrical consumption, and productivity will demonstrate the problems solved by the new system. Quality test runs will be the same as prior to installation and will include hardness ductility, etc. Clarence Peger Hard Chrome Plating Consultants, Ltd. will be contracted to initiate the changeover and training in the use of the new chrome system. NCEL and NARF will collect the data and analyze the results. A Technical Report will be produced, detailing the results. Tank numbers 366 and 367 at NARF Pensacola are proposed for use in the project.

Installation of a CAT-napper system will proceed at the same time on tank 365. Production data on the tank adjacent, 353, and on tank 365 along with sample analysis of both tanks will demonstrate the viability of the CAT-napper system in prolonging the life of the Navy plating baths, thus eliminating or reducing one of the major pollutants. Initially, data will be taken daily, but will extend to weekly sampling as acquired data dictates.

Installation of the spray rinse will proceed in Tank 362 in the part presently designated as the first rinse. Modifications will be made in the "second" rinse to produce a dead rinse which will be sampled for increase in chrome content. The "third" rinse or final rinse will be modified to remain a running rinse to insure proper rinsing until the spray has proven itself. The chrome line will operate without the spray for several months, with the dead rinse and the final rinse. Samples of the dead rinse will be periodically taken and analyzed. Also, production rates will be kept. Water meters will keep track of water usage and chrome returned to bath.

NARF Pensacola has been contacted relative to this experiment and is in full agreement with this proposal.

FUNDING

Timer/Spray System

		Cost (K$) FY84	FY85
1.	Prepare design	5	--
2.	Make-in-plant changes and hardware purchase	3	--
3.	Install	5	--
4.	Monitor/data collection	12	10
5.	Evaluate system	20	10
6.	Prepare cost analysis	5	--
7.	Evaluate logistics (ILS), RAM, and human factors analysis	--	15
8.	Prepare a design package and a draft of specifications	--	15
9.	Prepare a final report	10	20
	TOTAL	60	70

Innovative Hard Chrome

		Cost (K$) FY84	FY85
1.	Prepare design	5	--
2.	Make in-plant changes and hardware purchases	10	--
3.	Install	5	--
4.	Monitor/data collection	12	10
5.	Evaluate system	20	15
6.	Prepare cost analysis	5	5
7.	Evaluate logistics (ILS), RAM, and human factors analysis	--	20
8.	Prepare a design package and a and a draft of specifications	--	20
9.	Prepare final report	10	20
	TOTAL	67	90

CAT-napper

		Cost (K$) FY84	FY85
1.	Prepare test plan	5	--
2.	Make in-plant changes and hardware purchases	15	--
3.	Install	5	--
4.	Monitor/data collection	12	10
5.	Evaluate system	20	15
6.	Prepare cost analysis	5	5
7.	Evaluate logistics (ILS), RAM, and human factors	--	15
8.	Prepare design package and a draft of specifications	--	20
9.	Prepare final report	10	15
	TOTAL	72	80

JUSTIFICATION

DOD guidelines emphasize the conservation of natural resources. The Clean Water Act places a premium value on high quality water throughout the United States. The Resource Conservation and Recovery Act, PL94-580, calls for reduction, recovery, and reuse as the best pollution abatement alternative. Through amendments in 1977 to the Federal Water Pollution Act, all federal agencies must now use innovative treatment processes and techniques including, but not limited to, methods of reuse. These treatment processes must be used when their life cycle cost is no more than 15% greater than the most cost effective alternatives.

In the studies proposed we not only eliminate wastewater from the chrome plating system, but reuse it as bath make-up. The proposed changes in the hard chrome system reduce or eliminate contaminates introduced into the environment. These changes also will improve production, and quality control. In short, many benefits are derived, with no foreseeable disadvantages.

A letter from NARF Pensacola to NCEL, Port Hueneme on Dec 15, 1983 (copy enclosed) requested mutually beneficial testing of the processes described above to be incorporated into their system if data indicated the benefits described. The letter references an IDR put out by NCEL which includes the processes which are the subject of this proposal. The specific benefits of these changes are detailed as follows:

- Follow DOD guidelines and Federal Water Pollution Act
- Eliminate wastewater from rinsing procedures
- Eliminate treatment of rinsing waters
- Eliminate sludges due to rinsing water
- Reduction of water usage by orders of magnitude
- Reduction of bath dumps (possibly eliminate bath dumps)
- Eliminate possible requirement for expensive recovery equipment
- Improve production rates
- Improve quality control
- Reduce operation and maintenance costs
- Avoid costly chemical replacement
- Removes bath impurities and converts CR^{+3} to CR^{+6}

- Reduces generation, handling, transporting, and storing of hazardous wastes
- Lowers energy costs
- Economically beneficial overall

Preliminary Cost/Benefit Analysis

1. Innovative Hard Chrome Process (reduction of rinse water benefits)

Assumptions (based on Pensacola data):

Average of 12 gal/min used (no countercurrent rinses)
260 days, 24 hr/day operation
15 gal to rinse one part with innovative method
5 parts/day average production
Treatment cost, $5.40/1,000 gal
Water costs, $0.66/1,000 gal
50 chrome lines Navy-wide that could use system
P 442 Guidelines use for economic analysis (i.e., 10% interest, 10-year life of equipment)

Analysis

Treatment Costs.

12 gal/min x 60 min/hr x 260 day/yr x 24 hr/day
= 4,492,800 gal/yr presently used/line

15 gal/part x 5 parts/day x 260 day/yr = 19,500 gal/yr
19,500 gal/yr/line use with new system

4,492,800 - 19,500 gal = 4,473,300 gal/yr/line saved

4,473,300 (5.40 + 0.66)/1,000 = $27,108 saved/yr/chrome line

50 x $27,108 = $1,355,409 saved Navy-wide/yr

Production Costs.

Process is estimated to increase production by 50%, thus reduction of manhours by 50%. Assume 1 man/chrome line/yr reduced to 1/2 man/chrome line/yr at $14.00/hr.

= >130 days x 24 hr x 14.00/hr = $43,680/chrome line saved

= >43,680 x 50 = $2,184,000 saved Navy-wide

Quality Savings.

This is more difficult to forecast, but at present NARF is experiencing 40% rejection rate. If the new system reduces this to 10% rejection rate, we save 30% manhours, and save materials. We also save on manhours for réworking and stripping parts. All but reduction of rejects will be ignored here.

0.3 x 24 hr/day x $14.00 x 260 day/yr x 50 lines
= 1,310,400 dollars saved Navy-wide/yr

Total saving due to innovative hard chrome changes
= $4,849,809 saved/yr

Cost.

$7,000/system x 50 systems = $350,000

Present worth over 10 year life span (P 442)

6.447 x $4,849,809 = $31,266,718

$31,266,718 - $350,000 = Total benefit to Navy
= $30,916,718

Total payback in 0.07 year or 3.8 weeks

2. CAT-napper Benefits

Assumptions (based on Pensacola data):

Average of 2 bath dumps/yr now
50 baths Navy-wide
$4,000 cost/bath dump
With CAT-napper 1 dump/5 yr
Use P442 for economic guideline

Analysis

Present worth of dumps of 1 chrome line as is
6.447 x $8,000 = $51,576

Present worth of dumps with CAT-napper
0.6209(4,000) + 0.3855(4,000) = $4025

Savings for one line = 51,576 - 4,025 = $47,551 over 10 years

Savings Navy-wide = 50 x 47,551 = $2,377,550

Cost.

$6,000/tank = >50 x 6,000 = $300,000 Navy-wide

Payback in 0.75 years.

Total benefit to Navy = $2,377,550 - $300,000
= $2,077,550 over 10-year life

3. Spray Rinse Savings

Assumptions

Estimate 300 applicable rinses Navy-wide
Estimate 12 gal/min now being used
Pensacola values of costs used, $5.40/1,000 gal treatment
0.66/1,000 gal cost
Cost of installation to existing system estimated, $1,500
Savings in chemical costs minimal

300 rinses x 12 gal/min x 60 min/hr x 24 hr/day/260 day/yr
= 1,347,840 x 10^3 gal

1,347,840 x 10^3 gal x $6.06/1,000 gal
= $8,167,910 saved/yr Navy-wide

$1,500 x 300 rinses = $450,000 for installation Navy-wide

(P.W.) 6.447 x $8,167,910 = $52,658,515 saved over 10 years

Payback in 0.06 year or 2.9 weeks

Total Benefit to Navy

$52,658,515 - $450,000 = $52,208,515

Total Savings of Proposal over 10-year life of equipment:

Innovative Hard Chrome	$30,916,718
CAT-napper	2,077,550
Spary Rinses with Timers	52,208,515
TOTAL SAVINGS	$85,202,783

5.0 PRODUCTION BENEFITS

Techdata Sheet 84-17, A Better Way to Chrome Plate, Naval Civil Engineering Laboratory, September 1984.

Table 5.1 Conventional System Vs. IHCP System: Comparison of Plating Rates and Grinding Requirements

Table 5.2 Conventional System Vs. IHCP System: Labor Requirements

Message from COMNAVAIRSYSCOM, Washington, DC, Incorporation of Innovative Hard Chrome Plating Process, 26 July 1985.

Techdata Sheet
Sep 1984 84-17

A Better Way to Chrome Plate

This TDS describes the adaptation of a commercial process to Navy hard chrome plating. This process incorporates reversible racks, two bus bars, conforming anodes, and a zero-discharge spray rinse. Some advantages – sixfold increase in productivity, improved quality, zero discharge, easy mounting of work pieces, isolation of pieces to be plated, fivefold increase in number of pieces that can be plated in a tank, and elimination of expensive reversing switches and recovery equipment.

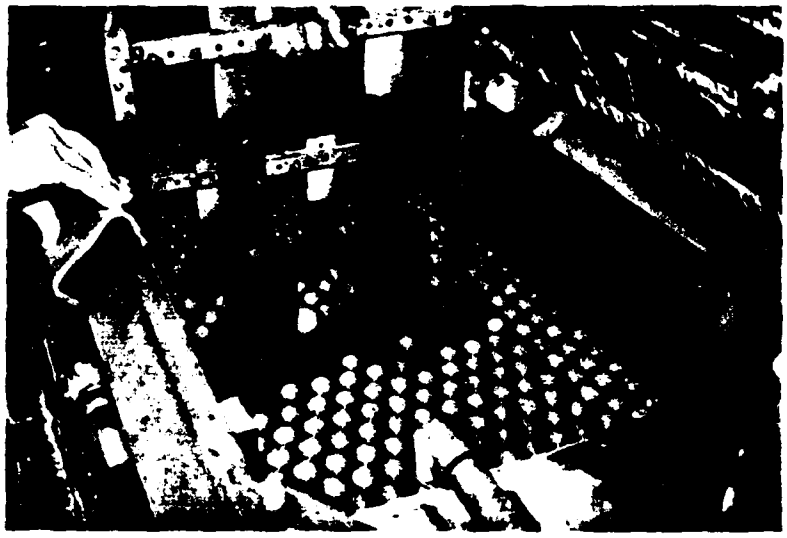

Figure 1. Process showing reversible rack and conforming anodes.

Hard chrome plating is the process of applying a chromium deposit to a part to obtain one or more of the following properties: hardness, low coefficient of friction, corrosion resistance, nongalling and nonwetting qualities, wear resistance, and rebuilding of worn surfaces. Hard chrome plating in Navy applications is usually for building up worn surfaces. The two fundamental elements controlling Navy hard chrome plating are: (1) the engineering quality of the completed product, and (2) operator response time. Economies in operation, so important in commercial plating, are of little significance compared to the value of the *reliability* of the weapon part being plated. Navy hard chrome plating may require layers of greater than 1/4 inch and plating times measured in days.

Approved for public release; distribution unlimited.

THE COMPONENTS

An innovative hard chrome plating process which is highly applicable to Navy hard chrome plating is the reversible rack, two bus bar system (Figure 1). This system combines the use of special racks, conforming anodes, and a spray rinse to provide increased productivity (up to six times), very even plating (variation can be less than 0.001 inch over a 6-foot length), high quality plating, and zero-discharge rinsing. Many side benefits of this system are not detailed here.

The reversible rack is an integral part of the system. It is shown in exploded view in Figure 2.

The rack is built as shown with the anode hook and the conforming anode mount insulated from the cathode hook and the "work piece" (cathode) mount. The insulated section isolates the anode and cathode portions of the reversible rack. The result is that if the anode is mounted from the top and the work piece from the bottom, you incorporate ease of mounting, ease of reversing, and isolation of the part from the activities in the rest of the plating tank. You no longer require a course in imaginative C-clamp application for odd size pieces. You no longer require expensive reversing switches. You may now reverse a part in the same tank you are plating in without affecting the plating of the other parts, and you may now plate three to five times as many parts in the same size tank.

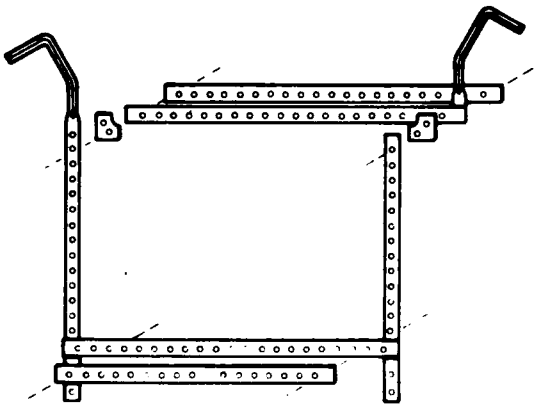

Figure 2. Reversible rack exploded view.

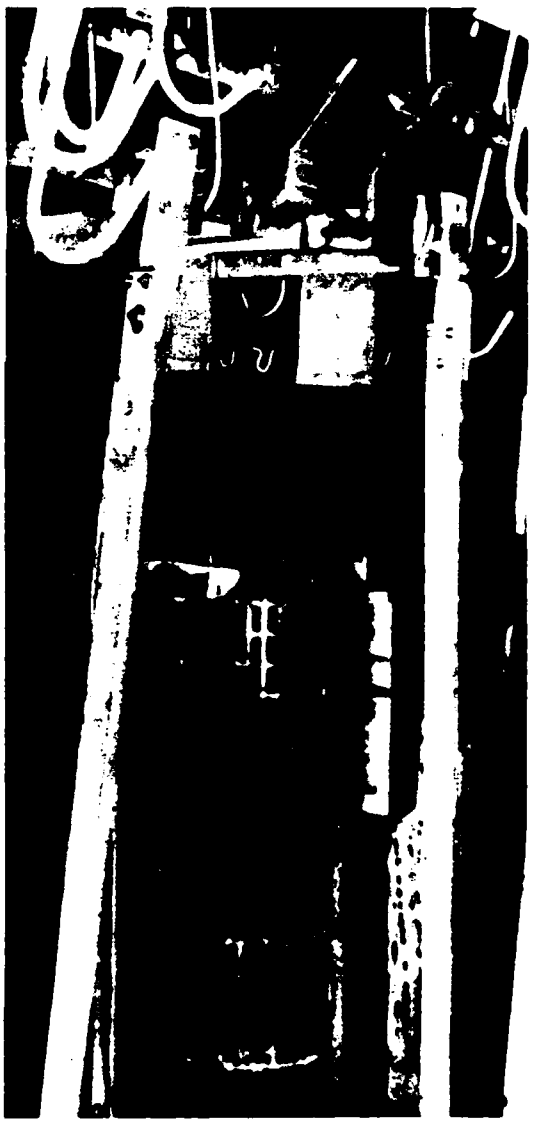

Figure 3. Large conforming anode.

The conforming anode is the second important part of the system. Basically the conforming anode is a mat of lead, shaped to surround or be inserted into the part with 1/2-inch clearance as optimum. Examples of the conforming anode are shown in Figure 3.

THE BENEFITS

Once the initial anode is produced it will be used over and over again for similar sized or shaped parts. Benefits of this conforming anode configuration are increased plating rates (up to six times as great), uniformity in plating (variation less than 0.001 inch over a 6-foot length after a day of plating), less energy loss (not heating a lot of solution), and isolation of the part from effects of nearby operations in the same tank. Reversing may be accomplished next to a plating part. A diagram of a racked part and anode is shown in Figures 4 and 5.

Figure 4. Racked part with conforming anode.

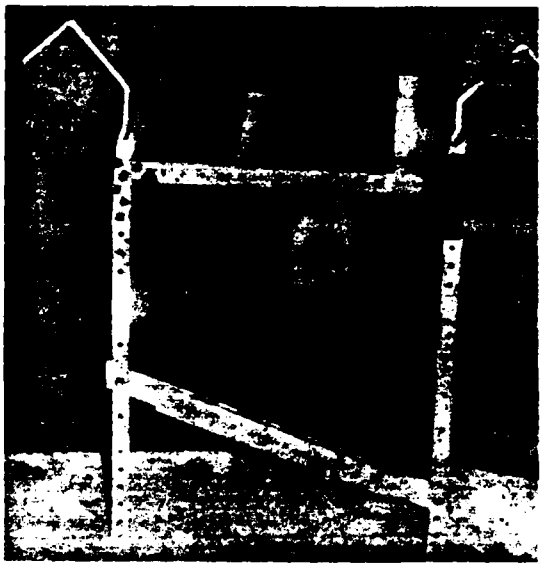

Figure 5. Racked parts ready for plating.

The elimination of rinsewater discharge by use of a modified spray system is the third important part to the system. With proper ventilation you do not require a vapor suppressor of any type. This and the higher temperature (140°F) result in large losses from the plating tank by evaporation. This evaporation can then be made up from a rinse tank. You can put a dead rinse tank (empty) at the end of the plating line, with a sprayer to rinse the parts off. A picture of a simple system is shown in Figure 6. Then as the tank fills you return that water back to your plating tank to make up for evaporation. If conditions in your plating shop permit, you may even rinse over the top of your plating tank.

A good ventilation system is required – a double pull system with demister section to recover the mist off the tank. The recovered mist is returned to the plating tank.

Plating using this general system requires maintaining a voltage of 4.5 volts. You do not care about amperage. As parts are added or subtracted from the tank you adjust the voltage to maintain 4.5 volts. This allows plating rates greater than 0.006 in./hr. Plating

may be done with solutions between 16 to 40 oz/gal chromic acid. A simple bath purification system may be required according to the specific situation. This system provides high productivity, high quality, zero discharge, and ease of use. There are many commercial shops plating around the country using a similar method, and a Navy shop at Pensacola, Fla., has converted to this improved process. In addition, NARF at MCAS Cherry Point, N.C., is in the process of converting over to this improved method as well as the shipyard at Pearl Harbor.

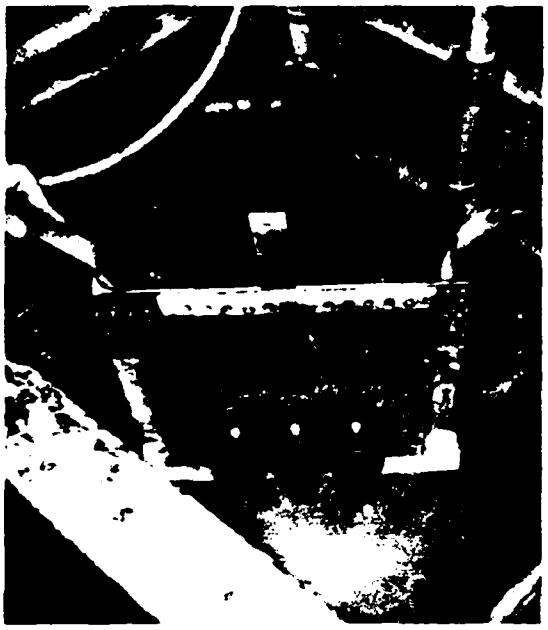

Figure 6. Simple no-discharge spray rinse system.

Technical assistance in incorporating the system at Pensacola was provided by C. Carpenter of the Naval Civil Engineering Laboratory. Contractual assistance was provided by C. Peger of Hard Chrome Plating Consultants Ltd., Cleveland, Ohio.

NCEL CONTACT

C. Carpenter, Code L71; tel: Autovon 360-4116, FTS 799-4191, Comm (805) 982-4116.

DEPARTMENT OF THE NAVY

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

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Presented by Charles Carpenter, Project Developer, NCEL

Table 5.1

CONVENTIONAL SYSTEM vs. IHCP SYSTEM
COMPARISON OF PLATING RATES AND GRINDING REQUIREMENTS

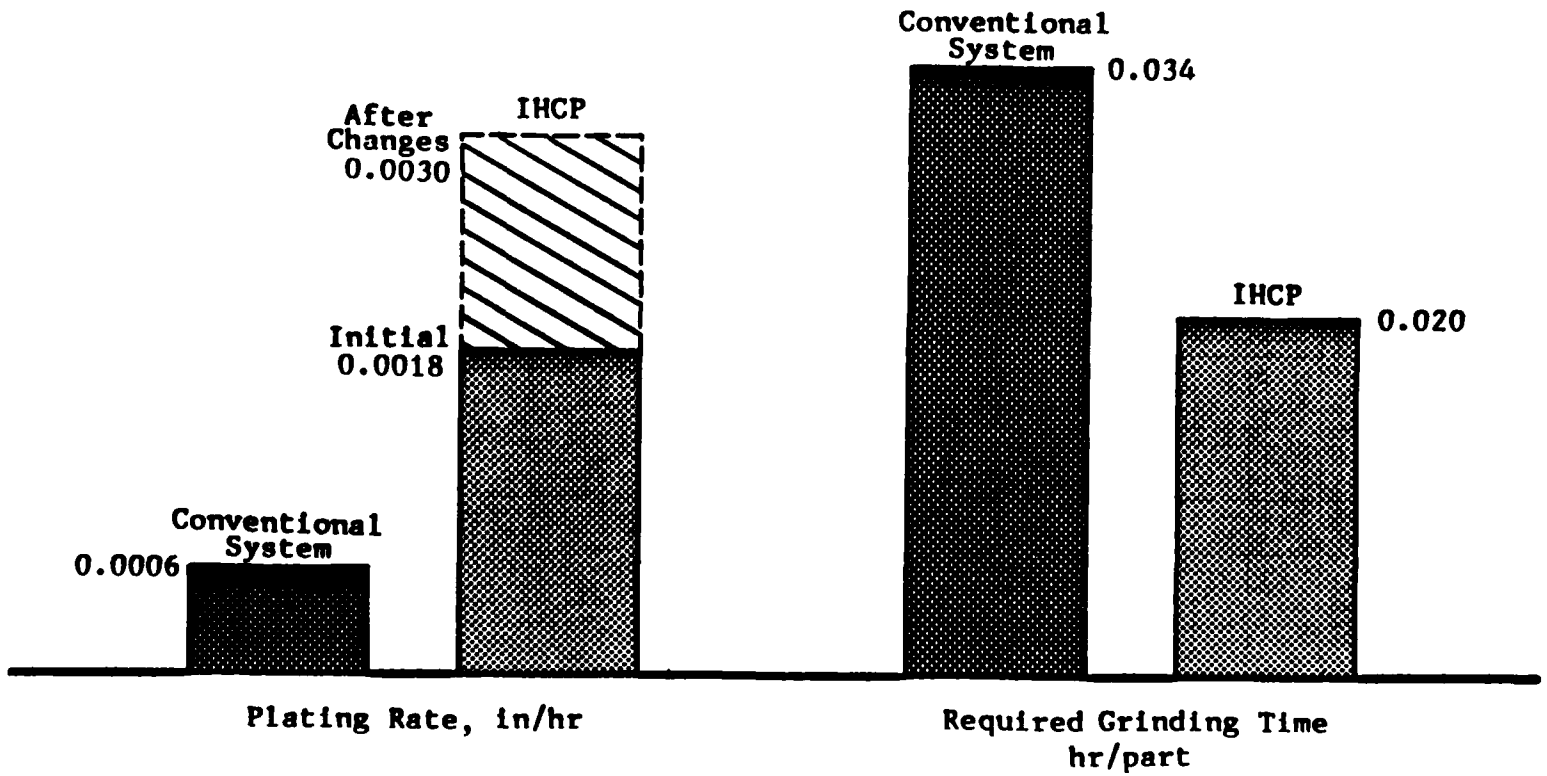
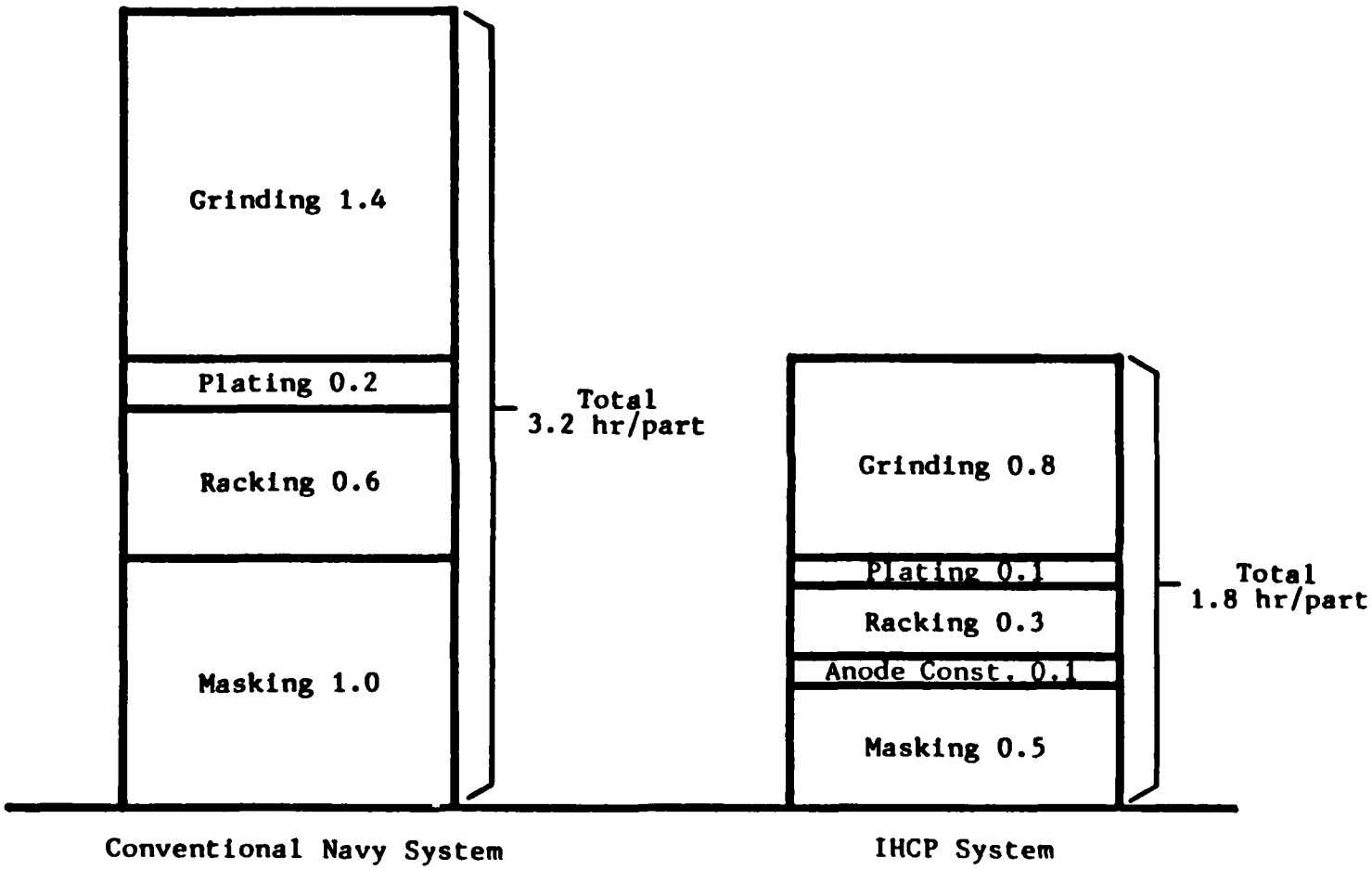


Table 5.2

CONVENTIONAL SYSTEM vs. IHCP SYSTEM: LABOR REQUIREMENTS



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ROUTINE

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FM COMNAVAIRSYSCOM WASHINGTON DC

TO NAVAVNLOGCEN PATUXENT RIVER MD

INFO NAVAIREWORKFAC NORFOLK VA NARF NAVAIREWORKFAC CHERRY PT NC NARF
NAVAIREWORKFAC JACKSONVILLE FL NARF NAVAIREWORKFAC PENSACOLA FL NARF
NAVAIREWORKFAC NORTH ISLAND CA NARF NAVAIREWORKFAC ALAMEDA CA NARF
COMNAVFACENGCOM ALEXANDRIA VA NAVFAC NAVCIVENGRLAB PORT HUENEME CA NCEL

UNCLAS //N013023//

SUBJ: INCORPORATION OF INNOVATIVE HARD CHROME PLATING PROCESS

A. NCEL LTR 3900 SER L71/1830 of 31 OCT 84 (NOTAL)
B. AIR-71 MEMO AIR-7123F/606/84 of 23 NOV 84 (NOTAL)
C. QQ-C-3208 FEDERAL SPECIFICATION CHROMIUM PLATING

(ELECTRODEPOSITED)

1. THIS MSG OF INTEREST TO NAVFAC CODES 112A AND 1122E AND HAS BEEN COORDINATED WITH AIR-5304.

2. REFS A AND B PROVIDED NAVAL CIVIL ENGINEERING LABORATORY (NCEL) TECHNICAL INFORMATION ON INNOVATIVE HARD CHROME PLATING PROCESS NOTING INCREASED PRODUCTIVITY, IMPROVED QUALITY AND REDUCED POLLUTION. THIS PROCESS HAS BEEN INCORPORATED AT NAVAIREWORKFACS PENSACOLA AND CHERRY POINT WITH OPERATING RESULTS CONFIRMING PRODUCTIVITY INCREASES UPWARDS OF 300 PERCENT WITH ATTENDANT IMPROVEMENT OF QUALITY AND ELIMINATION OF CONTAMINANT DISCHARGE. IT SHOULD BE NOTED THAT THE INNOVATIVE HARD CHROME PLATING PROCESS IS USED FOR CLASS 2 ENGINEERING PLATING REQUIREMENTS OF REF C WITH PLATING APPLIED DIRECTLY TO THE BASIS METAL. THE PROCESS IS SIMILAR TO THAT CURRENTLY IN USE AT THE NAVAIREWORKFACS FOR CONVENTIONAL CLASS 2 HARD CHROME PLATING EXCEPT FOR THE USE OF CONFORMING ANODES AND PLATING TANK MODIFICATIONS.

3. NCEL PERSONNEL HAVE COORDINATED INSTALLATION OF THE PROCESS AND

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THE TRAINING OF PERSONNEL AT NAVAIREWORKFAC PENSACOLA AND NAVSEA FACILITIES AT LOUISVILLE, PUGET SOUND AND PEARL HARBOR, NCEL IS ALSO MONITORING THE OPERATIONS AT THESE ACTIVITIES TO ENSURE MAXIMUM PROCESS BENEFITS.

4. IN VIEW OF THE DEMONSTRATED BENEFITS DERIVED FROM SUBJECT PLATING PROCESS, AND THE ESTIMATED $145,000 INVESTMENT PAYBACK WITHIN ONE YEAR, IT IS EVIDENT THAT THE PROCESS SHOULD BE INCORPORATED WITH MINIMUM DELAY AT ALL NAVAIREWORKFACS. THEREFORE, REQUEST FOLLOWING ACTION BE TAKEN TO INITIATE IMPLEMENTATION AT THE REMAINING NAVAIREWORKFACS AND INCLUDING EXPANDED TRAINING PROGRAMS FOR NAVAIREWORKFACS CHERRY POINT AND PENSACOLA:

A. ESTABLISH WORKSHOP AT NAVAIREWORKFAC PENSACOLA WITH REPRESENTATIVES FROM ALL NAVAIREWORKFACS TO REVIEW EXPERIENCE/PLANNING FOR INCORPORATING PROGRAM BASED UPON NAVAIREWORKFACS PENSACOLA AND CHERRY POINT EXPERIENCE.

B. INVITE NCEL PARTICIPTATION TO PROVIDE DETAILS OF ITS COORDINATING PR OGRAM ASSISTANCE AT NAVAIR AND NAVSEA ACTIVITIES. POC AT NCEL IS MR. NICK OLAH, AV 360-4116 OR COMMERCIAL (805) 982-4116.

5. REQUEST ADVISE PLANNED ACTION TO INCORPORATE INNOVATIVE HARD CHROME PROGRAM AT NAVAIREWORKFACS NORFOLK, JACKSONVILLE, NORTH ISLAND AND ALAMEDA.

6. MR. P. BUKOFF, AIR-40011, AV 222-9804 IS AIR-400'S POC FOR SUBJECT PROGRAM.

BT

6.0 OCCUPATIONAL AND ENVIRONMENTAL CONSIDERATIONS

6.1 Occupational Health and Safety

- Worker Exposures
  - Metals
  - Acids
  - Solvents
- Minimizing Worker Exposures
  - Protective Clothing
  - Process Modifications

6.2 Plating Wastes - Environmental Regulations

- Hazardous Wastes
- Wastewater Pretreatment Requirements
- Wastewater Treatment for Direct Discharge

Dose-Response Curves for Carcinogens and Systemic Toxicants

Representative Potency Slopes for Carcinogens and Acceptable Daily Intake Values for Systemic Toxicants

Health Effects of Chromium, American Conference of Governmental Industrial Hygienists, 1980.

Material Safety Data Sheet for Chromic Acid, M&T Chemicals, August 1983.

Lead Sampling Data Sheet for Welding Anodes

Occupational Exposure Guide for Lead

6.0 OCCUPATIONAL AND ENVIRONMENTAL CONSIDERATIONS

6.1 Occupational Health and Safety

Worker Exposures

Hard chrome plating exposes workers to a variety of chemicals including metals, acids, and solvents. Table 6.1 lists some characteristics of chemicals commonly used in chrome plating processes. The table also shows exposure limits.

Inhalation is the major worker exposure mode. This is reflected in the exposure limits which are expressed as ambient air concentrations. If a chemical causes eye or skin irritation at a low concentration, the limits are based on that concentration. Systemic toxicity, such as liver or central nervous system damage usually involves higher concentrations.

Metals

The ability of metals to pass across biologic membranes, such as skin or lung tissue varies from element to element. Soluble metal salts readily dissociate in the aqueous environment of biologic tissues, facilitating their transport as metal ions. Insoluble salts are relatively poorly absorbed.

Solubility especially affects the fate of metals deposited in the respiratory tract. The more insoluble the metal compound, the more likely it is to be cleared from the lungs. Systemic absorption is minimal.

The strong attraction between metal ions and organic molecules influences the dispersion of metals in the body and their rate of excretion. Most toxicologically important metals bind strongly to tissues and so are only slowly excreted. Consequently, if intake continues, the metal accumulates in body tissues. Affinities of metals for tissues varies. For example, lead concentrates in bone while cadmium concentrates in the kidney.

TABLE 6.1

CHARACTERISTICS OF CHEMICALS USED IN HARD CHROME PLATING (page 1 of 2)

Chemical Name(s)	Symbol or Formula	Physical Characteristics	Use	Toxicity[2,3]	Ambient Air Threshold Limit Values[1] Time Weighted Average (mg/m^3)	Ambient Air Threshold Limit Values[1] Short Term Exposure Limit (mg/m^3)
chromic acid (chromium trioxide)	CrO_3 dissolved in water (Cr valence is +6)	Solid consists of dark red crystals POWERFUL OXIDANT! Contact with combustible material may cause fire.	Plating solution	LD (subcutaneous) in dogs, 330mg/kg. Skin contact may result in irritation, ulceration, and allergic eczema. Inhalation can cause nasal irritation and septal perforation. Pulmonary irritation and bronchogenic carcinoma may result from breathing chromate dust. Acute exposure may result in eye inflammation and dental erosion. Ingestion causes violent gastrointestinal irritation with vomiting and diarrhea, and possibly renal injury.	0.05	Not available
chromium	Cr may have valence of +2, +3, or +6 (see chromic acid)	Steel-gray, lustrous metal	Plate	Trivalent chromium compounds show little or no toxicity.	0.5	Not available
hydrochloric acid (muriatic acid)	HCl in water	Liquid. May be colored yellow by traces of iron, chlorine, and organic matter.	Pickle liquor	External contact may cause severe burns and permanent visual damage. Dermatitis and photosensitization may occur from repeated exposures. Inhalation may cause inflammation and ulceration of the respiratory tract. Ingestion results in corrosion of mucous membranes, esophagus and stomach. Dysphagia, nausea, vomiting, intense thirst, diarrhea, circulatory collapse, and death may also occur.	7 (ceiling limit)	Not available

1. Limits recommended by the American Conference of Governmental Industrial Hygienists, 1980.
2. LD - lethal dose

TABLE 6.1
CHARACTERISTICS OF CHEMICALS USED IN HARD CHROME PLATING (page 2 of 2)

Chemical Name(s)	Symbol or Formula	Physical Characteristics	Use	Toxicity[2,3]	Ambient Air Threshold Limit Values[1] Time Weighted Average (mg/m^3)	Short Term Exposure Limit (mg/m^3)
lead	Pb	Bluish-white, silvery, gray metal. Soft and malleable, tarnishes on exposure to air.	conforming anodes	Kidney damage and anemia may occur. Male infertility is associated with lead poisoning. Peripheral nerve damage (lead palsy) may occur. Major features are weakness of extensor muscles, hyperaesthesia, and analgesia. Chronic or subchronic exposure may result in central nervous system damage. Major features of lead encephalopathy are dullness, restlessness, irritability, headaches, muscular tremor, ataxia, and memory loss. Convulsions, coma, and death may occur. Exposure may also cause epilepsy and idiocy. Lead concentration in urine more than 0.08 mg/l indicates poisoning.	0.15	0.45
nickel	Ni	Lustrous, white, magnetic metal.	protective plate under chromium plate	May cause dermatitis in sensitive individuals. Ingestion of soluble nickel salts causes nausea, vomiting, and diarrhea.	1.0	Not available
sulfuric acid (vitriolic acid)	H_2SO_4	Clear, colorless, odorless, oily liquid CORROSIVE!	plating catalyst	Corrosive to all body tissues. Inhalation may cause serious lung damage. Eye contact may result in total loss of vision. Skin contact may produce severe necrosis. Ingestion may cause severe injury and death. Frequent skin contact with dilute H_2SO_4 may cause dermatitis.	1.0	Not available
1-1-1 trichloroethane (methyl chloroform)	$Cl_2C = CHCl$	Nonflammable liquid	degreaser	LD_{50}, male rats, 12g/kg. Narcotic at high concentrations. central nervous system depressant. Possible liver and kidney damage. May cause death due to venticular fibrillation. Carcinogen.	50 ppm	150 ppm

3. LD_{50} - lethal dose for 50% of test population.

Acids

Acids are corrosive to body tissues. Breathing in even a small amount of acid can have serious consequences. Aspiration may result in skin and eye irritation in association with inability to swallow or pain upon swallowing, mucous membrane burns, respiratory distress, shock, and renal failure. Prompt first-aid is essential after exposure.

Solvents

The ability of halogenated hydrocarbons to clean metal parts, combined with their low flammability, has made them among the most widely used industrial solvents. The common biologic effect of these compounds is anesthesia.

Minimizing Worker Exposures

Protective Clothing

Workers in many military plating facilities are required to wear acid-resistant shirts and trousers or coveralls in combination with steel-toed acid-resistant boots and acid-resistant gloves.

While working over plating baths, workers are required to wear an acid-resistant apron and goggles in addition to the protective clothing described above. If the facility's ventilation system is operating near its peak capacity or if it is not functioning, respirators are also required.

Process Modifications

"Ping-pong balls" and commercial fume control agents may be used to minimize the mist rising from chrome plating baths. The balls float on top of the bath and physically prevent chromic acid droplets from escaping the tank when hydrogen bubbles off the cathode.

Proprietary chemicals may be added to the baths to decrease the amount of mist.

6.2 Plating Wastes--Environmental Regulations

Hazardous Wastes

The Resource Conservation and Recovery Act (RCRA) and the associated Code of Federal Regulations (40 CFR 261) define hazardous wastes which are produced from electroplating operations. Metal plating baths, cleaning solutions, and sludges are automatically defined as hazardous wastes if they are listed in one of EPA's generic categories for nonspecific sources (40 CFR 261.31). Table 6-2 summarizes the generic categories of hazardous waste applicable to the electroplating industry. Metal plating waste can also be classified as hazardous if it exhibits any of the characteristics identified below:

Ignitability - Liquid with a flash point below 140°F, nonliquid which burns vigorously and persistently when lighted, ignitable compressed gas, or an oxidizer.

Corrosivity - Liquid with pH less than or equal to 2 or greater than or equal to 12.5, or liquid which corrodes steel (SAE 1020) at a rate greater than 0.25 inch per year.

Reactivity - Substance which is normally unstable and readily undergoes violent change without detonating, reacts violently with water, forms explosive mixtures with water, generates toxic gases, vapors, or fumes when mixed with water, or is capable of detonation.

Toxicity - Waste that fails the extraction procedure (EP) test (i.e., a measurement of the leaching of heavy metals and pesticides from sludges).

A more detailed description of the four characteristics can be found in 40 CFR 261.2.

Table 6-2
HAZARDOUS WASTE FROM NONSPECIFIC SOURCES

EPA Hazardous Waste Number	Hazardous Waste Description	Hazard Code Designation
F006	Waste treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc, and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.	Toxic
F007	Spent cyanide plating bath solutions from electroplating operations where cyanides are used in the process (except for precious metals electroplating spent cyanide plating bath solutions).	Reactive, Toxic
F008	Sludges from the bottom of plating baths in electroplating operations where cyanides are used in the process (except for precious metals electroplating bath sludges).	Reactive, Toxic
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process (except for precious metals electroplating spent stripping and cleaning bath solutions).	Reactive, Toxic

If a facility produces over a 1,000 kg per month of hazardous wastes, it must comply with all RCRA regulations.

In the October 1984 reauthorization of RCRA, Congress reduced the small quantities exclusion limit from 1000 kg to 100 kg per month, to take effect in March 1986. Many small electroplating and surface finishing shops will then have to comply with the new RCRA requirements; however, few military industrial facilities will be affected since most of them are large waste producers and thus are already required to follow EPA regulations.

EPA is also required to promulgate new regulations which will ban the landfilling of bulk or noncontainerized liquids and severely restrict the land disposal of other hazardous wastes. The regulations are expected to motivate DOD facilities to implement alternative hazardous waste disposal practices, such as incineration.

Wastewater Pretreatment Requirements

The EPA has established "National Categorical Pretreatment Standards" that limit wastewater contaminant concentrations which can be discharged to publicly owned treatment works. In July of 1983, final regulations (40 CFR 413 and 433) were issued for the metal finishing point source category. These pretreatment regulations pertain to the following operations: electroplating, electroless plating, chemical etching and milling, anodizing, conversion coating, and printed circuit board manufacture.

For regulatory purposes, EPA has divided the electroplating industry into two major groups: "captive facilities," which own the material they process, and "job shops," which do not. DOD electroplating shops fall into the first category. Most DOD electroplating shops are further defined by EPA as "integrated" facilities because electroplating waste streams are combined with other waste streams before treatment and discharge. "Nonintegrated" facilities are defined by EPA as those which have significant wastewater discharges only from an electroplating shop. Job shops, nonintegrated captive facilities, and captive facilities were required to meet interim pretreatment standards by June of 1984.

Table 6-3 presents the final pretreatment limitations for the metal finishing category of electroplaters. Pollutants of concern include toxic metals, cyanide, and toxic organics. The compliance date for these standards is February 15, 1986. State and local regulatory agencies are required to administer and enforce these regulations and are allowed to implement more stringent standards than the federal pretreatment limits.

Table 6-3
EPA METAL FINISHING SUBCATEGORY
PRETREATMENT STANDARDS FOR EXISTING SOURCES (mg/L)

Constituent	Maximum for Any 1 Day	Maximum Monthly Average[a]	Long-Term Concentration Average[b]
Cadmium (Total)	0.69	0.26	0.13
Chromium (Total)	2.77	1.71	0.572
Copper (Total)	3.38	2.07	0.815
Lead (Total)	0.69	0.43	0.20
Nickel (Total)	3.98	2.38	0.942
Silver (Total)	0.43	0.24	0.096
Zinc (Total)	2.61	1.48	0.549
Cyanide (Total)	1.20	0.65	0.18
Cyanide (Amenable)[c]	0.86	0.32	0.06
TTO[d]	2.13	--	0.434

[a]Monthly average of 10 samples.

[b]EPA guidelines to be used as a design basis; not a limitation.

[c]For facilities with cyanide treatment, upon agreement with the pollution control authority, cyanide amenable to alkaline chlorination may be substituted for total cyanide.

[d]Total toxic organics (TTO) refers to the summation of all values greater than 10 micrograms per liter for the toxic organics listed in 40 CFR 413-11.

Wastewater Treatment For Direct Discharge

In September of 1984, EPA promulgated final amended National Pollutant Discharge Elimination System (NPDES) regulations for the direct discharge of pollutants in waterways. The NPDES has put forth an extensive effort to regulate the discharge of toxic pollutants, including development of the NPDES Toxic Control Strategy. One element of this strategy is that all industrial dischargers, including military industrial facilities, must report quantitative data for any toxic pollutant that they know or have reason to believe is present in the discharge above 10 ppb. This requirement is designed to ensure that the permitting authority receives adequate information to make appropriate judgments about the establishment of permit limitations and testing requirements.

NPDES permit limitations are generally based upon promulgated EPA effluent limitation guidelines (technology-based limits) and/or state water quality standards (water quality-based limits). NPDES permits are issued case-by-case by EPA or the state regulatory agency, and the concentration limits specified in the permit are based on one or more of the following: best available technology economically achievable (BAT), flow rate of receiving waters, quality of receiving waters, and pollutant volume and concentration of industrial discharge.

6.3 Problem Definition--Metal Plating

Following plating, parts are rinsed to remove plating solution that adhered to the parts (drag-out). Most military plating operations use single overflow rinse tanks that operate at flow rates of from 2 to 8 gallons per minute. Rinsewater flows are typically the predominant sources of wastewater at military plating facilities. Additional discharges of hazardous waste include: cleanup of spills; aerosol spray from such operations as chromium plating that is exhausted to the atmosphere or removed by wet scrubbers; and discarded process solutions.

Wastewaters from plating facilities can be segregated into four waste streams: chromium wastewaters, cyanide wastewaters, non-cyanide wastewaters, and acid/alkali wastewaters. Figure 6-1 shows processes used to treat these various waste streams.

Hexavalent chromium is commonly used in chromium plating bath formulations and is a major concern in the design of waste treatment processes for chrome plating facilities. Chromium must be reduced to its trivalent state before it can be removed by precipitation as a hydroxide. Reduction is normally carried out at an acidic pH, utilizing a reducing agent, such as sodium metabisulfite, sulfur dioxide, or ferrous sulfate. The resulting trivalent chromium can then be removed by hydroxide precipitation with the other plating metals in an industrial wastewater treatment plant. This complicates and adds significantly to the cost of treatment. Ion exchange and electrostatic treatment methods are more expensive alternative treatment processes.

Cyanide wastewaters are typically the product of cadmium and zinc plating, since these metals are typically plated from alkaline cyanide baths. Unfortunately, cyanide baths are dangerous to operate and the resulting cyanide-containing wastes are complicated and costly to treat. The cyanide is typically oxidized at an alkaline pH, using chlorine or sodium hypochlorite.

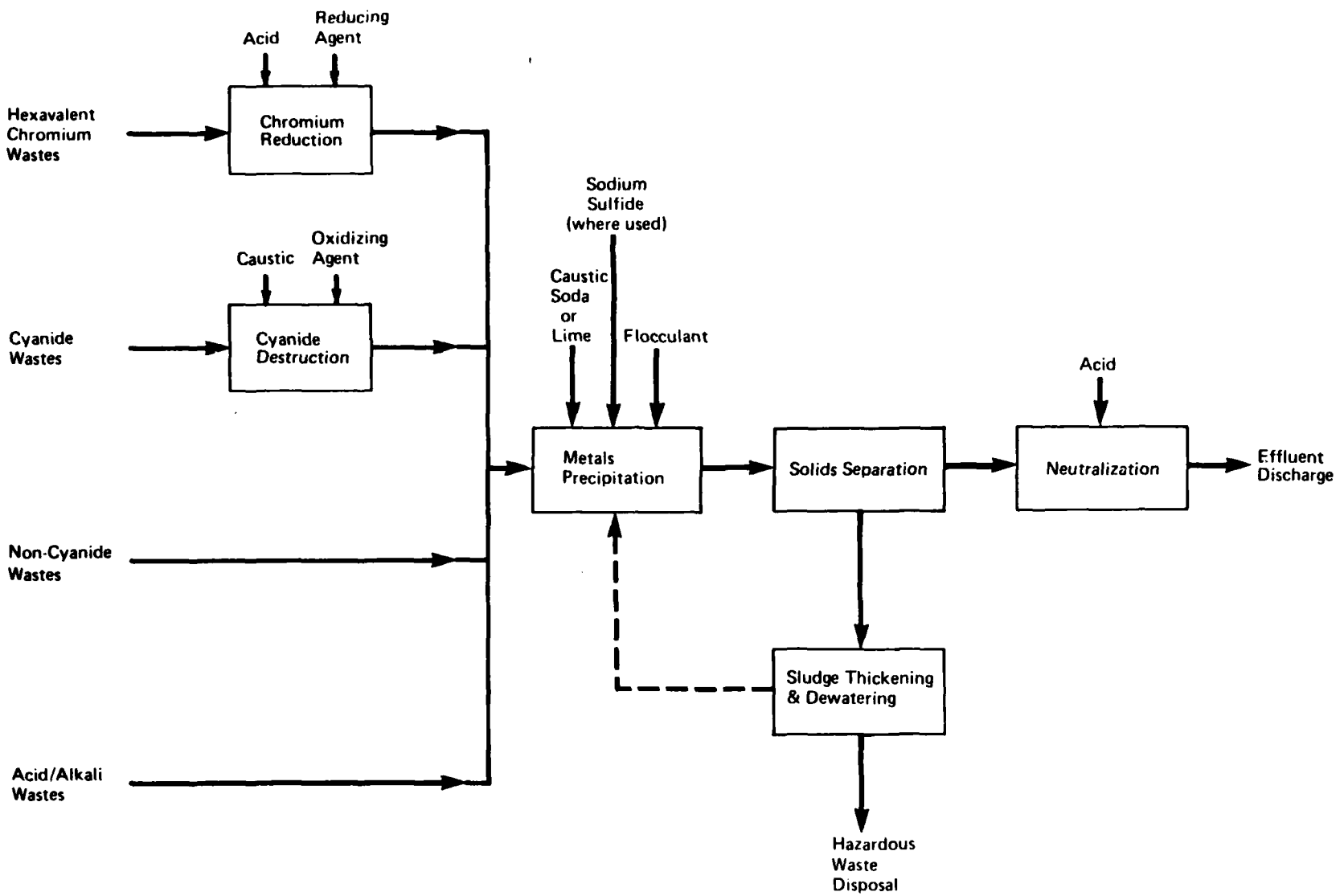


Figure 6–1. Typical treatment of plating wastewater.

Non-cyanide wastewaters are usually those produced in nickel plating. Acid/alkali wastes are produced in metal cleaning and etching operations. These wastes can normally be treated directly for metals removal by hydroxide precipitation.

Following separate treatment for hexavalent chromium reduction and cyanide oxidation, the four waste streams are typically combined for metals removal by hydroxide precipitation. Precipitation as sulfides has been proposed due to the low solubility of most metal sulfides. The resulting solids are typically removed by gravity settling and filtration.

In a review of Army plating operations, Chesler (November 1982) found that 23 DARCOM installations perform metal plating or finishing operations, with wastewater productions varying from less than 100 gallons per day (gpd) to over 150,000 gpd. Metals plated at these facilities include chromium, cadmium, nickel, zinc, tin, lead, brass, and gold. Chesler found that the principal sources of hazardous waste generation at Army plating facilities were drag-out to rinsewater, spills of plating solutions, disposal of acid and alkaline cleaners, and occasional plating bath dumps.

Metal finishing processes were being used at more than 70 Navy facilities, according to a report by CENTEC Corporation (October 1983). The largest naval electroplating operations were found at Naval Air Rework Facilities (NARFs), Naval Shipyards (NSYs), Naval Air Stations (NASs), the Naval Ordnance Station (Louisville, KY), and the Naval Avionics Center (Indianapolis, IN). Metals plated included copper, chromium, cadmium, nickel, tin, lead, zinc, brass, gold, silver, iron, and rhodium. Wastewater production at the facilities varied from less than 100 to 360,000 gpd. The total wastewater effluent from these metal finishing shops was estimated to be over 3.6 million gpd.

Rinsewaters were found to be the greatest source of wastewaters at Navy plating facilities. Due to low production rates, long plating times, excessive water use, and lack of countercurrent rinsing, Navy rinsewaters were found to be much more dilute than those in commercial operations. Concentrations of metals ranged from 0.2 to 2 mg/L compared with 10 to 1,000 mg/L found in commercial facilities (CENTEC, October 1983).

Process solutions disposed of were primarily spent alkaline and acidic cleaners used to condition parts prior to plating and to remove metal deposits from rejected or damaged parts. These discarded solutions contained significant concentrations of metals and cyanide due to drag-in from previous process cycles and attack of the basis metals by

the chemicals in the cleaning solutions. Navy experience has indicated that the concentration of metals and cyanides in stripping solutions usually exceeds 50,000 mg/L.

Another significant contribution of metals and cyanide was the disposal (dumping) of plating baths that failed to perform as required. Dumping of plating baths is rarely practiced in private industry, due to the high costs of chemical replacement and disposal. However, it was reported that many Navy shops dumped plating baths (especially chromium) once or twice a year, usually before plating quality deteriorated, either on a pre-set schedule or based on observation.

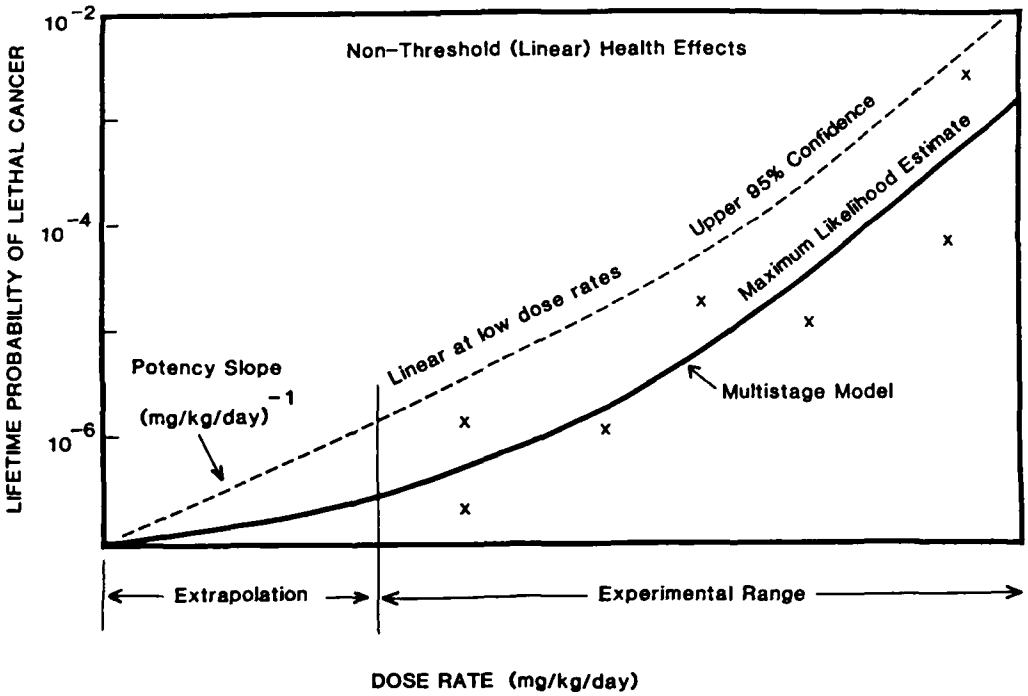
Most Navy plating shops drum spent plating baths and have a contractor haul these wastes to a permitted hazardous waste treatment/disposal site. Some shops slowly bleed these concentrated wastes to the industrial wastewater treatment plant. Plating baths are also discharged accidentally due to overflow of process tanks, which is aggravated by a lack of high level alarms and adequate operator attentiveness. Because of accidental bath dumps, the total volume dumped exceeds that planned at Navy plating facilities.

For hard chrome plating operations, bath dumping is usually the principal source of chromium discharge. Drag-out to rinse tanks is minimized due to the extended plating times of from 24 to 48 hours. Chromium drag-out from a typical Navy plating bath was found to be approximately 100 pounds per year. It was estimated that the amount of chromium dumped in plating baths at Pensacola NARF was over 20,000 pounds per year, or approximately 170 times the amount lost to drag-out. This is in contrast to decorative chromium plating operations, where parts remain in the plating tanks for a minute or less, and drag-out can exceed 35,000 pounds of chromium per year. Impurities generated in the plating process are removed with this drag-out, reducing or eliminating the need for bath dumping (Carpenter, January 1984).

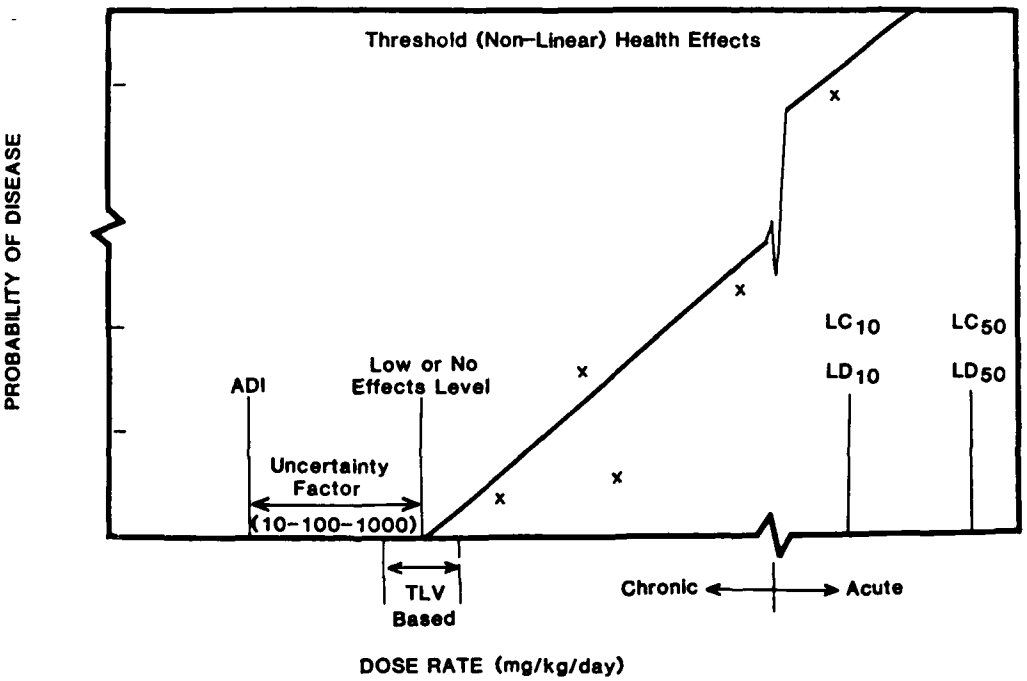
Plating wastewater treatment sludges are classified (listed) as hazardous. The cost of sludge disposal from Navy facilities was reported to range from $113 to $320 per ton, which has amounted to an annual disposal cost of hundreds of thousands of dollars per facility.

The Air Force was reported to operate 15 electroplating facilities (Aldridge, November 1984). These facilities ranged from the small, three to four plating bath operation, to the very large operation with over 40,000 square feet of floor space. These shops plated a variety of metals in support of both local maintenance and periodic major overhaul of engines and aircraft at Air Logistics Centers (Higgins and Termaath, 1982). In addition, plating was performed by private contractors at government-owned, contractor-operated (GOCO) facilities.

DOSE-RESPONSE CURVE FOR A CARCINOGEN



DOSE-RESPONSE CURVE FOR A SYSTEMIC TOXICANT



Carcinogen Potency Slope - $q_1^*(H)$

	$(mg/kg/day)^{-1}$
Dioxin (2,3,7,8 TCDD)	156,000
Aflatoxin B_1	2,930
Benzidene	234
Chromium	41
Arsenic	15
Cadmium	6.65
Beryllium	1.4
Chloroform	0.2
Benzene	0.05
Range for 62 Carcinogens	0.00492 - 156,000

Acceptable Daily Intake (ADI) Values

	(mg/day)
Phorate	0.0024
Lead	0.0045
Acrolein	0.009
Phosgene	0.019
Mercury	0.020
Pentachlorophenol	0.18
Cyanides	0.33
Methanol	12
Toluene	134
Range for 114 Non-Carcinogens	0.0024 - 11,300

Source: American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values, 4th Edition, Cincinnati, Ohio, 1980.

CHROMIUM

Cr

Metal and Inorganic Compounds, as Cr

TLV, 0.5 mg/m³ — Metal

0.5 mg/m³ — Cr II Compounds

0.5 mg/m³ — Cr III Compounds

0.05 mg/m³ — Water Soluble Cr VI Compounds

0.05 mg/m³, Appendix A1a — Recognized Carcinogen — Certain Water Insoluble Cr VI Compounds

Chromium is a metallic element; atomic number 24, atomic weight 51.996, in Group VIB of the periodic table. It is a steel-gray, lustrous metal, with a specific gravity of 7.20. The melting point is 1900° C and boils at 2642° C. The metal reacts with dilute hydrochloric acid and sulfuric acid, but not with nitric acid.

Chromium metal was first isolated in 1798. The chief uses of chromium and chromium compounds are in stainless and alloy steels, refractory products, tanning agents for leather, pigments, electroplating, catalyst and in corrosion resistant products. Chromium is obtained from chromite ores ($FeO{\cdot}Cr_2O_3$). Relatively large deposits of chromite ore were found near Baltimore in the United States but no mining has taken place there since 1961.

Chromium can have a valence of 2, 3 or 6, and a wide range of chromium alloys and inorganic chromium compounds are encountered in the workplace. These chromium compounds vary greatly in their toxic and carcinogenic effects. For this reason it is necessary to divide chromium and its inorganic compounds into a number of groupings — each with its specific TLV based on available toxicological and epidemiological evidence. These groupings are:

1. **Chromium metals and alloys**
   This grouping includes chromium metal, stainless steels and other chromium-containing alloys.
2. **Divalent chromium compounds (Cr^{2+}) (Chromous compounds)**
   This grouping includes chromous chloride ($CrCl_2$) and chromous sulfate ($CrSO_4$).
3. **Trivalent chromium compounds (Cr^{3+}) (Chromic compounds)**
   This grouping includes chromic oxide (Cr_2O_3), chromic sulfate ($Cr_2[SO_4]_3$), chromic chloride ($CrCl_3$), chromic potassium sulfate ($KCr[SO_4]_2$) and chromite ore ($FeO{\cdot}Cr_2O_3$).
4. **Hexavalent chromium compounds (Cr^{6+})**
   This grouping includes chromium trioxide (CrO_3) — the anhydride of chromic acid — chromates (e.g., Na_2CrO_4), dichromates (e.g., $Na_2Cr_2O_7$) and polychromates. Certain hexavalent chromium compounds have been demonstrated to be carcinogenic on the basis of epidemiological investigations on workers and experimental studies in animals. In general, these compounds tend to be of low solubility in water and thus may be subdivided into two subgroups:
   (a) **Water soluble hexavalent chromium compounds**
   These include chromic acid and its anhydride, and the monochromates and dichromates of sodium, potassium, ammonium, lithium, cesium and rubidium.
   (b) **Water insoluble hexavalent chromium compounds**
   These include zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate and sintered chromium trioxide.

Hexavalent Chromium

The first cases of occupational health effects from hexavalent chromium were reported in 1827[2] by Cumin, who observed cases of skin ulceration and dermatitis in dye workers handling potassium dichromate. Mackenzie[3] in

1884 reported that perforation of the nasal septum occurred in workers exposed to potassium bichromate. DaCosta *et al*[4] in 1916 described chrome ulcers in tanners and dryers. Parkhurst[5] in 1925 reported chrome dermatitis in blueprint workers exposed to potassium dichromate. Bloomfield and Blum[6] reported on their study of electroplaters exposed to acidic mist of hexavalent chromium compounds. They noted that 20 or 23 workers examined showed evidence of perforated or ulcerated nasal septa and skin ulcers (*chrome holes*). The Factory Inspectorate in Great Britain[7] reported in 1930 on the results of medical examinations of 223 persons engaged in chromium plating; 42.6% had dermatitis or skin ulcers and 52% had perforated or ulcerated nasal septa.

The occupational health literature affords abundant evidence that hexavalent chromium compounds may cause irritant and allergic contact dermatitis, skin ulcers, and nasal irritation varying from rhinitis to perforation of the nasal septum. Dermatitis from exposure to soluble hexavalent chromium has been reported in lithographers[8,9] diesel repair shop workers[10] and leather workers.[11] Soluble chromates in cement have been stated to be the cause of cement dermatitis in some workers.[12]

Attempts have been made to correlate the airborne levels of hexavalent chromium with irritation of the nasal mucosa. In the study by Bloomfield and Blum,[6] electroplaters were exposed to estimated exposures ranging from 0.06 to 2.8 mg/m^3 (as Cr^{6+}). Levels of Cr^{6+} in the form of chromium trioxide, were capable of giving rise to nasal irritation at concentrations as low as 0.06 mg/m^3. It is difficult to rule out the importance of personal hygiene in the production of nasal symptoms from direct transfer of chromium (Cr^{6+}) to the nasal mucosa. Nasal irritation is produced from exposure to soluble chromate and bichromate salts as well as to chromic acid mist.[12,13] The study by the U.S. Public Health Service[14] noted that the mean concentration of water-soluble chromium in plants where nasal irritation was encountered was 0.068 mg/m^3 as Cr^{6+}.

Epidemiological studies showing an increased incidence of lung cancer among workers involved in the manufacture of chrome pigments have been reported from Germany,[15] Norway[16] and United States.[17] Machle and Gregorius[13] first reported increased incidence of lung cancer in the United States chromate industry. Baetjer[18] carried out a case control study and confirmed the increased risk of lung cancer among the U.S. chromate workers. Mancuso and Hueper[19] attempted to estimate the airborne exposures to chromium in those who developed lung cancer. They found that these workers were exposed to 0.01 to 0.15 mg/m^3 of water soluble chromium and 0.1 to 0.58 mg/m^3 of water insoluble chromium. The insoluble fraction was denoted as Cr^{3+} and the soluble as Cr^{6+} but it is impossible to assign Cr^{6+} or Cr^{3+} exclusively to either fraction.

The chromate workers in the preceding studies were exposed to various Cr^{3+} and Cr^{6+} compounds as well as to other substances. In general, the evidence does not suggest that chromite ore, a water insoluble Cr^{3+} substance, is a carcinogen. While the evidence is incomplete it does appear that certain Cr^{6+} compounds, mainly water insoluble, were involved in increased risk of lung cancer. The experimental data from animals supports the view that water insoluble Cr^{6+} compounds, e.g., chromic and zinc chromates, are carcinogenic, whereas the soluble forms are not.[20] Royle,[21] however, has reported an increase in lung and other cancers in chrome platers in England.

Hexavalent chromium compounds have been said to also cause kidney damage in workers[22,23] where absorption through damaged skin has occurred.

The TLVs for hexavalent chromium compounds are recommended as follows:

(a) *Water soluble hexavalent chromium compounds* (see examples noted above). A TLV of 0.05 mg/m^3 as water soluble Cr^{6+} is considered adequate to protect against irritation of the respiratory tract and possible kidney and liver damage. NIOSH in the criteria document on chromic acid[24] recommended that occupational exposures be controlled to prevent exposures above 0.05 mg/m^3 TWA. In a later criteria document on hexavalent chromium[25] NIOSH recommended a permissible exposure limit of 0.025 mg/m^3.

(b) Certain water insoluble hexavalent chromium compounds (see examples noted above). A TLV of 0.05 mg/m^3 as water insoluble Cr^{6+} and insertion in appendix Ala is recommended. There is, unfortunately, little previous environmental data from those exposures associated with increased respiratory cancer risk. With the data available, however, this TLV provides an adequate margin of safety. NIOSH recommended a permissible exposure limit of 0.001 mg/m^3 for certain insoluble hexavalent chromium compounds.[25]

(c) Mixed exposure to soluble and insoluble hexavalent chromium compounds. A TLV of 0.05 mg/m^3 as Cr^{6+} is recommended.

(d) Chromite ore processing
Chromate pigment manufacture
It may be advisable to list these process TLVs both as 0.05 mg/m^3 as Cr and include them in appendix Ala. This TLV will serve to draw attention to those processes where increased risk of cancer has been associated with chromium compounds.

Chromium Metal

Divalent chromium compounds
(see examples listed earlier)
Trivalent chromium compounds
(see examples listed earlier)

Early studies indicated that rivalent chromium and divalent chromium compounds have a low order of toxicity.[26] Dermatitis has been reported in workers handling trivalent chromium compounds.[27,28]

Chest X-rays carried out in workers exposed to chromite dust have been reported to show "exaggerated pulmonary markings"[29] and Princi*et al*[30] have reported pulmonary disease in workers exposed to ferrochrome alloys with chromium levels in air of 0.27 mg/m^3 reported. Other dusts and fumes were present, however, in this plant. Exposure to chromium metal does not give rise to pulmonary fibrosis or pneumoconiosis.

Because of the low toxicity of the metal and its divalent and trivalent compounds, a TLV of 0.5 mg/m³ as Cr is recommended. This TLV should be adequate to prevent pulmonary disease or other toxic effect.

Other recommendations: Chromic acid and chromates, as Cr, Sweden (1978) 0.02 mg/m³; Czechoslovakia (1969) 0.05 mg/m³; USSR (1976) 0.005 mg/m³. Lower valence chromium, Sweden 0.5 mg/m³ for metal and compounds, as Cr, USSR, chromic oxide 1 mg/m³, chrome alum 0.02 mg/m³ and chromium trichloride 0.01 mg/m³, all as Cr.

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M&T CHEMICALS INC.
GENERAL OFFICES, RAHWAY, NEW JERSEY 07065

EMERGENCY PHONE NUMBERS
During Office Hours,
8:30 A.M. - 4:30 P.M.
Call (201) 499-2401
After Hours
Call (201) 499-2445

Material Safety Data Sheet

(Approved by U.S. Department of Labor Essentially Similar to Form LSBS-005-4)

8/83
(supersedes 3/77)

CHEMICAL NAME: Chromium Trioxide

SYNONYMS: Chromic Anhydride

CHEMICAL FAMILY: Chromium Compound

FORMULA: CrO_3

CODE:

TRADENAME AND SYNONYMS: M&T Chromic Acid

I. INGREDIENTS

MATERIAL	CAS No.	%	TLV (Units)
chromic acid	11115-74-5	)99	0.05 mg/M^3 -Cr

II. PHYSICAL DATA

BOILING POINT, 760 mm. Hg	N/A	FREEZING POINT	N/A
SPECIFIC GRAVITY (H_2O = 1)	2.7	VAPOR PRESSURE at 20°C.	N/A
VAPOR DENSITY (air = 1)	N/A	SOLUBILITY IN WATER, % by wt. at 20°C.	complete
PER CENT VOLATILES BY VOLUME	N/A	EVAPORATION RATE (Butyl Acetate = 1)	N/A
APPEARANCE AND ODOR	dark red crystals characteristic odor	MOLECULAR WEIGHT	100.01

III. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (test method)	N/A	AUTOIGNITION TEMPERATURE	N/A
FLAMMABLE LIMITS IN AIR, % by volume	LOWER N/A		UPPER N/A

EXTINGUISHING MEDIA	☒ Water Spray ☒ Carbon Dioxide ☐ Other ☐ Foam ☐ Dry Chemical — A corrosive liquid is formed if water is used.
SPECIAL FIRE FIGHTING PROCEDURES	☒ Avoid Eye and Skin Contact ☐ Do Not Breathe Fumes ☒ Other — Fire fighters should be equipped with self-contained breathing apparatus and protective clothing.
UNUSUAL FIRE AND EXPLOSION HAZARDS	Do not inhale dust. Irritating fumes or mist may develop if exposed to elevated temperature or open flame. Corrosive-strong oxidant-contact with organic material may cause fire or vigorous reaction.

The information set forth herein has been gathered from standard reference materials and/or M&T Chemicals Inc. test data and is, to the best knowledge and belief of M&T Chemicals Inc., accurate and reliable. Such information is offered solely for your consideration, investigation and verification, and it is not suggested or our intend that the hazard precautions or procedures mentioned are the only ones which exist. M&T Chemicals Inc. makes no warranties, express or implied, with respect to the use of such information or the use of the specific material identified herein in combination with any other material or process, and assumes no responsibility therefor.

IV. HEALTH HAZARD DATA

RECOMMENDED EXPOSURE LIMIT	0.05 mg/M^3 for chromic acid, ACGIH standard.
EFFECTS OF OVEREXPOSURE	Contact with eyes and skin may cause severe burns or ulceration. Toxic if ingested. Inhalation of dust or mist is irritating to the respiratory tract and may cause damage.
In case of eye contact GET MEDICAL ATTENTION! EMERGENCY AND FIRST AID PROCEDURES	Flush with flowing water at least 15 minutes. Skin - Flush exposed area with water while removing contaminated clothing. Wash area thoroughly with soap and water. Get medical attention. Inhalation- Move exposed individual to fresh air. Give oxygen or artificial respiration if needed. Ingestion- Do Not induce vomiting; call a physician. Never give fluids or induce vomiting if patient is unconscious or having convulsions

V. REACTIVITY DATA

STABILITY			
UNSTABLE	STABLE	CONDITIONS TO AVOID	Keep container tightly closed. Granules will pick up moisture from the air. May explode on contact with reducers; ignites on contact with organics.
	X		
INCOMPATIBILITY (Materials to avoid)	☐ xx Water ☐ Acids ☐ Bases ☐ Oxidizers ☐ xx Reducers ☐ xx Other	Organic materials, acetic acid, alcohol.	
HAZARDOUS DECOMPOSITION PRODUCTS	N/A		
HAZARDOUS POLYMERIZATION		CONDITIONS TO AVOID	N/A
May Occur	Will Not Occur		
	X		

VI. SPILL OR LEAK PROCEDURES

ENVIRONMENTAL IMPACT IF RELEASED OR SPILLED	May be hazardous to aquatic life if released to open waters.
CORRECTIVE ACTION TO BE TAKEN	Carefully sweep up material and place in a metal container for disposal. Avoid creating a dusty atmosphere. After sweeping, flush area where spill occurred with water. Neutralize area of spill with soda ash.
WASTE DISPOSAL METHOD	Reduce hexavalent chrome to trivalent form. Collect solids and dispose of as solid waste. Follow All Chemical Pollution Control Regulations.

VII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)	☐ Not normally required	☐ xx Other	Use NIOSH approved air-supplied or chemical cartridge respirator.
VENTILATION	LOCAL EXHAUST	required	SPECIAL
	MECHANICAL (general)	required	OTHER
PROTECTIVE GLOVES [ ]xx	EYE PROTECTION	☐ Not normally necessary	☐xx Chemical workers goggles ☐ Other
OTHER PROTECTIVE EQUIPMENT	Eye wash & shower. Protective clothing.		

VIII. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING	DOT Oxidizer and Corrosive labels are required. See Attachment.
OTHER PRECAUTIONS	Chromic acid may be absorbed through the broken skin. Persons with cuts bruises or dermatitis should take added precautions to avoid skin contact.
OTHER HANDLING AND STORAGE CONDITIONS	Store in an area suitable for strong oxidizers.

FORM NO M&T 1966

Chromic Acid - attachment

Precautionary labeling:

Danger! POISON
Strong Oxidant-Contact With Other Material May Cause Fire
-May Cause Burns Or Ulceration.

Long term exposure can cause liver and kidney damage.

Skin contact with hexavalent chromium compounds may cause allergic dermatitis.

Keep containers closed. Do not get in eyes, on skin, on clothing. Do not breathe dust or mist from solutions.

First Aid: In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Launder contaminated clothing before re-use. Use fresh clothing daily. Take hot shower after work using plenty of soap.

If Swallowed, Do Not induce vomiting. Call a physician.
Never give anything by mouth to an unconcious person.

LEAD SAMPLING DATA SHEET

SUBJECT: Bldg 873 DATE: 1985

SHEET NO. 1

SAMPLE SUBMIT NUMBER	DATE	SAMPLE TYPE	RESULTS	SHIFT	JOB	AREA/LOCATION
14072	2/1/85	Personal	0.007 mg/m3	Day	welding anodes	s.w. corner
14073		Bkg	0.002			
14074			Invalid			
14075		Bkg	<0.002 mg/m3			
14076		Bkg				
14077		Area	<0.002 mg/m3			
14078		Area				
14079		Blank	<1.0 ug			
14130	2-14-85	P (1)	(1) 0.05 mg/m3	Day	Welding Anodes	SW corner
14131		A (2)	(2) 0.006 mg/m3			
14132		P (1)	(1) 0.05 mg/m3			
14133		A (2)	(2) 0.006 mg/m3			
14134		Blank	<1.0 ug			

CALCULATED BY _____ CHECKED BY _____

LEAD SAMPLING DATA
CODE 106

PSNS 6260/20 (10-83)

SAMPLED BY	SAMPLING DATE/TIME	WORK PROCESS	LOCATION	HAZARD CATEGORY
Weston, Marty	2-1-85 0900-	Welding Anodes	Bldg 873	LO MOD HIGH

NUMBER OF EMPLOYEES INVOLVED IN WORK PROCESS	AMBIENT CONDITIONS	DURATION OF EXPOSURE	FREQUENCY OF EXPOSURE
1	inside, approx. 70°F, no drafts	for shipyard wkr. off/on for 2-3 months	unknown

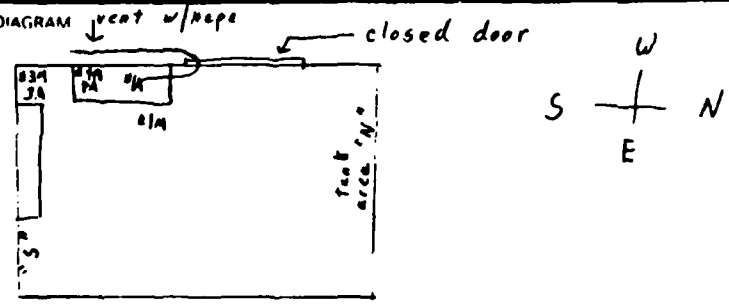
PERSONNEL SAMPLES: NAME	BADGE #	SSN	SHOP	SAMPLE NO	PUMP ID	(LPM) PRE FR	(LPM) POST FR	TIME ON	TIME OFF	VOLUME (LITERS)	SAMPLE SUBMIT #	RESULTS C/134	RESULTS TWA	SAMPLE TYPE A P R	PUMP CHECK TIME	PPE WORN	JOB TITLE	SUPERVISOR	COMMENTS
1		NA	S/71	1M	106MP 58	2.0	2.0	0935	103 1118	206	14072	6.4µg	.007 mg/m³		1117	* See Below			
2				1A	106MP 58	2.0	2.0	1317	1523	252	14073	2.3µg	.002 mg/m³		1523	NA			
Bkg (at capture point of vent)																			
3 ~~Area~~ Bkg				2M	106MP 74	2.0	—	0917	?	—	14074	15.0µg			1120				
~~Bkg~~ (at capture point of vent)					invalid: pump failure														
4 ~~Area~~ ~~Area~~ Bkg				3M	106MP 134	2.0	2.02	0918	122 1120	244	14075	<1.0µg	~~<.001 mg/m³~~	B	1119				
~~Bkg~~				3A	"	"	"	1320	123 1523	246	14076	<1.0µg	<.002 mg/m³	B	1523				
5				4M	106MP 137	2.0	2.02	0918	123 1121	246	14077	<1.0µg	~~<.001 mg/m³~~	A	1120				
~~Bkg~~				4A	"	"	"	1320	124 1524	248	14078	<1.0µg	<.002 mg/m³	A	1523	✓			
				BLANK		—	—	—	—	—	14079	<1.0µg	<.001 mg/m³		—				

COMMENTS Private contactor hired to put in new chrome plating system & train S/71 shipyard employees on procedure for welding lead anodes, (75-100 anodes to be made by S/71 for future use).

Private contractor working in area prior to shipyard worker starting. Shipyard worker began work at 0935 and worked thru to 1119

Afternoon sampling: Shipyard worker not working in area, only private contractor. Therefore I did not set up a personal sample for afternoon

SAMPLE LOCATION DIAGRAM



* PPE worn by Shipyard worker: Cloth coveralls, cloth gloves, respirator & cartridge (type N)

Private Contractor did not wear any PPE

FIELD NOTES

A. Description of operation and complaints:
Repair anodes and seam welding of anodes approx temp. of flame 1800°F
Vacuum cleaner not operable. Mr. Palmer trying to locate a better one.
I had rubber grated foot matt removed. Concrete was better surface for working & cleaning up.

B. Ventilation:

1. Type: 8 in flex w/Flang

2. Location: 6-12 ins from work area

3. Operation Status: 100C FPA

4. Effectiveness: check sample no. 1A from vent opening

C. Engineering controls in effect:

D. Sampling Comments: Private contractor.
Clarence Peger
Hard Chrome Plating Consultants
Cleveland, Ohio
(2 wks at PSNS)

Charles Carpenter
Civil Eng. EPA
Naval Civil Eng. Lab.
Port Hueneme, CA
(over seeing work of private contractor

Samples Submitted: 8 Date: 2-1-85

Copy to:
NH Brem 037A

Marty Weston
Principal Investigator — Date 2-1-85

L. Boyer
Reviewed By — Date 2-11-85

D212

CHEMICAL ANALYSIS REPORT
LABORATORY DIVISION
13ND PSNS 4730/463 (4-81)

REPORT NO. C 0489-85
E 76-85

SAMPLE IDENTIFICATION Air filters for lead Bldg 873

DATE 2/6/85

JOB ORDER NO. 9186 030003 000

Filter # ~~ANALYTE~~	RESULTS in µg lead
1. 14072	6.4
2. 14073	2.3
3. 14074	15.
4. 14075	<1.0
5. 14076	<1.0
6. 14077	<1.0
7. 14078	<1.0
8. 14079	<1.0
9.	
10.	

COMMENTS:
results are reported as micrograms lead / filter

ANALYST (SIGNATURE)

ANALYST (SIGNATURE)

HEAD, ANALYTICAL CHEMISTRY BRANCH (SIGNATURE)

DISTRIBUTION:
C 106.3 (WESTON)

LEAD SAMPLING DATA
CODE 106

PSNS 8260/20 (10-83)

SAMPLED BY	SAMPLING DATE/TIME	WORK PROCESS	LOCATION	HAZARD CATEGORY
M. Weston	02-14-85 0800-1551	welding lead anodes	Bldg 973	LO MOD HIGH

NUMBER OF EMPLOYEES INVOLVED IN WORK PROCESS	AMBIENT CONDITIONS	DURATION OF EXPOSURE	FREQUENCY OF EXPOSURE
1	inside	appox. 7 hrs.	several wks to months

PERSONNEL SAMPLES: NAME	BADGE #	SSN	SHOP	SAMPLE NO	PUMP ID	(LPM) PRE FR	(LPM) POST FR	TIME ON	TIME OFF	VOLUME (LITERS)	SAMPLE SUBMIT #	RESULTS C/134	RESULTS TWA	SAMPLE TYPE A P B	PUMP CHECK TIME	PPE WORN	JOB TITLE	SUPERVISOR	COMMENTS
				1M	106 MP 233	2.0	2.0	0807	1126	398	14130	21.5ug	0.050 ~~0.044~~	P	1125	* ~~yes~~			
		N/A	71	1A	"	2.0	2.0	1229	1546	394	14132	26.3ug	mg/m³	P	1546	"		"	
2 SW corner of bldg.				2M	106 MP 235	2.0	2.0	0807	1126	398	14131	4.5ug	0.006 ~~0.066~~	A	1125			"	
above work bench, hanging on wall				2A	"	2.0	2.0	1229	1551	404	14133	1.3ug	mg/m³	A	1550			"	
3 blank				blank	—	—	—	—	—	—	14134	<1.0ug	—	—	—			"	
4.																			
5.																			

COMMENTS

* PPE worn

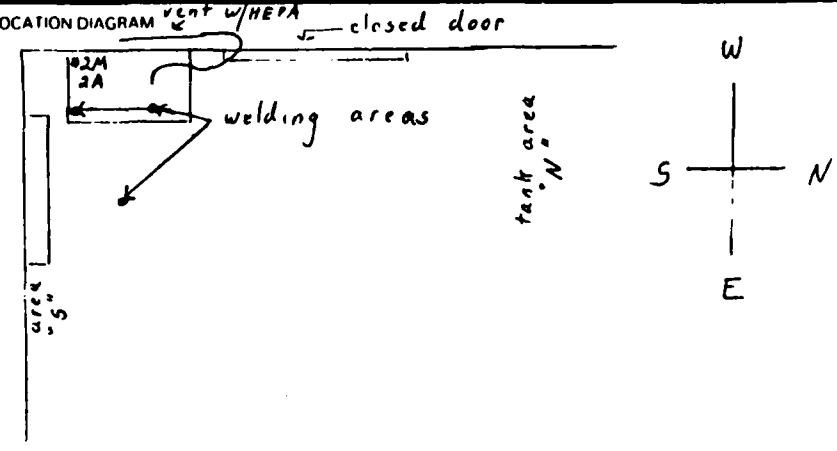
Coveralls, gloves, and respirator (1/2 face w/ cartridge type "H.") Main work areas marked with a "o".

working times:

morning 0807 - 0905
1030 - 1120

afternoon 1240 - 1400
1500 - 1540

SAMPLE LOCATION DIAGRAM



FIELD NOTES

A. Description of operation and complaints: Repair and seam welding of anodes. Approx. Temp of flame 1200°F. At end of day area was vacuumed w/ Hepa filter vacuum.

B. Ventilation: 8in flex w/flange

1. Type: ~~6-12 ins from one work area, 3ft and 5ft from other work areas~~

2. Location: 6-12ins from one work area, 3ft and 5ft from other work areas.

3. Operation Status: 419.0 CFM at vent opening. 105.0 CFM 6ins. from vent

4. Effectiveness: Vent was not effective for areas 3 & 5 ft away.

C. Engineering controls in effect: none

D. Sampling Comments: none

6-26

Samples Submitted: Fire Date: 02-14-85

Copy to:
NH Brem 037A

M. Weston — Principal Investigator — Date 02-14-85

L. Boyer — Reviewed By — Date 02-20-85

D212

CHEMICAL ANALYSIS REPORT
LABORATORY DIVISION
13ND PSNS 4730/463 (4-81)

REPORT NO. C 0754-85
E 106-85

SAMPLE IDENTIFICATION Air filters for lead

DATE 2/19/85

JOB ORDER NO. 9186 - 030003-000

Filter # ~~ANALYTE~~	RESULTS
1. 14130	21.5
2. 14131	4.5
3. 14132	26.3
4. 14133	1.7
5. 14134	<1.0
6.	
7.	
8.	
9.	
10.	

COMMENTS:

Results are in micrograms (µg) lead per filter

ANALYST (SIGNATURE) [signature]

ANALYST (SIGNATURE)

HEAD, ANALYTICAL CHEMISTRY BRANCH (SIGNATURE) [signature]

DISTRIBUTION:
C106.3 (Weston)

LOW EXPOSURE HAZARD/CONTROLS CHECKLIST FOR LEAD WORK

1. Have any of the following changes occurred?

   a. Process changes — No

   b. New personnel — No

   c. Lead Exposure Control Alterations — No

2. Isolate work area and keep all surfaces as free of dust accumulations as practicable. — yes

3. Prohibit the use of compressed air for cleaning of surfaces. — yes

4. Prohibit wet or dry:

   a. Sweeping — yes

   b. Shoveling — yes

   c. Brushing — yes

5. Use only HEPA filtered vacuum. — yes

6. Train all potentially exposed personnel in the health effects of lead and lead work requirements. — yes

OCCUPATIONAL EXPOSURE GUIDE

1910.1025 LEAD

NOTE: The lead standard has been partially stayed by the District of Columbia Court of Appeals, pending full judicial review of the standard. The portions of the standard that have been stayed are duly noted in the regulations.

(a) Scope and application.

(1) This section applies to all occupational exposure to lead, except as provided in paragraph (a)(2

(2) This section does not apply to the contruction industry or to argicultural operations covered by 29 CFR Part 1928.

(b) Definitions.

"Action level" means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 ug/m^3) averaged over an 8-hour period.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Director" means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or designee.

"Lead" means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

(c) Permissible exposure limit (PEL).

(1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 ug/m^3) averaged over and 8-hour period.

(2) If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

Maximum permissible limit (in ug/m^3)
$= 400 \div$ hours worked in the day.

(3) When respirators are used to supplement engineering and work practice controls to comply with the PEL and all the requirements of paragraph (f) have been met, employee exposure, for the purpose of determining whether the employer has complied with the PEL, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

(d) Exposure monitoring.

(1) General.

(i) For the purposes of paragraph (d), employee exposure is that exposure which would occur if the employee were not using a respirator.

(ii) With the exception of monitoring under paragraph (d)(3), the employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.

OCCUPATIONAL EXPOSURE GUIDE

(iii) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.

(2) **Initial determination.** Each employer who has a workplace or work operation covered by this standard shall determine if any employee may be exposed to lead at or above the action level.

(3) **Basis of initial determination.**

(i) The employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:

(A) Any information, observations, or calculations which would indicate employee exposure to lead;

(B) Any previous measurements of airborne lead made in the preceding year if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section; and

(C) Any employee complaints of symptoms which may be attributable to exposure to lead.

(ii) Monitoring for the initial determination may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.

(iii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy the requirement to monitor under paragraph (d)(3)(i) if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

(4) **Positive initial determination and initial monitoring.**

(i) Where a determination conducted under paragraphs (d)(2) and (d)(3) of this section shows the possibility of any employee exposure at or above the action level, the employer shall conduct monitoring which is representative of the exposure for each employee in the workplace who is exposed to lead.

(ii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy this requirement if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

(5) **Negative initial determination.**

Where a determination, conducted under paragraphs (d)(2) and (d)(3) of this section is made that no employee is exposed to airborne concentrations of lead at or above the action level, the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3) of this section and shall also include the date of determination, location within the worksite, and the name and social security number of each employee monitored.

(6) **Frequency.**

(i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

(ii) If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the permissible exposure limit the employer shall repeat monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

(iii) If the initial monitoring reveals that employee exposure is above the permissible exposure limit the employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii), except as otherwise provided in paragraph (d)(7) of this section.

(7) **Additional monitoring.** Whenever there has been a production, process, control or personnel change which may result in new or additional exposure to lead, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to lead, additional monitoring in accordance with this paragraph shall be conducted.

(8) **Employee notification.**

(i) Within 5 working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, exceeds the permissible exposure limit, the employer shall include in the

OCCUPATIONAL EXPOSURE GUIDE

written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken or to be taken to reduce exposure to or below the permissible exposure limit.

(9) **Accuracy of measurement.** The employer shall use a method of monitoring and analysis which has an accuracy (to a confidence level of 95%) of not less than plus or minus 20 percent for airborne concentrations of lead equal to or greater than 30 ug/m³.

(e) **Methods of compliance.**

(1) **Engineering and work practice controls.**

(i) Where any employee is exposed to lead above the permissible exposure limit for more than 30 days per year, the employer shall implement engineering and work practice controls (including administrative controls) to reduce and maintain employee exposure to lead in accordance with the implementation schedule in Table I below, except to the extent that the employer can demonstrate that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest feasible level and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (f) of this section.

TABLE I
IMPLEMENTATION SCHEDULE

Industry[1]	Compliance dates[2] 200 ug/m³	100 ug/m³	50 ug/m³
Primary lead production	(3)	3	10
Secondary lead production	(3)	3	5
Lead-acid battery manufacturing	(3)	2	5
Automobile manufacture/solder grinding	(3)	N/A	7
Electronics, gray iron foundries, ink manufacture, paints and coatings manufacture, wall paper manufacture, can manufacture, and printing	(3)	N/A	1
Lead pigment manufacture, nonferrous foundries, leaded steel manufacture, lead chemical manufacture, shipbuilding and ship repair, battery breaking in the collection and processing of scrap (excluding collection and processing of scrap which is part of a secondary smeltng operation), secondary lead smelting of copper, and lead casting	(3)	N/A	N/A
All other industries	(3)	N/A	2½

[1]Includes ancillary activities located on the same worksite.
[2]Expressed as the number of years from the effective date by which compliance with the given airborne exposure level, as an 8-hour TWA must be achieved.

(ii) Where any employee is exposed to lead above the permissible exposure limit, but for 30 days or less per year, the employer shall implement engineering controls to reduce exposures to 200 ug/m³, but thereafter may implement any combination of engineering, work practice (including administrative controls), and respiratory controls to reduce and maintain employee exposure to lead to or below 50 ug/m³.

(2) **Respiratory protection.** Where engineering and work practice controls do not reduce employee exposure to or below the 50 ug/m³ permissible exposure limit, the employer shall supplement these controls with respirators in accordance with paragraph (f).

(3) **Compliance program.**

(i) Each employer shall establish and implement a written compliance program to reduce exposures to or below the permissible exposure limit, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with the implementation schedule in paragraph (e)(1).

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each operation in which lead is emitted; e.g. machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices;

(B) A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead;

(C) A report of the technology considered in meeting the permissible exposure limit;

(D) Air monitoring data which documents the source of lead emissions;

(E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;

(F) A work practice program which includes items required under paragraphs (g), (h) and (i) of this regulation;

(G) An administrative control schedule required by paragraph (e)(6), if applicable;

(H) Other relevant information.

(iii) Written programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

OCCUPATIONAL EXPOSURE GUIDE

(iv) Written programs shall be revised and updated at least every 6 months to reflect the current status of the program.

(4) Bypass of interim level. Where an employer's compliance plan provides for a reduction of employee exposures to or below the PEL solely by means of engineering and work practice controls in accordance with the implementation schedule in table I. and the employer has determined that compliance with the 100 ug/m³ interim level would divert resources to the extent that it clearly precludes compliance, otherwise attainable, with the PEL by the required time, the employer may proceed with the plan to comply with the PEL in lieu of compliance with the interim level if:

(i) The compliance plan clearly documents the basis of the determination;

(ii) The employer takes all feasible steps to provide maximum protection for employees until the PEL is met; and

(iii) The employer notifies the OSHA Area Director nearest the affected workplace in writing within 10 working days of the completion or revision of the compliance plan reflecting the determination.

(5) Mechanical ventilation.

(i) When ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every 3 months. Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control which might result in a change in employee exposure to lead.

(ii) **Recirculation of air.** If air from exhaust ventilation is recirculated into the workplace, the employer shall assure that (A) the system has a high efficiency filter with reliable back-up filter; and (B) controls to monitor the concentration of lead in the return air ad to bypass the recirculation system automatically if it fails are installed, operating, and maintained.

(6) Administrative controls. If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

(i) Name or identification number of each affected employee;

(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

(f) Respiratory protection.

[Note: (f)(2)(ii), relating to employee selection of powered, air-purifying respirators (PAPR), was modified by court order on March 1, 1979, so that PAPR's must be provided under that paragraph only when the physical characteristics of the employee are such that the respirators specified in Table II are inadequate for the employee's protection.]

(1) General.

Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement engineering or work practice controls, except that after the dates for compliance with the interim levels in table I, no employer shall require an employee to wear a negative pressure respirator longer than 4.4 hours per day;

(ii) In work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit; and

(iii) Whenever an employee requests a respirator.

(2) Respirator selection.

(i) Where respirators are required under this section the employer shall select the appropriate respirator or combination of respirators from table II on following page.

OCCUPATIONAL EXPOSURE GUIDE

TABLE II
RESPIRATORY PROTECTION FOR LEAD AEROSOLS

Airborne concentration of lead or condition or use	Required respirator[1]
Not in excess of 0.5 mg/m³ (10X PEL).	Half-mask, air-purifying respirator equipped with high efficiency filters.
Not in excess of 2.5 mg/m³ (50X PEL).	Full facepiece, air-purifying respirator with high efficiency filters.[3]
Not in excess of 50 mg/m³ (1000X PEL).	(1) Any powered, air-purifying respirator with high efficiency filters,[3] or (2) Half-mask supplied-air respirator operated in positive-pressure mode.[2]
Not in excess of 100 mg/m³ (2000X PEL).	Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive pressure mode.
Greater than 100 mg/m³, unknown concentration or fire fighting.	Full facepiece, self-contained breathing apparatus operated in positive-pressure model.

[1]Respirators specified for high concentrations can be used at lower concentrations of lead.

[2]Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

[3]A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

7.0 DEMONSTRATIONS AND TOURS

(Refer to Workshop Location Map 2)

7.1 Foundry - Making Lead Anode Mats (Building 104)

7.2 Anode Fabrication Shop (Building 604)

7.3 Masking and Racking Shop (Building 604)

7.4 Hard Chrome Plating Shop (Building 604)

7.5 Satellite Laboratory (Trailer adjacent to Building 604)

7.6 Other Plating Lines (Building 604)

7.7 Hazardous Materials Control Facility (Building 3819)

7.8 Wastewater Treatment Plant (North of Chevalier Field)

7.9 Machine Shop (Building 604)

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APPENDIX

1.0 Policy Documents Concerning DoD Hazardous Waste

1.1 The Hazardous and Solid Waste Amendments (Ward and Harris, March 1985)

1.2 Executive Order 12088, Federal Compliance with Pollution Control

1.3 DEQPPM 80-5, DoD Hazardous Material Disposal Policy

1.4 DEQPPM 80-8, RCRA Hazardous Waste Management Regulations

1.5 DoD 4160.21-M, Defense Disposal Manual, Chapter XXI, Hazardous Property Management

1.6 NAVFAC Instruction 4862.5B, Industrial Facilities Projects Which Generate or Treat Controlled Wastes.

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3.2 Pfaudler Co.

Electrolytic Purification Cell

HAZARDOUS WASTE MANAGEMENT

APPENDIX 1.1

The 1984 Hazardous and Solid Waste Amendments: A Bold Experiment in Hazardous Waste Management

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The 1984 amendments by Congress to the Resource Conservation and Recovery Act (RCRA) resulted primarily from a sense of frustration with EPA's apparent lack of progress in addressing the myriad problems associated with hazardous waste management. The amendments were also a manifestation of Congress' clear sense of purpose in wanting to steer a radically different course at much greater speed. Whether this bold experiment works remains to be seen. EPA appears to be committed to carrying out both the letter and spirit of the Hazardous and Solid Waste Amendments of 1984, but no one should underestimate the magnitude of the task.

"Cradle to grave."

The term gained currency in the environmental field in the mid-seventies. "From beginning to end," it was meant to imply . . . and all in between. No voids or loopholes.

The "cradle to grave" approach was what Congress had in mind when in 1976 it passed the Resource Conservation and Recovery Act. By enacting RCRA Congress believed it was "closing the loop," that is, extending to the land the kind of regulatory safety net previously extended to air through the Clean Air Act and to water through the Federal Water Pollution Control Act. Among the reforms mandated by that Act was the requirement that generators comply with a comprehensive manifest system, a method by which hazardous wastes would be traced from the point of manufacture through to their ultimate—and presumably safe—disposal or destruction.

However, the theory and practice didn't quite match. And the public's awareness of that fact (prompted in part by Congressional scrutiny of the RCRA program) ultimately lead to the enactment in 1984 of a dramatic overhaul of the entire RCRA waste management system. Looking back over the past few years it is apparent that a number of related factors converged in the early 1980s to set the stage for the revolutionary changes that Congress prescribed.

First, it became increasingly clear to the Congress that far more hazardous waste actually was being produced each year in the United States than previously had been estimated. In 1980 while EPA was working to develop implementing RCRA regulations, and as Congress in 1982 began to consider reauthorization of RCRA, estimates were that some 11 billion gallons—40 million metric tons—of hazardous wastes were produced each year in the U.S. By mid-1983, however, the estimated amount of hazardous waste produced in the United States increased to about 40 billion gallons annually—150 million metric tons—a nearly fourfold increase. In mid-1984, EPA's final "National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities" calculated that the amount of hazardous wastes generated each year in the U.S. in fact totaled more than 71 billion gallons—264 million metric tons. The actual quantity was widely acknowledged to be higher since various categories of hazardous waste (such as the amount produced by the so called small quantity generators) were not included in the survey.

Second, reliance on land disposal of hazardous waste continued unabated. EPA's National Survey revealed that far more hazardous waste was disposed of in surface impoundments, in underground injection wells or landfills than through incineration or other methods of treatment. In fact, less than one-fourth of the nation's hazardous waste treatment capacity was being used, according to the EPA study.

Third, concern over groundwater contamination became widespread throughout the early 1980s. The public's awareness of groundwater contamination increased dramatically as a result of investigations of the environmental and health problems associated with hazardous waste sites under the Comprehensive Environmental Response, Compensation and Liability Act (commonly known as Superfund). Superfund sites were blamed, in large part, on the failure to require operating hazardous waste sites to comply with the most basic safeguards to protect groundwater. At the same time leaks from underground storage tanks that caused the contamination of drinking water supplies in dozens of communities received national media attention.

Fourth, as Congress investigated the integrity of hazardous waste landfills, it came to the conclusion that there is no such thing as a "secure" landfill (particularly for liquid wastes) and that virtually all conventional landfills ultimately will leak into subsurface soils and groundwater. Congress also learned that an even greater danger is posed by surface impoundments because they receive much larger quantities of waste and because four out of ten impoundments have no liner. (Very few have been equipped with double liners.) Proponents of the 1984 RCRA Amendments were convinced that continued

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overdependence on these methods of land disposal created an unnecessary risk to human health and the environment, particularly since cost-effective methods of treatment were available.

Driven primarily by these considerations, but also clearly influenced by the political controversies surrounding EPA mismanagement of the hazardous waste programs during the first two years of the Reagan Administration, Congress in 1984 succeeded in doing what it previously had been unable to do since the December 1980 passage of Superfund: that is, enact a major piece of environmental legislation. In fact, President Reagan's November 8, 1984 signing of the Hazardous and Solid Waste Amendments of 1984 constituted the final step of the most comprehensive revision of any environmental law since the 1977 rewrite of the Clean Water Act.

Land Disposal Provisions—The Heart of the New Law

Despite the enormous scope of the 1984 amendments, it is not difficult to single out the set of provisions that form the keystone of the new statute. As expressed in the provision setting forth its finidings and objectives, Congress declared that certain classes of land disposal facilities are not capable of assuring long-term containment of certain hazardous wastes. To avoid substantial risk to human health and the environment, Congress said reliance on land disposal should be minimized or eliminated, and it said land disposal, particularly landfill and surface impoundments, should be the least favored method for managing hazardous wastes.

To accomplish this purpose, the 1984 amendments provide EPA with unusually detailed instructions on cutting back on land disposal. Section 201 requires EPA by November 1986 to promulgate rules to prohibit land disposal of dioxins and solvents unless the EPA Administrator affirmatively finds, "to a reasonable degree of certainty," that the prohibition on land disposal of those wastes is not necessary to protect public health and the environment. Eight months later, all "California list" wastes (arsenic, cyanide, mercury, lead, halogenated organics and several other hazardous wastes) are banned from land disposal unless the Administrator makes the same type of finding.

The law also gives EPA rolling deadlines of 45, 55 and 66 months by which it must adopt rules or make similar "not necessary" findings on land disposal of all remaining listed and identified hazardous wastes, with EPA to decide the first third of the wastes within 45 months, another third within 55 months and the final third by the end of 66 months after enactment. In a unique Congressional strategy known as the "hammer," Congress mandated that the land disposal bans will take place automatically if EPA misses the statutory deadlines for acting on its own.

Section 202 of the 1984 Amendments specifies that for new, replacement, or expanded landfills permitted after November 8, 1984 EPA's minimum acceptable technology standard must provide for at least two liners as well as for a leachate collection system above and between the liners.

In Section 215 Congress went beyond the issue of addressing merely new surface impoundments and extended additional control requirements also to existing impoundments. Specifically, Congress established detailed technological retrofit requirements—double liners and leak detection, or their equivalents, along with groundwater existing monitoring requirements—as the minimum standard. Unless these impoundments are allowed an exemption through a limited variance, the impoundments have four years in which to comply; otherwise they can no longer receive, store, or treat any hazardous wastes.

Leaking Underground Storage Tanks

It is worth mentioning that the Hazardous and Solid Waste Amendments were not limited to hazardous and solid wastes. The new law also creates a major new regulatory program to control leaks from the uncounted hundreds of thousands of underground product storage tanks around the country. As a result, it is quite possible that the underground storage tanks regulatory program could be as large as all other elements of the RCRA program.

In passing the new regulatory program, Congress was acting on information, compiled by the Congressional Research Service, that probably somewhere between 75,000 and 100,000 tanks are leaking into the groundwater, surface water, or subsurface soils and that another 350,000 will be leaking in the next five years. However, the actual number of underground storage tanks in the United States is unknown, as is the number of tanks actually leaking. Given that many tanks are believed to be nearing the end of their expected 15–20 years life spans, estimates are that a great many more tanks will begin leaking over the next decade.

Congress in Title VI mandated adoption of a new regulatory program applying to tanks (and connected piping) that store at least 10% of the total volume of their "regulated substance" underground. The program is to apply to petroleum products and hazardous substances designated under Superfund.

To assist EPA and the states in developing a nationwide inventory of underground tanks, owners of underground tanks have until May 1986 to notify a designated state or local agency of the existence of each tank as well as its age, size, type, location and uses. Similar information is also required for tanks which have been taken out of operation since January 1, 1974.

On the regulatory front, EPA is charged with promulgating leak detection, prevention, and corrective action regulations for underground storage tank owners. EPA's regulations, which will apply to new as well as existing tanks, must be "sufficient to protect human health and the environment" and they may take into account differences in climate conditions, tank use and age, hydrogeology, and other factors. EPA also has authority under the law to adopt rules on insurance or other forms of financial responsibility for corrective actions and for compensation to third parties for bodily injury or property damages.

Title VI also prohibits the installation of "bare steel" tanks (i.e. those without adequate corrosion protection) unless properly conducted soil tests show that the resistivity (the corrosion potential) of the soil is 12,000 ohm/cm or greater. Although the Administrator is authorized to modify this prohibition, it is not likely that it would be made less stringent.

Small Quantity Generators

When EPA promulgated its RCRA regulations in 1980, it exempted "small quantity generators" (those producing up to 1000 kg of hazardous waste per month) from most RCRA requirements. This regulatory decision in effect allowed those generators to dispose of wastes directly in sanitary landfills or into sewers, practices not generally regarded as safe. This "regulatory loophole," as critics described it, also exempted small quantity generators from having to notify transporters that the wastes being transported were in fact hazardous.

In response to EPA's unwillingness to impose any substantial requirements of small quantity generators, Congress in the 1984 Amendments mandated that anyone producing between 100 and 1000 kg of waste per month must, by August 1985, properly identify the wastes being transported off-site for treatment, storage or disposal. While requiring that the wastes be properly manifested, the new law states that generators in the 100–1000 kg/month range need not comply, at least initially, with the more complex requirements such as waste testing. Under the law, EPA is to complete a study of small quantity generators by the end of March 1985, and by March 1986 it must adopt rules for small generators in the 100–1000 kg/month range. If the Agency fails to promulgate rules by the end of March 1986, small quantity generator wastes as of that date must go only to hazardous waste treatment, storage, or disposal facilities permitted under Subtitle C of RCRA.

Burning and Blending

Another regulatory "loophole" that caused Congress a great deal of concern was the exemption for facilities burning hazardous wastes for the purpose of "energy recovery." The practice of blending of hazardous wastes (such as PCBs or chlorinated solvents) with heating oil for subsequent sale to unsuspecting customers had become a serious potential health problem in New York and New Jersey, and Congress was in no mood to allow it to become a nationwide health threat. Of particular concern to the Congress was the possibility—and even likelihood—that more and more hazardous wastes would be burned in boilers and other heat recovery facilities precisely to avoid RCRA regulation and the costs of treatment or disposal.

To address the "burning and blending" problem, Congress mandated that EPA be notified by facilities blending hazardous wastes with fuel for distribution or marketing for energy recovery. EPA has until November 1987 to adopt standards for transporters and facilities burning fuels containing hazardous wastes. In addition, purchasers of such fuels must be notified of the hazardous makeup of their fuels. Certain exemptions from the rules are provided for petroleum coke and for *de minimis* quantities of hazardous wastes. Onsite petroleum refinery operations are specifically exempted from the labeling requirements.

Continuing Releases—The "Mini-Superfund"

Section 206 of the 1984 Amendments, "Continuing Releases at Permitted Facilities," has been described as a "Mini-Superfund," as something of a "sleeper" within the overall Amendments.

In passing Section 206, Congress was concerned that EPA regulations did not require facilities permitted under RCRA to address all releases of hazardous wastes from all solid waste management units at a particular facility. "A facility which is causing, for example, groundwater contamination from inactive units could, therefore, seek a permit under RCRA for active units and receive the permit without having to clean up the contamination," Senate Environment and Public Works Committee Counsel Steven J. Shimberg has written.

Under the new law, permits must require "corrective action for all releases of hazardous waste or constituents from any solid waste management unit at a treatment, storage, or disposal facility seeking a permit (under Subtitle C) regardless of the time at which waste was placed in such unit."

Writing in *Legal Times of Washington*, attorneys James A. Rogers and Dorothy A. Darrah of Skadden, Arps, Slate, Meagher & Flom in Washington, D.C., have stated accurately that Section 206 "is designed to remedy the situation in which a landfill owner attempts to demonstrate to EPA that contamination in groundwater emanates from 'old' (pre-RCRA) disposal and that therefore remedial action required as part of a RCRA permit is inappropriate." According to Rogers and Darrah, under EPA's current regulations, an owner need not clean up plumes of contamination under a facility when those plumes are attributable to wastes disposed of prior to the effective date of EPA's groundwater cleanup (corrective action) requirements. "Congress now has deemed this dichotomy unacceptable," they wrote. Rogers and Darrah see in the Section 206 provisions "enormous implications for the many industrial sites with subsurface contamination resulting from pre-RCRA activities. The new section appears to say that any permit issued (by EPA or an authorized state) must require the cleanup of problems at all areas on the site even if the source of the pollution would not itself now be regulated as a hazardous waste unit under RCRA because the materials disposed of are not hazardous wastes or because they were placed there before RCRA, or both."

However, in order to avoid delays in the permit process, Congress provided that permits may be issued with compliance schedules for corrective action in cases where the corrective action cannot be completed prior to issuance of the permit.

Imminent and Substantial Endangerment and Citizen Suits

Although RCRA is fundamentally a *regulatory* scheme for addressing hazardous waste problems, it also provides

EPA under Section 7003 with the ability to obtain injunctive relief against any person contributing to an "imminent and substantial" endangerment created by the handling, storage, treatment, transportation or disposal of any solid or hazardous waste. According to a 1979 report by the Subcommittee on Oversight and Investigations of the House Interstate and Foreign Commerce Committee (the Eckhardt Report), Section 7003 was designed to provide the EPA Administrator with "overriding authority" to respond to situations involving a substantial threat to public health or the environment regardless of other remedies provided in RCRA.

Since 1979, the Department of Justice, on behalf of EPA, has filed approximately 90 Section 7003 actions. (One of the first of these was against the companies responsible for the improper disposal at Love Canal.) Yet, despite its extensive use, the wording of Section 7003 was not free from ambiguity, and a number of courts have ruled that its reach is limited.

Taken together, these adverse rulings held that a Section 7003 action could not be used to compel a non-negligent offsite generator to help in the clean-up of a waste site where its wastes were disposed of. Although other court decisions gave Section 7003 a much broader reading, Congress was worried that the Government's principal enforcement tool was being misinterpreted and seriously weakened. Section 7003 was rewritten and, although the revisions were labeled a simple "clarification" of existing law, the House Energy and Commerce Committee left no doubt that it intended to legislatively overrule the adverse holdings:

> "These amendments are intended to clarify the breadth of Section 7003 as to the persons, conditions and acts it covers. . . . [A]nyone who has contributed to the creation, existence or maintenance of an imminent and substantial endangerment is subject to the equitable power of Section 7003, without regard to fault or negligence. Such persons include, but are not limited to, past and present generators (both off-site and on-site) . . . past and present owners and operators of waste treatment storage or disposal facilities and past and present transporters . . . Thus, for example, non-negligent generators whose wastes are no longer being deposited or dumped at a particular site may be ordered to abate the hazard to health or the environment posted by the leaking of wastes they once deposited or caused to be deposited on the site."

Having made sure that the imminent and substantial endangerment provision could be used as originally intended, Congress also provided to individual citizens the right to force clean-up of hazardous waste sites. Thus, as a result of a major expansion of the existing citizens suit provision (7002), any person may bring an action to abate an imminent and substantial endangerment involving the management or disposal or solid or hazardous waste.

Although Congress placed substantial enforcement authority in the hands of ordinary citizens, it took steps to assure that the citizens suit provision was not used to prevent or delay Superfund clean-ups or interfere with ongoing RCRA enforcement efforts. Therefore, a citizen may not sue 1) where EPA has commenced, and is diligently prosecuting, actions under Section 7003 or Section 106 of Superfund; 2) where the State has commenced and is diligently prosecuting an imminent and substantial endangerment action under Section 7002; 3) while the Administrator or the State is actually engaging in a removal action under Section 104 of Superfund or has incurred costs to initiate a Remedial Investigation/Feasibility Study (RIFS) under Section 104 of Superfund and is diligently proceeding with a remedial action; and 4) where the Administrator has obtained a court order (including a consent degree) or issued an administrative order under Section 106 of Superfund, or Section 7003 pursuant to which a responsible party is diligently conducting a removal action, RIFS or proceeding with a remedial action.

Moreover, citizen suits cannot be used to challenge the siting or permitting of hazardous waste facilities.

Conclusion

The numerous and, in some cases, drastic revisions that Congress made to RCRA resulted primarily from a sense of frustration with EPA's apparent lack of progress in addressing the myriad problems associated with hazardous waste management. The 1984 amendments were also a manifestation of Congress' clear sense of purpose in wanting to steer a radically different course—and at much greater speed. Whether this bold experiment works remains to be seen. EPA appears to be committed to carrying out both the letter and spirit of the Hazardous and Solid Waste Amendments of 1984, but no one should underestimate the magnitude of the task.

Bud Ward is Editor of *The Environmental Forum*, a monthly magazine published by the Environmental Law Institute (ELI) in Washington, D.C. Christopher Harris, previously the lead House counsel on the 1984 Hazardous and Solid Waste Amendments, is an attorney with the law firm of Zuckert, Scoutt, Rasenberger and Johnson in Washington, D.C. Ward and Harris are coauthors of *Hazardous Waste—Confronting the Challenge*, a new book to be published this spring by ELI.

presidential documents

[3195-01-M]

Title 3—The President

Executive Order 12088 **October 13, 1978**

Federal Compliance With Pollution Control Standards

By the authority vested in me as President by the Constitution and statutes of the United States of America, including Section 22 of the Toxic Substances Control Act (15 U.S.C. 2621), Section 313 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1323), Section 1447 of the Public Health Service Act, as amended by the Safe Drinking Water Act (42 U.S.C. 300j-6), Section 118 of the Clean Air Act, as amended (42 U.S.C. 7418(b)), Section 4 of the Noise Control Act of 1972 (42 U.S.C. 4903), Section 6001 of the Solid Waste Disposal Act, as amended (42 U.S.C. 6961), and Section 301 of Title 3 of the United States Code, and to ensure Federal compliance with applicable pollution control standards, it is hereby ordered as follows:

1-1. *Applicability of Pollution Control Standards.*

1-101. The head of each Executive agency is responsible for ensuring that all necessary actions are taken for the prevention, control, and abatement of environmental pollution with respect to Federal facilities and activities under the control of the agency.

1-102. The head of each Executive agency is responsible for compliance with applicable pollution control standards, including those established pursuant to, but not limited to, the following:

(a) Toxic Substances Control Act (15 U.S.C. 2601 *et seq.*).

(b) Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 *et seq.*).

(c) Public Health Service Act, as amended by the Safe Drinking Water Act (42 U.S.C. 300f *et seq.*).

(d) Clean Air Act, as amended (42 U.S.C. 7401 *et seq.*).

(e) Noise Control Act of 1972 (42 U.S.C. 4901 *et seq.*).

(f) Solid Waste Disposal Act, as amended (42 U.S.C. 6901 *et seq.*).

(g) Radiation guidance pursuant to Section 274(h) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2021(h); see also, the Radiation Protection Guidance to Federal Agencies for Diagnostic X Rays approved by the President on January 26, 1978 and published at page 4377 of the FEDERAL REGISTER on February 1, 1978).

(h) Marine Protection, Research, and Sanctuaries Act of 1972, as amended (33 U.S.C. 1401, 1402, 1411-1421, 1441-1444 and 16 U.S.C. 1431-1434).

(i) Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 U.S.C. 136 *et seq.*).

1-103. "Applicable pollution control standards" means the same substantive, procedural, and other requirements that would apply to a private person.

1-2. *Agency Coordination.*

1-201. Each Executive agency shall cooperate with the Administrator of the Environmental Protection Agency, hereinafter referred to as the Adminis-

trator, and State, interstate, and local agencies in the prevention, control, and abatement of environmental pollution.

1-202. Each Executive agency shall consult with the Administrator and with State, interstate, and local agencies concerning the best techniques and methods available for the prevention, control, and abatement of environmental pollution.

1-3. *Technical Advice and Oversight.*

1-301. The Administrator shall provide technical advice and assistance to Executive agencies in order to ensure their cost effective and timely compliance with applicable pollution control standards.

1-302. The administrator shall conduct such reviews and inspections as may be necessary to monitor compliance with applicable pollution control standards by Federal facilities and activities.

1-4. *Pollution Control Plan.*

1-401. Each Executive agency shall submit to the Director of the Office of Management and Budget, through the Administrator, an annual plan for the control of environmental pollution. The plan shall provide for any necessary improvement in the design, construction, management, operation, and maintenance of Federal facilities and activities, and shall include annual cost estimates. The Administrator shall establish guidelines for developing such plans.

1-402. In preparing its plan, each Executive agency shall ensure that the plan provides for compliance with all applicable pollution control standards.

1-403. The plan shall be submitted in accordance with any other instructions that the Director of the Office of Management and Budget may issue.

1-5. *Funding.*

1-501. The head of each Executive agency shall ensure that sufficient funds for compliance with applicable pollution control standards are requested in the agency budget.

1-502. The head of each Executive agency shall ensure that funds appropriated and apportioned for the prevention, control and abatement of environmental pollution are not used for any other purpose unless permitted by law and specifically approved by the Office of Management and Budget.

1-6. *Compliance With Pollution Controls.*

1-601. Whenever the Administrator or the appropriate State, interstate, or local agency notifies an Executive agency that it is in violation of an applicable pollution control standard (see Section 1-102 of this Order), the Executive agency shall promptly consult with the notifying agency and provide for its approval a plan to achieve and maintain compliance with the applicable pollution control standard. This plan shall include an implementation schedule for coming into compliance as soon as practicable.

1-602. The Administrator shall make every effort to resolve conflicts regarding such violation between Executive agencies and, on request of any party, such conflicts between an Executive agency and a State, interstate, or a local agency. If the Administrator cannot resolve a conflict, the Administrator shall request the Director of the Office of Management and Budget to resolve the conflict.

1-603. The Director of the Office of Management and Budget shall consider unresolved conflicts at the request of the Administrator. The Director shall seek the Administrator's technological judgment and determination with regard to the applicability of statutes and regulations.

1-604. These conflict resolution procedures are in addition to, not in lieu of, other procedures, including sanctions, for the enforcement of applicable pollution control standards.

1-605. Except as expressly provided by a Presidential exemption under this Order, nothing in this Order, nor any action or inaction under this Order, shall be construed to revise or modify any applicable pollution control standard.

1-7. *Limitation on Exemptions.*

1-701. Exemptions from applicable pollution control standards may only be granted under statutes cited in Section 1-102(a) through 1-102(f) if the President makes the required appropriate statutory determination: that such exemption is necessary (a) in the interest of national security, or (b) in the paramount interest of the United States.

1-702. The head of an Executive agency may, from time to time, recommend to the President through the Director of the Office of Management and Budget, that an activity or facility, or uses thereof, be exempt from an applicable pollution control standard.

1-703. The Administrator shall advise the President, through the Director of the Office of Management and Budget, whether he agrees or disagrees with a recommendation for exemption and his reasons therefor.

1-704. The Director of the Office of Management and Budget must advise the President within sixty days of receipt of the Administrator's views.

1-8. *General Provisions.*

1-801. The head of each Executive agency that is responsible for the construction or operation of Federal facilities outside the United States shall ensure that such construction or operation complies with the environmental pollution control standards of general applicability in the host country or jurisdiction.

1-802. Executive Order No. 11752 of December 17, 1973, is revoked.

Jimmy Carter

THE WHITE HOUSE,
October 13, 1978.

[FR Doc. 78-29406 Filed 10-13-78; 3:40 pm]

EDITORIAL NOTE: The President's statement of Oct. 13, 1978, on signing Executive Order 12088 and his memorandum for the heads of departments and agencies, dated Oct. 13, 1978, on Federal compliance with pollution control standards are printed in the Weekly Compilation of Presidential Documents (vol. 14, no. 41).

APPENDIX 1.3

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MANPOWER,
RESERVE AFFAIRS
AND LOGISTICS

13 MAY 1980

Defense Environmental Quality Program Policy Memorandum
(DEQPPM No. 80-5)

MEMORANDUM FOR DEPUTY FOR ENVIRONMENT, SAFETY AND OCCUPATIONAL HEALTH, OASA (IL&E)
DEPUTY UNDER SECRETARY OF THE NAVY
DEPUTY FOR ENVIRONMENT AND SAFETY, SAF/MIQ
DIRECTOR, DEFENSE LOGISTICS AGENCY

SUBJECT: Department of Defense Hazardous Material Disposal Policy

PURPOSE: This is to provide Department of Defense (DoD) policy guidance on the disposal of hazardous materials. This memorandum supercedes DEQPPM 79-4, "Department of Defense Hazardous Material Disposal Policy," of December 17, 1979.

BACKGROUND: DoD possesses large quantities of hazardous materials, both new items and waste products, that must be disposed of in an environmentally acceptable manner. The Resource Conservation and Recovery Act of 1976 (RCRA) and the Toxic Substance Control Act of 1976 (TSCA) require that DoD update its disposal policy regarding hazardous materials.

In 1974, DoD designated the Defense Supply Agency, subsequently renamed the Defense Logistics Agency (DLA), to be responsible ". . . for the disposition of items identified as unsalable because the material has no sales value . . . (except) refuse and trash . . . (and) items . . . restricted by law or military regulation." Some of the materials reassigned to DLA were hazardous, but the overall hazardous material disposal responsibility was not specifically addressed in the 1974 policy.

In December of 1979, the Deputy Assistant Secretary of Defense, Energy, Environment and Safety (DASD-EES), in coordination with the Deputy Assistant Secretary of Defense, Supply, Maintenance, and Transportation (DASD-SM&T), issued Defense Environmental Quality Program Policy Memorandum 79-4 (DEQPPM 79-4) which provided urgently needed guidance on hazardous material disposal. After the policy was issued, representatives of the military departments, DLA, and OASD(MRA&L) agreed to refine further DoD policy. This DEQPPM 80-5 includes the refinements which those representatives recommended. For purposes of this memorandum, the term DoD components refers to the military departments and all defense agencies except disposal operating entities of DLA. Other terms used in this policy are defined in Tab A.

POLICY: DoD policy is to dispose of hazardous materials in an environmentally acceptable manner:

- DLA is designated the responsible agency within DoD for worldwide disposal of all hazardous materials, except for those categories of materials specifically designated for DoD component disposal (Tab B). Specific DLA responsibilities for disposal of assigned hazardous materials are in Tab C.

- DoD components shall dispose of those categories of hazardous materials listed in Tab B. In addition, the DoD component shall support DLA disposal actions as specified in Tab D.

- The DASD(EES), in coordination with DASD(SM&T) and other OSD offices as necessary, shall formulate, implement, and monitor policy for disposal of hazardous material and shall decide any unresolved issues which may develop, including the reassignment of responsibility for disposal of specific categories of hazardous material when circumstances warrant.

- No other changes are made to the respective disposal mission responsibilities of the DoD components or DLA.

IMPLEMENTATION: This memorandum is effective immediately and should be implemented as rapidly as possible.

- DLA shall make optimum use of existing disposal capabilities and resources.

- DLA shall program for the additional resources required to discharge its responsibilities under this memorandum.

- DLA is directed to organize immediately and chair an interservice task group to plan actions and milestones for the full implementation of this policy and submit their report to DASD(EES) within 120 days from the date of this memorandum.

- The task group will develop and promulgate a hazardous materials data call to identify current and projected hazardous materials disposal workload, as well as the actions and methodology employed to dispose of those materials. The task group should also identify, in as much detail as possible, the technical support and assistance which can be provided DLA in its efforts to insure expeditious disposal of hazardous materials in an environmentally safe manner. The task group will identify those additional resource requirements which, if made available to DLA, can be effectively applied to expedite hazardous materials disposal during FY 80 and FY 81.

SIGNED

Paul H. Riley
Deputy Assistant Secretary of Defense
(Supply, Maintenance and Transportation)

SIGNED

George Marienthal
Deputy Assistant Secretary
of Defense
(Energy, Environment and Safety

Enclosures:
- Tab A - Definitions
- Tab B - Materials Assigned to DoD Components for Disposal
- Tab C - Responsibilities of DLA for Disposal of Assigned Hazardous Materials
- Tab D - Responsibilities of the DoD Components in Support of the DLA Disposal of Hazardous Materials.

MR/Reading/EES
P. Haviland/ds/57820/6May80

DEFINITIONS

Material is hazardous when, because of its quantity, concentration, or physical, chemical, or infectious characteristics, it may: (a) cause, or significantly contribute to, an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

For the purposes of this memorandum, hazardous materials do not include those radioactive materials that the Nuclear Regulatory Commission controls. Licensees shall be responsible for the disposal of those materials per 10 CFR 20.

Hazardous material may be defined as personal property consisting of items, scrap, and waste:

Items - All unused, used, or contaminated property or combinations of property, (unused, used, mixed or contaminated) which can be identified by a national stock number, manufacturer's part number, military specification number, or locally purchased property with a locally applied stock number. Also, that property which by military regulation requires application of a local stock number prior to disposal.

Scrap - Used or unused property which has no value except for basic material content.

Waste - Used or unused property, residues, by-products, sludges, and other materials, which have no known utility and must, therefore, be discarded.

Conforming storage is a facility or location which conforms to regulations of the Environmental Protection Agency and other regulatory authorities governing the storage of hazardous materials.

The generating activity is an organization or element authorized to turn-in property to the Defense Property Disposal Service.

Materials Assigned to DoD Components for Disposal

DoD components shall be responsible for disposal of the following categories of hazardous materials which have not been assigned to DLA:

1. Toxicological, biological, radiological, and lethal chemical warfare materials which, by U.S. law, must be destroyed. Disposal of the by-products of such material is the responsibility of the DoD component with assistance from DLA.

2. Material which cannot be disposed of in its present form due to military regulations, e.g., consecrated religious items and cryptographic equipment.

3. Municipal type garbage, trash, and refuse resulting from residential, institutional, commercial, agricultural, and community activities, which the facility engineer or public works office routinely collect.

4. Contractor generated materials which are the contractor's responsibility for disposal under the terms of the contract.

5. Sludges resulting from municipal type wastewater treatment facilities.

6. Sludges and residues generated as a result of industrial plant processes or operations.

7. Refuse and other discarded materials which result from mining, dredging, construction, and demolition operations.

8. Unique wastes and residues of a non-recurring nature which research and development experimental programs generate.

TAB C

Responsibilities of DLA for Disposal of Assigned Hazardous Materials

Specific DLA responsibilities in this area shall include, but not necessarily be limited to, the following:

1. Accomplish documentation for DLA disposal actions as required under laws and regulations.

2. Initiate contracts or agreements for disposal.

3. Accept accountability for all hazardous materials except those categories specifically excluded in Tab B, which have been properly identified, packaged, labeled, and certified in conformance with established criteria.

4. Accept custody of hazardous materials within the following guidelines:

- If DLA possesses conforming storage at the defense property disposal offices (DPDO), DLA will accept physical custody at the time it accepts accountability.

- If DLA does not possess conforming storage at the DPDO, and the generating activity has conforming storage in support of mission requirements, the generating activity will retain physical custody, and DLA will accept accountability.

- In those instances where neither DLA nor the generating activity possess conforming storage, the activity with the "most nearly" conforming storage will accept or retain physical custody and DLA will accept accountability.

- DLA will be responsible for the long term programming of military construction funding for conforming storage in support of its disposal mission.

- If DLA and the component involved cannot mutually agree on the best procedure for storage and handling pending final disposal, the issue shall be referred at once to OASD(MRA&L) for resolution.

5. Provide any required repackaging or handling of hazardous materials subsequent to acceptance of accountability from the generating activity.

6. Establish an inventory control system for the types, quantities, and locations of available hazardous materials for which DLA is responsible in the event that some other activity might be able to use a particular material as a resource.

7. Provide feedback to the military departments and defense agencies on the costs associated with disposal in order that this information might serve as an economic incentive to minimize waste generation.

8. Contract for disposal technology not available in-house or from the DoD components.

9. Minimize environmental risks and costs associated with extended care, handling, and storage of hazardous materials by accomplishing disposal within a significantly compressed disposal cycle. Initiate actions and projects within DoD and in conjunction with federal civil agencies and industry to realize this objective and expedite final disposal.

10. Devise a system by which the time of turn-in will be highly visible on hazardous materials to insure proper application of resources to dispose of these materials. DLA should insure that sufficient disposal capability is programmed to preclude extended delays in the hazardous materials disposal process.

11. Establish and maintain an analysis and information distribution capability to:

- Evaluate the impact and applicability of current technological advances on DoD hazardous material disposal procedures and inform the DoD components of these developments on a continuing basis.

- Assure that the DoD components are apprised, on a continuing basis, of any federal, state, regional, and local regulations being developed to control hazardous material disposal.

12. Become the DoD focal point to recommend to DASD(EES) matters of policy and guidance for hazardous material disposal.

13. Establish procedures relative to assigned responsibility for hazardous material disposal. Unresolved issues will be forwarded to OASD(MRA&L) with appropriate comments.

14. DLA shall program to carry out their responsibilities through normal budgeting channels.

Responsibilities of the DoD Components in Support of the DLA Disposal of Hazardous Materials

1. Where feasible, minimize quantities of hazardous waste through resource recovery, recycling, source separation, and acquisition policies.

2. Provide available technical and analytical assistance, including R&D support, to DLA to accomplish disposal, if requested.

3. Provide all available information to DLA, as required, to complete environmental documentation, e.g., environmental impact statement associated with disposal.

4. Properly identify, package, label, and certify conformance with established criteria prior to transfer of accountability to DLA. Subsequent repackaging or handling is the responsibility of DLA.

5. DoD components will retain custody of hazardous materials within the following guidelines:

- If DLA does not possess conforming storage at the DPDO, and the generating activity has conforming storage in support of mission requirements, the generating activity will retain physical custody, and DLA will accept accountability.

- In those instances where neither DLA nor the generating activity possesses conforming storage, the activity with the "most nearly" conforming storage will accept/retain custody.

- If DLA and the component involved cannot agree on the best procedure for storage and handling pending final disposal, the issue will be referred at once to OASD(MRA&L) for resolution.

- When a DoD component retains custody of a hazardous material, this hazardous material shall be kept on the accountable records of DLA.

6. When requested, the DoD components will assist DLA by providing information and comments on federal, state, regional, and local regulations being developed to control hazardous material disposal, e.g., ability of particular installations to comply and impact on DoD. The DoD components will alert DLA to any local situation which could impact on hazardous materials disposal.

7. DoD components shall program to carry out their responsibilities through normal budgeting channels.

APPENDIX 1.4

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D C 20301

21 OCT 1980

MANPOWER,
RESERVE AFFAIRS
AND LOGISTICS

DEFENSE ENVIRONMENTAL QUALITY PROGRAM POLICY MEMORANDUM (DEQPPM) 80-8

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (IL&FM)
ASSISTANT SECRETARY OF THE NAVY (MRA&L)
DEPUTY UNDER SECRETARY OF THE NAVY
ASSISTANT SECRETARY OF THE AIR FORCE (MRA&I)
ASSISTANT SECRETARY OF THE AIR FORCE (RD&L)
DIRECTORS OF DEFENSE AGENCIES

SUBJECT: RCRA Hazardous Waste Management Regulations

PURPOSE: This is to provide additional policy guidance to implement within the Department of Defense the hazardous waste management regulations of the Resource Conservation and Recovery Act (RCRA) of 1976.

BACKGROUND: On May 19, 1980, the Environmental Protection Agency (EPA) published implementing instructions to Subtitle C of RCRA which established a federal program to provide comprehensive regulation of hazardous waste. When fully implemented, this program will provide "cradle-to-grave" regulation of hazardous waste.

The Department of Defense is an entity responsible for determining when a material becomes a waste subject to RCRA Regulations. Applying the criteria set forth in Subparts C and D of 40 CFR Part 261 further qualifies the waste as hazardous at which point the RCRA Regulations become effective. Also, RCRA establishes standards for generators and transporters of hazardous waste that will ensure proper record-keeping and reporting, the use of a manifest system to track shipments of hazardous waste, the use of proper labels and containers, and the delivery of the waste to properly permitted treatment, storage, and disposal facilities. To ensure that these facilities are designed, constructed, and operated in a manner which protects human health and the environment, the regulations promulgate technical, administrative, monitoring, and financial standards for them. EPA will use these independently enforceable standards to issue permits to owners and operators of facilities.

Also in May, 1980, Defense Environmental Quality Program Policy Memorandum 80-5 was published to provide DoD policy on the disposal of hazardous materials. That policy designates the Defense Logistics Agency as responsible for the disposal of all hazardous materials except those that specifically remain the other DoD components' responsibilities.

POLICY: The DoD policy is:

- To limit the generation of hazardous waste through alternative procurement practices and operational procedures that are attractive environmentally yet are fiscally competitive,

- To reutilize, reclaim, or recycle resources where practical and thus conserve on total raw material usage,

- To exhaust all other actions mandated by Federal statutes or regulations prior to identifying the material as discardable,

- To dispose of hazardous waste in an environmentally acceptable manner according to the disposal policy established in DEQPPM 80-5,

- To implement within DoD the hazardous waste management regulations that EPA published under Subtitle C of RCRA or that states enact under EPA authorization,

- To consider all unused hazardous materials as not regulated under RCRA until a decision is made to discard them, and

- To insure that all used hazardous materials are safely handled, accounted for, and controlled by internal DoD documentation. The internal controlling documentation will be applied to all movement among DoD activities and will reflect all data elements prescribed for auditing purposes and for shipping manifests as required by EPA or the states. The DoD component/entity assigned disposal responsibility by DEQPPM 80-5 will advise the using activities as to which "used" hazardous material must be controlled as a hazardous waste.

ACTION REQUIRED: DoD components will:

- Reduce hazardous waste generation to the maximum extent practical,

- Reutilize, reclaim, or recycle resources where practical, and

- Implement EPA hazardous waste management regulations.

As part of that implementation, any DoD installation that generates or transports hazardous waste or owns or operates a facility that treats, stores, or disposes of hazardous waste will notify EPA regional administrators as required. Each installation will obtain one EPA identification number. That identification number will be used for all subsequent reports and permit applications required for the installation.

Also, any installation which owns, operates, or proposes to own or operate a facility that treats, stores, or disposes of hazardous waste will apply for a permit from EPA or the state. That application is in two parts:

- Part A, which defines the process to be used, the design capability, and the hazardous waste to be handled, must be submitted by November 19, 1980.

- Part B, which contains more detailed information intended to establish that the facility can meet the technical standards that RCRA promulgated, must be submitted at a date that the regional administrator sets.

The installation commander will sign the permit application as the facility owner, and the operational manager of the permitted facility will sign the permit application as the operator. DLA or other tenants will sign as operation manager for all functions for which they have been assigned responsibility under DEQPPM 80-5. Each installation that requires a permit will submit one EPA Form 3510-1 for the installation (Form 1 - General Information) and an EPA Form 3510-3 for each permitted facility (Form 3 - Hazardous Waste Permit Application).

Implementation of the comprehensive hazardous waste management program mandated by RCRA requires maximum cooperation of all activities on an installation. The installation commander is responsible to ensure compliance with all RCRA requirements for the installation. The installation commander is responsible to notify, to apply for permits, and to report to EPA or the state, as required, for all installation activities, including tenants. The individual facility operational managers are accountable for conducting their activities in accordance with RCRA. Those facility managers, including supporting property disposal activities and tenant activities, will provide necessary documentation to the installation commander for permit application, will provide to the installation commander reports required by EPA or the state, and will ensure compliance with RCRA regulations and permit requirements at that facility. All reports to EPA or the state will be co-signed by the installation and facility operator or their designated officials.

For facilities that DoD owns but does not operate, the DoD component that owns the facility is responsible as the owner for purposes of the permit. For example, on an Army government-owned, contractor-operated plant, the contractor may be the applicant for the permit, but the local Army commanding officer is still responsible to ensure compliance.

DoD components will use the Disposal Turn In Document (DTID) or a bill of lading, as appropriate, modified to meet the EPA requirements, for the shipping manifest. The shipping activity, either servicing property disposal activity or facility operator, will manifest any shipment of hazardous waste off the installations in accordance with RCRA. The responsibility for tracking the manifest terminates at the permitted facility destination for that shipment; however, the shipper must obtain a copy of the completed manifest to show arrival at that destination. For shipments among DoD components, whether on the same installation or between installations, the turn-in activity's responsibility terminates upon receipt of a signed copy of the Disposal Turn In Document (DTID) or the govern-

ment bill of lading which serves as the internal manifest between the generator, the servicing DPDO, or other permitted receiver.

Each DoD component will take immediate action to identify all resources required to achieve full compliance with EPA and state regulations. Those resources will then be addressed, within program decision memorandum approved overall component resource levels, in future budget submissions.

An installation that requires permits for more than one program (RCRA, Safe Drinking Water Act, Clean Water Act, and Clean Air Act programs) is encouraged to consolidate its application, if possible, under EPA's consolidated permit program.

In special circumstances, and where it is mutually agreed among the installation, tenant, and EPA/State, exceptions to the above policies will be documented by the DoD component concerned and forwarded to DASD(EES) for approval.

The DASD(EES), in coordination with DASD(SM&T) and other OSD offices as necessary, shall monitor policy implementation for RCRA hazardous waste management, and shall decide any unresolved issues which may develop.

This memorandum is effective this date. Progress toward implementation of this memorandum and the RCRA hazardous waste regulations will be included in the environmental management-by-objective (MBO) semi-annual reports.

George Marienthal
Deputy Assistant Secretary of Defense
(Energy, Environment and Safety)

Paul H. Riley
Deputy Assistant Secretary of Defense
(Supply, Maintenance and Transportation)

CHAPTER XXI

HAZARDOUS PROPERTY MANAGEMENT

A. GENERAL

1. The purpose of this chapter is to provide DoD installations and DLA personnel with guidance for handling, processing, and disposing of hazardous property, in accordance with applicable environmental and other pertinent laws and regulations.

2. The DoD policy is to store and dispose of all hazardous property in an environmentally acceptable manner in accordance with applicable environmental and other pertinent laws and regulations.

3. For definitions see Attachment 1 and Chapter III, this manual.

B. RESPONSIBILITIES

1. DoD installation responsibilities are as follows:

a. Where feasible, minimize quantities of hazardous property through resource recovery, recycling, source separation, and acquisition policies.

b. Provide available technical and analytical assistance, including research and development support, to DLA to accomplish disposal, if requested.

c. Provide all available information to DLA, as required, to complete environmental documentation; e.g., environmental impact statements associated with disposal.

d. Properly identify, package, label and certify conformance with established environmental and transportation criteria prior to transfer of accountability for hazardous property to DLA.

e. When requested, assist DLA by providing information and comments on federal, state, regional, and local regulations being developed to control hazardous property disposal; e.g., ability of particular installation to comply and impact on DoD. Alert DLA to any local situation which could impact hazardous property disposal.

f. Retain physical custody of hazardous property within the guideline provided in paragraph C, this chapter.

g. Provide for disposal of the following categories of hazardous property:

(1) Toxicological, biological, radiological, and lethal chemical warfare materials which, by U.S. law, must be destroyed. Disposal of the by-products of such material is the responsibility of the DoD installation with assistance from DLA.

(2) Material which cannot be disposed of in its present form due to military regulations; e.g., Ammunition, Explosives and Dangerous Articles (AEDA), controlled medical items. This category would include those instances where military regulations require the obliteration of all markings that could relate an excess material to its operational program. Once the appropriate actions are taken to meet the military regulation, the resulting material could then be turned in to the servicing DPDO.

(3) Municipal-type garbage, trash, and refuse resulting from residential, institutional, commercial, agricultural, and community activities, which can be disposed of in a state or locally permitted sanitary landfill.

(4) Contractor generated materials which are the contractor's responsibility for disposal under the terms of the contract.

(5) Sludges resulting from municipal-type waste-water treatment facilities.

(6) Sludges and residues generated as a result of industrial plant processes or operations. Properly identified industrial process sludges and residues which are not commingled or a product of an industrial waste treatment facility are the responsibility of DLA. DLA does not take sludges and residues from waste water treatment facilities. DLA does take sludges and residues from industrial processes that have not been commingled. For example, sludges and residues from industrial process "A" must be collected and stored separately from sludges and residues resulting from industrial process "B". Each process may result in sludges and residues that contain a mixture of ingredients and contaminants but the sludges and residues from each process must be collected and stored separately and not commingled.

(7) Refuse and other discarded material which result from mining, dredging, construction, and demolition operations.

(8) Unique wastes and residues of a nonrecurring nature which research and development experimental programs generate.

2. The DLA responsibilities are as follows:

a. Accomplish documentation (including records) for DLA disposal actions as required under applicable

environmental and other pertinent laws and regulations.

b. Initiate contracts or agreements for DLA disposal actions.

c. Accept accountability for all hazardous property, except those categories under responsibility of DoD installations (paragraph B1 above) which have been properly identified, packaged, labeled, and certified in accordance with environmental and transportation laws and regulations.

d. Accept sludges and residues from industrial processes that have not been commingled, e.g., sludges and residues from industrial process "A" must be collected and stored separately from sludges and residue resulting from industrial process "B".

e. Accept custody of hazardous property within the guidelines provided in paragraph C, this chapter.

f. Program for construction of storage facilities in support of the DLA disposal mission.

g. Provide any required repackaging or handling of hazardous property subsequent to acceptance of accountability from the turn-in activity.

h. Establish an inventory control system for the types, quantities, and locations of available hazardous property for which DLA is responsible in the event that some other activity might be able to use particular property as a resource.

i. Provide an economic incentive for DoD installations to segregate and minimize waste generation by:

(1) Providing feedback to military departments and defense agencies on the costs associated with destruction of HW.

(2) Providing 100 percent reimbursement to DoD installations with qualified recycling programs for hazardous wastes sold by DLA for recycling in accordance with DoD policy.

j. Contract for disposal technology not available within the DoD.

k. Minimize environmental risks and costs associated with the extended care, handling, and storage of hazardous property by accomplishing disposal within a significantly compressed disposal cycle. Initiate actions and projects within DoD and in conjunction with federal, state and local agencies and industry to realize this objective and expedite final disposal.

l. Operate a system to ensure that sufficient disposal capability is programmed to preclude extended delays in the hazardous property disposal process.

m. Maintain an analysis and information distribution capability of current technological advances on DoD hazardous property disposal procedures and advise DoD installations of such developments on a continuing basis. Additionally, ensure that DoD installations are apprised of any federal, state, regional, and local regulations being developed to control hazardous property disposal.

n. Serve as the DoD focal point to recommend to OASD matters of policy and guidance for hazardous property disposal.

o. Establish procedures relative to assigned responsibility for hazardous property disposal. Unresolved issues will be forwarded to OASD with appropriate comments.

C. RESERVED

D. TURN-IN PROCEDURES (GENERAL)

DoD installations and DLA are responsible for compliance with environmental and other pertinent laws and regulations. In order to ensure environmental compliance turn-in activities and DPDOs will:

1. Preplan, schedule, and coordinate hazardous property turn-ins.

2. Process turn-ins of hazardous property as follows:

a. Identification

(1) NSN-identified hazardous property.

(a) The turn-in activity will provide the following upon turn-in of NSN-identified hazardous property to the DPDO:

1. Valid NSN.

2. Noun name as cataloged in the supply system.

3. Chemical name of hazardous contaminants and noun name of nonhazardous contaminants.

4. Amount of hazardous and nonhazardous contaminants based on user's knowledge or testing of the item expressed in a range of content by percentage or parts per million as applicable.

(b) When necessary, the DPDO will:

1. Search HMIS and/or other data sources for chemical names of hazardous components.

2. Search HMIS for transportation and other data as required.

3. Contact manufacturer for data as required.

CHAPTER XXI

HAZARDOUS PROPERTY MANAGEMENT

A. GENERAL

1. The purpose of this chapter is to provide DoD installations and DLA personnel with guidance for handling, processing, and disposing of hazardous property, in accordance with applicable environmental and other pertinent laws and regulations.

2. The DoD policy is to store and dispose of all hazardous property in an environmentally acceptable manner in accordance with applicable environmental and other pertinent laws and regulations.

3. For definitions see Attachment 1 and Chapter III, this manual.

B. RESPONSIBILITIES

1. DoD installation responsibilities are as follows:

a. Where feasible, minimize quantities of hazardous property through resource recovery, recycling, source separation, and acquisition policies.

b. Provide available technical and analytical assistance, including research and development support, to DLA to accomplish disposal, if requested.

c. Provide all available information to DLA, as required, to complete environmental documentation; e.g., environmental impact statements associated with disposal.

d. Properly identify, package, label and certify conformance with established environmental and transportation criteria prior to transfer of accountability for hazardous property to DLA.

e. When requested, assist DLA by providing information and comments on federal, state, regional, and local regulations being developed to control hazardous property disposal; e.g., ability of particular installation to comply and impact on DoD. Alert DLA to any local situation which could impact hazardous property disposal.

f. Retain physical custody of hazardous property within the guideline provided in paragraph C, this chapter.

g. Provide for disposal of the following categories of hazardous property:

(1) Toxicological, biological, radiological, and lethal chemical warfare materials which, by U.S. law, must be destroyed. Disposal of the by-products of such material is the responsibility of the DoD installation with assistance from DLA.

(2) Material which cannot be disposed of in its present form due to military regulations; e.g., Ammunition, Explosives and Dangerous Articles (AEDA), controlled medical items. This category would include those instances where military regulations require the obliteration of all markings that could relate an excess material to its operational program. Once the appropriate actions are taken to meet the military regulation, the resulting material could then be turned in to the servicing DPDO.

(3) Municipal-type garbage, trash, and refuse resulting from residential, institutional, commercial, agricultural, and community activities, which can be disposed of in a state or locally permitted sanitary landfill.

(4) Contractor generated materials which are the contractor's responsibility for disposal under the terms of the contract.

(5) Sludges resulting from municipal-type waste-water treatment facilities.

(6) Sludges and residues generated as a result of industrial plant processes or operations. Properly identified industrial process sludges and residues which are not commingled or a product of an industrial waste treatment facility are the responsibility of DLA. DLA does not take sludges and residues from waste water treatment facilities. DLA does take sludges and residues from industrial processes that have not been commingled. For example, sludges and residues from industrial process "A" must be collected and stored separately from sludges and residues resulting from industrial process "B". Each process may result in sludges and residues that contain a mixture of ingredients and contaminants but the sludges and residues from each process must be collected and stored separately and not commingled.

(7) Refuse and other discarded material which result from mining, dredging, construction, and demolition operations.

(8) Unique wastes and residues of a nonrecurring nature which research and development experimental programs generate.

2. The DLA responsibilities are as follows:

a. Accomplish documentation (including records) for DLA disposal actions as required under applicable

environmental and other pertinent laws and regulations.

b. Initiate contracts or agreements for DLA disposal actions.

c. Accept accountability for all hazardous property, except those categories under responsibility of DoD installations (paragraph B1 above) which have been properly identified, packaged, labeled, and certified in accordance with environmental and transportation laws and regulations.

d. Accept sludges and residues from industrial processes that have not been commingled, e.g., sludges and residues from industrial process "A" must be collected and stored separately from sludges and residue resulting from industrial process "B".

e. Accept custody of hazardous property within the guidelines provided in paragraph C, this chapter.

f. Program for construction of storage facilities in support of the DLA disposal mission.

g. Provide any required repackaging or handling of hazardous property subsequent to acceptance of accountability from the turn-in activity.

h. Establish an inventory control system for the types, quantities, and locations of available hazardous property for which DLA is responsible in the event that some other activity might be able to use particular property as a resource.

i. Provide an economic incentive for DoD installations to segregate and minimize waste generation by:

(1) Providing feedback to military departments and defense agencies on the costs associated with destruction of HW.

(2) Providing 100 percent reimbursement to DoD installations with qualified recycling programs for hazardous wastes sold by DLA for recycling in accordance with DoD policy.

j. Contract for disposal technology not available within the DoD.

k. Minimize environmental risks and costs associated with the extended care, handling, and storage of hazardous property by accomplishing disposal within a significantly compressed disposal cycle. Initiate actions and projects within DoD and in conjunction with federal, state and local agencies and industry to realize this objective and expedite final disposal.

l. Operate a system to ensure that sufficient disposal capability is programmed to preclude extended delays in the hazardous property disposal process.

m. Maintain an analysis and information distribution capability of current technological advances on DoD hazardous property disposal procedures and advise DoD installations of such developments on a continuing basis. Additionally, ensure that DoD installations are apprised of any federal, state, regional, and local regulations being developed to control hazardous property disposal.

n. Serve as the DoD focal point to recommend to OASD matters of policy and guidance for hazardous property disposal.

o. Establish procedures relative to assigned responsibility for hazardous property disposal. Unresolved issues will be forwarded to OASD with appropriate comments.

C. RESERVED

D. TURN-IN PROCEDURES (GENERAL)

DoD installations and DLA are responsible for compliance with environmental and other pertinent laws and regulations. In order to ensure environmental compliance turn-in activities and DPDOs will:

1. Preplan, schedule, and coordinate hazardous property turn-ins.

2. Process turn-ins of hazardous property as follows:

a. Identification

(1) NSN-identified hazardous property.

(a) The turn-in activity will provide the following upon turn-in of NSN-identified hazardous property to the DPDO:

1. Valid NSN.

2. Noun name as cataloged in the supply system.

3. Chemical name of hazardous contaminants and noun name of nonhazardous contaminants.

4. Amount of hazardous and nonhazardous contaminants based on user's knowledge or testing of the item expressed in a range of content by percentage or parts per million as applicable.

(b) When necessary, the DPDO will:

1. Search HMIS and/or other data sources for chemical names of hazardous components.

2. Search HMIS for transportation and other data as required.

3. Contact manufacturer for data as required.

(2) LSN/FSC-identified property.

(a) The turn-in activity will provide the following for turn-in of hazardous property to the DPDO:

1. Chemical name of hazardous components.

2. Chemical name of hazardous contaminants and noun name of nonhazardous contaminants.

3. Amounts of hazardous and nonhazardous contaminants based on user's knowledge or testing of the item expressed in a range of content by percentage or parts per million as applicable.

(b) The DPDO will:

1. Accept accountability of property identified in the above manner.

2. Accept physical custody in accordance with paragraph C, this chapter.

3. Assign proper DoT shipping description to item received from on-site or for property that is received in-place and is not transported over public highways.

4. Assist turn-in activity in determining proper identification as capabilities permit.

5. Reject turn-in when proper identification in accordance with the above is not provided.

(3) PCBs. An analysis of PCB concentration as determined by a scientifically acceptable analytical method will accompany the DTID unless the property has a manufacturer's label or nameplate that indicates the presence of PCBs; e.g., generic or commercial name. The analysis will indicate the amount of PCB in parts per million (ppm) or in the following ranges:

a. Less than 50 ppm

b. 50-499 ppm

c. 500 ppm or more

Individual analysis is required for each item. Items such as capacitors which do not have sampling or servicing parts and are sealed by the manufacturer and are suspected to contain PCBs will be turned in as PCB items (500 ppm and over) without analysis. DPDS may accept batch testing results of mineral oil dielectric on a case-by-case basis. However, approval for batch testing will be obtained from DPDS prior to turn-in.

b. Packaging.

(1) Property turned in to the DPDO must be in containers that are non-leaking and safe to handle. The containers must be able to withstand normal handling or the turn-in will be rejected.

(2) DoT specified containers are required for storage and movement of hazardous wastes. These wastes may also be accumulated in bulk in RCRA permitted facilities.

(3) DoT specified containers are not required for turn-in to the DPDO of anything other than the hazardous wastes. The transporting agency does have a responsibility to comply with DoT requirements for transport over public highways.

(4) When hazardous property turned in for disposal is packaged in the original military containers, the turn-in activity will provide the DPDO with a certification as to the true condition/reliability of the containers. The certification will be placed in Block Y of the DTID by the turn-in activity and will contain one of the following statements:

(a) Packaged in accordance with DoT 49 CFR 170-189.

(b) Packaging equals/exceeds DoT 49 CFR 170-189.

(c) Packaging is substandard to DoT 49 CFR 170-189 (this is not acceptable for hazardous waste "HW" or off-site hazardous property turn-ins).

(5) DoD property in foreign countries or territories shall be packaged in accordance with the host country's environmental laws and/or status of forces agreements.

c. Labeling.

(1) Hazardous property will be labeled in conformance with established environmental and transportation laws and regulations.

(2) PCB marking requirements are as prescribed by the EPA in 40 CFR 761.45. Items containing 50 ppm or more PCB must be marked, with the exception of transformers. Only PCB transformers, i.e., 500 ppm or more PCB, must be marked.

d. Disposal Turn-In Document (DTID).

(1) All property turned in to the DPDO will be done so with a properly prepared DTID. Standard procedures for preparation of a DTID are found in DoD 4140.17-M MILSTRIP. In addition, insert "HM" in block C if turn-in is hazardous material or "HW" if hazardous waste.

(2) The DTID will be modified to satisfy internal DoD auditing requirements. Where they exist, State/EPA required shipping manifests will be used in addition to the modified DTID for transporting haz-

ardous wastes. Information required on the State/EPA manifest must be completed by the turn-in activity when transporting hazardous wastes off-site and over public highways to a servicing DPDO.

(a) Block A – "Shipped From": add telephone number and EPA identification number. Installations qualifying as RCRA defined "small quantity generators" will enter "small generator exclusion" in lieu of the EPA identification number.

(b) Block B – "Ship To": add telephone number and EPA identification number.

(c) Block U – "Freight Classification Nomenclature": add Hazard Class (maximum 18 alpha characters) and six character (2 alpha, 4 numeric) identification number as shown in DoT 49 CFR 172.

(d) Blocks W-X-

1. For non-NSN hazardous waste items enter the word 'waste' and the item's proper shipping name as shown in DoT 49 CFR 172 and as much descriptive information as possible in Blocks W and X, and/or attach additional documentation with this data.

2. For NSN hazardous waste items Block W will be used for internal purposes and Block X must contain the word "waste" followed by the item's proper shipping name as shown in DoT 49 CFR 172.

(e) Block Y – Use this Block (in lieu of blocks AA through EE) for the deposit account number. Note: This is not an entry required on behalf of hazardous property documentation but a movement of data prescribed to permit use of the previously identified blocks for other purposes.

(f) Blocks AA and BB – Use these two blocks for the transporter's name and EPA identification number.

(g) Block CC – Have transporter (identified in Blocks AA and BB) sign and date for shipment received.

(h) Blocks DD, EE, FF and CC – Insert the following statement in these blocks (Note: Rubber stamped, typewritten or machine-produced copy required): "This is to certify that the above named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of DoT and EPA." To comply with RCRA, the turn-in activity will sign as the generator under the certification statement.

(i) Block-2. Enter DoT container classification.

(j) Block-3. Enter total quantity of hazardous waste by units of weight or volume (includes packaging).

(3) Block 8 of the DTID will be signed and dated by the DPDO and returned to the turn-in activity within 5 working days from receipt. The signed copy of the DTID will serve as valid receipt of accountability for the hazardous property by the DPDO.

E. TURN-IN PROCEDURES (SPECIFIC).

Detailed guidance governing turn-in as well as handling and processing of specific hazardous property is contained in Chapter VI, this manual.

F. IMPLEMENTATION OF RCRA.

1. Permits.

a. The installation commander is responsible to ensure compliance with all RCRA requirements for the installation. The installation commander is also responsible to notify, to apply for permits, and to report to EPA or the state, as required, for all installation activities, including tenants. Tenants are responsible for conducting their activities in accordance with RCRA and permit requirements at the facility. Tenants will provide necessary documentation, signed and completed, to the host for permit applications and for reports as required by EPA or the state. Submittals will be in the format required by the regulatory agencies.

b. The individual facility operational managers are responsible for conducting their activities in accordance with RCRA. Those facility managers, including tenants, will provide necessary documentation to the installation commander for permit applications, will provide to the installation commander reports required by EPA or the state, and will ensure compliance with RCRA regulations and permit requirements at that facility.

c. The installation commander will sign as the owner and the Defense Property Disposal Region Commander will sign as the operator.

2. Hazardous Waste Management Plan.

Implementation of the comprehensive hazardous waste management program, mandated by RCRA, requires maximum cooperation of all activities on an installation. The following guidance applies to development and implementation of a Hazardous Waste Management Plan:

a. The installation commander is responsible for developing and implementing a Hazardous Waste Management Plan to include all tenants on the in-

(2) LSN/FSC-identified property.

(a) The turn-in activity will provide the following for turn-in of hazardous property to the DPDO:

1. Chemical name of hazardous components.

2. Chemical name of hazardous contaminants and noun name of nonhazardous contaminants.

3. Amounts of hazardous and nonhazardous contaminants based on user's knowledge or testing of the item expressed in a range of content by percentage or parts per million as applicable.

(b) The DPDO will:

1. Accept accountability of property identified in the above manner.

2. Accept physical custody in accordance with paragraph C, this chapter.

3. Assign proper DoT shipping description to item received from on-site or for property that is received in-place and is not transported over public highways.

4. Assist turn-in activity in determining proper identification as capabilities permit.

5. Reject turn-in when proper identification in accordance with the above is not provided.

(3) PCBs. An analysis of PCB concentration as determined by a scientifically acceptable analytical method will accompany the DTID unless the property has a manufacturer's label or nameplate that indicates the presence of PCBs; e.g., generic or commercial name. The analysis will indicate the amount of PCB in parts per million (ppm) or in the following ranges:

a. Less than 50 ppm

b. 50-499 ppm

c. 500 ppm or more

Individual analysis is required for each item. Items such as capacitors which do not have sampling or servicing parts and are sealed by the manufacturer and are suspected to contain PCBs will be turned in as PCB items (500 ppm and over) without analysis. DPDS may accept batch testing results of mineral oil dielectric on a case-by-case basis. However, approval for batch testing will be obtained from DPDS prior to turn-in.

b. Packaging.

(1) Property turned in to the DPDO must be in containers that are non-leaking and safe to handle. The containers must be able to withstand normal handling or the turn-in will be rejected.

(2) DoT specified containers are required for storage and movement of hazardous wastes. These wastes may also be accumulated in bulk in RCRA permitted facilities.

(3) DoT specified containers are not required for turn-in to the DPDO of anything other than the hazardous wastes. The transporting agency does have a responsibility to comply with DoT requirements for transport over public highways.

(4) When hazardous property turned in for disposal is packaged in the original military containers, the turn-in activity will provide the DPDO with a certification as to the true condition/reliability of the containers. The certification will be placed in Block Y of the DTID by the turn-in activity and will contain one of the following statements:

(a) Packaged in accordance with DoT 49 CFR 170-189.

(b) Packaging equals/exceeds DoT 49 CFR 170-189.

(c) Packaging is substandard to DoT 49 CFR 170-189 (this is not acceptable for hazardous waste "HW" or off-site hazardous property turn-ins).

(5) DoD property in foreign countries or territories shall be packaged in accordance with the host country's environmental laws and/or status of forces agreements.

c. Labeling.

(1) Hazardous property will be labeled in conformance with established environmental and transportation laws and regulations.

(2) PCB marking requirements are as prescribed by the EPA in 40 CFR 761.45. Items containing 50 ppm or more PCB must be marked, with the exception of transformers. Only PCB transformers, i.e., 500 ppm or more PCB, must be marked.

d. Disposal Turn-In Document (DTID).

(1) All property turned in to the DPDO will be done so with a properly prepared DTID. Standard procedures for preparation of a DTID are found in DoD 4140.17-M MILSTRIP. In addition, insert "HM" in block C if turn-in is hazardous material or "HW" if hazardous waste.

(2) The DTID will be modified to satisfy internal DoD auditing requirements. Where they exist, State/EPA required shipping manifests will be used in addition to the modified DTID for transporting haz-

ardous wastes. Information required on the State/EPA manifest must be completed by the turn-in activity when transporting hazardous wastes off-site and over public highways to a servicing DPDO.

(a) Block A – "Shipped From": add telephone number and EPA identification number. Installations qualifying as RCRA defined "small quantity generators" will enter "small generator exclusion" in lieu of the EPA identification number.

(b) Block B – "Ship To": add telephone number and EPA identification number.

(c) Block U – "Freight Classification Nomenclature": add Hazard Class (maximum 18 alpha characters) and six character (2 alpha, 4 numeric) identification number as shown in DoT 49 CFR 172.

(d) Blocks W-X-

1. For non-NSN hazardous waste items enter the word 'waste' and the item's proper shipping name as shown in DoT 49 CFR 172 and as much descriptive information as possible in Blocks W and X, and/or attach additional documentation with this data.

2. For NSN hazardous waste items Block W will be used for internal purposes and Block X must contain the word "waste" followed by the item's proper shipping name as shown in DoT 49 CFR 172.

(e) Block Y – Use this Block (in lieu of blocks AA through EE) for the deposit account number. Note: This is not an entry required on behalf of hazardous property documentation but a movement of data prescribed to permit use of the previously identified blocks for other purposes.

(f) Blocks AA and BB – Use these two blocks for the transporter's name and EPA identification number.

(g) Block CC – Have transporter (identified in Blocks AA and BB) sign and date for shipment received.

(h) Blocks DD, EE, FF and CC – Insert the following statement in these blocks (Note: Rubber stamped, typewritten or machine-produced copy required): "This is to certify that the above named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of DoT and EPA." To comply with RCRA, the turn-in activity will sign as the generator under the certification statement.

(i) Block-2. Enter DoT container classification.

(j) Block-3. Enter total quantity of hazardous waste by units of weight or volume (includes packaging).

(3) Block 8 of the DTID will be signed and dated by the DPDO and returned to the turn-in activity within 5 working days from receipt. The signed copy of the DTID will serve as valid receipt of accountability for the hazardous property by the DPDO.

E. TURN-IN PROCEDURES (SPECIFIC).

Detailed guidance governing turn-in as well as handling and processing of specific hazardous property is contained in Chapter VI, this manual.

F. IMPLEMENTATION OF RCRA.

1. Permits.

a. The installation commander is responsible to ensure compliance with all RCRA requirements for the installation. The installation commander is also responsible to notify, to apply for permits, and to report to EPA or the state, as required, for all installation activities, including tenants. Tenants are responsible for conducting their activities in accordance with RCRA and permit requirements at the facility. Tenants will provide necessary documentation, signed and completed, to the host for permit applications and for reports as required by EPA or the state. Submittals will be in the format required by the regulatory agencies.

b. The individual facility operational managers are responsible for conducting their activities in accordance with RCRA. Those facility managers, including tenants, will provide necessary documentation to the installation commander for permit applications, will provide to the installation commander reports required by EPA or the state, and will ensure compliance with RCRA regulations and permit requirements at that facility.

c. The installation commander will sign as the owner and the Defense Property Disposal Region Commander will sign as the operator.

2. Hazardous Waste Management Plan.

Implementation of the comprehensive hazardous waste management program, mandated by RCRA, requires maximum cooperation of all activities on an installation. The following guidance applies to development and implementation of a Hazardous Waste Management Plan:

a. The installation commander is responsible for developing and implementing a Hazardous Waste Management Plan to include all tenants on the in-

stallation. This plan shall identify and implement hazardous waste management actions required by RCRA. Tenants are responsible for providing input to the installation commander for their portion of the plan.

b. All tenants will comply with applicable portions of the Hazardous Waste Management Plan and ensure that internal operational procedures are consistent.

c. Reserved.

d. Reserved.

e. Reserved.

3. Manifesting.

When required by EPA and/or State RCRA derived regulations, a manifest will be prepared in addition to the modified DTID in accordance with paragraph D2d(2) above. The permit holder (installation commander) has primary responsibility for signing manifests, but may delegate signature authority. However, the DPDO will co-sign all manifests for shipments of hazardous property on DLA accountable records. In those instances where the permit holder delegates signature authority to the DPDO, only one signature will appear.

4. Record Keeping and Reporting.

Installations shall comply with federal and state hazardous waste record keeping and reporting requirements. Tenants shall submit reports required by the installation's Hazardous Waste Management Plan within time frames established by the installation commander. All reports to EPA or the state will be prepared in proper format by the operators and co-signed and submitted by the installation commander.

G. HAZARDOUS MATERIALS INFORMATION SYSTEM (HMIS)/HAZARDOUS MATERIALS TECHNICAL CENTER (HMTC)

1. DoD Instruction 6050.5, Hazardous Material Information System, assigns responsibilities for the establishment and use of a DoD hazardous material information system.

2. The HMIS is designed to support the major areas of health, safety, and transportation. This includes a wide range of data related to safety, health, transportation, and disposal of hazardous materials. Caution should be exercised in applying this information without the proper training and knowledge of procedures which are related to specific hazards. Data in this system is reference information and must be used in conjunction with, not in lieu of, procedures and regulatory documents. If there is any doubt about use of the safety and health information in the microfiche, the local health and safety staff should be contacted.

3. HMIS data are published on microfiche annually with quarterly cumulative updates. Items on the list are identified by NSN, Manufacturer, and Part Number (Trade Name) and are sequenced by NIIN.

4. HMTC is a DLA managed, contractor operated information source for technical information on safety, health, handling, transportation, disposal and environmental aspects of hazardous materials management. HMTC maintains a telephone response capability for DoD use in accessing this information.

Telephone numbers are: (800) 638-8958
(301) 468-8858
FTS (202) 468-8858

CHAPTER XXI

ATTACHMENT 1

DEFINITIONS

1. *Hazardous Property.* Includes material and waste having one or more of the following characteristics:

a. has a flashpoint below 200° F (93° C) closed cup, or is subject to spontaneous heating or is subject to polymerization with release of large amounts of energy when handled, stored, and shipped without adequate control;

b. has a Threshold Limit Value[R] equal to or below 1,000 ppm for gases and vapors, below 500 mg/m^3 for fumes, and equal to or less than 30 mppcf or 10 mg/m^3 for dusts (less than or equal to 2.0 fibers/cc greater than 5 micrometers in length for fibrous materials);

c. a single oral dose that will cause 50 percent fatalities to test animals when administered in doses of less than 500 mg per kilogram of test animal weight;

d. is a flammable solid as defined in DoT 49 CFR 173.150, or is an oxidizer as defined in DoT 49 CFR 173.151, or is a strong oxidizing or reducing agent with a half cell potential in acid solution of greater than ± 1.0 volt as specified in Latimer's table on the oxidation-reduction potential;

e. causes first-degree burns to skin in short-time exposure, or is systemically toxic by skin contact;

f. in the course of normal operations, may produce dust, gases, fumes, vapors, mists, or smoke [illegible] or more of the above characteristics;

g. produces sensitizing or irritating effects;

h. is radioactive;

i. the item has special characteristics which in the opinion of the manufacturer could cause harm to personnel if used or stored improperly;

j. the item is hazardous in accordance with OSHA 29 CFR 1910;

k. the item is hazardous in accordance with DoT 49 CFR 171-179 or the International Maritime Dangerous Goods Code of the International Maritime Organization (IMO) or the Dangerous Goods Regulations of the International Air Transport Association (IATA); or

l. is regulated by the Environmental Protection Agency under 40 CFR.

2. *Hazardous Wastes.* Property which is regulated as a hazardous waste under the Resource Conservation and Recovery Act and subsequent legislation, including state and local regulatory authorities.

3. *Hazardous Material.* Any hazardous property which is not a hazardous waste.

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DRAFT

NAVI
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NAVFAC INSTRUCTION 4862.5B

From: Commander, Naval Facilities Engineering Command

Subj: Industrial Facilities Projects Which Generate or Treat Controlled Wastes

Encl: (1) Guidelines for Industrial Projects
(2) Milestones for Major Tasks

1. Purpose. To improve the Navy industrial facilities acquisition process.

2. Cancellation. NAVFAC Instruction 4862.5A of 31 July 1980 is superseded.

3. Definition. The projects covered by this instruction include Navy owned facilities and Government Owned Contractor Operated facilities (GOCOs) which generate or treat controlled wastes. A controlled waste is one which is regulated by Federal, state or local regulatory authorities, and may be in the form of air emissions, solid wastes or wastewater discharges. Facilities of concern may include, but not be limited to, drydocks, power plants, industrial waste treatment plants, electroplating shops, metal finishing facilities, pipe shops and paint stripping operations. Treatment systems which receive waste only from domestic systems and controlled through state and Federal guidelines are not applicable, except where unusually complex treatment requirements exist.

4. Discussion. A number of Navy owned industrial facilities which generate or treat controlled wastes have experienced, or are presently experiencing, operating problems and difficulties in complying with laws and regulations imposed by local, state and Federal authorities.

a. The Clean Water Act contains requirements for pretreatment, toxics control, and Best Available Technology (BAT) for treatment of Wastewater.

b. The Clean Air Act requires a facility to obtain construction and operating permits to ensure the prevention of significant deterioration of the ambient air.

c. The Resource Conservation and Recovery Act (RCRA) regulates the disposal of solid and hazardous wastes.

Industrial facilities, therefore, must be designed and operated at optimum condition to meet these requirements. The enclosure (1) Guidelines for Industrial Projects, developed from lessons learned on past projects, provides a scenario to be followed for subject facilities.

5. Action. Addressees will follow enclosure (1) for facilities acquisition projects which generate or treat controlled wastes. These include upgrading of existing facilities and new construction. The chart of Milestones for Major Tasks, enclosure (2) is provided as guidance.

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GUIDELINES FOR INDUSTRIAL PROJECTS

I. TECHNICAL CONSIDERATIONS

A. PRELIMINARY ENGINEERING STUDY

1. Close internal coordination on projects dealing with controlled waste is essential. Therefore, beginning with development of a Preliminary Engineering Study (PES), which is required, a "team" concept shall be implemented. Members of the team shall be selected from the activity, Engineering Field Division (EFD), and, if necessary, Naval Facilities Engineering Command Headquarters (NAVFACHQ). Timely review of all project documentation by these team members is essential. As a minimum, codes familiar with design, construction and environmental regulations must be included as project team members.

2. After selection of project team members, the EFD shall conduct a PES for project definition and basis of design. A Preliminary Hazard Analysis (PHA), as required by CNO letter Ser 454C/34394544 of 15 December 1983, with subject "System Safety Engineering for Facilities Acquisition", is to be conducted concomitantly and in conjunction with the PES. The PHA shall be considered as part of the PES. The PES, including the PHA, is a critical step in identifying and documenting deficiencies and problems and in developing firm cost estimates and viable alternatives. Timeliness is of essence, since it will provide information on the basic requirements, needed for development of Form 1391.

3. As part of the PES, it is essential that consideration be given to source control, including the possibility of substantially altering a process or plant operation to reduce pollutant loading. By reducing the volume of controlled waste and the amount of contaminant, treatment units can be made smaller, and capital, labor and material costs can be reduced. Consequently, it is often economical to eliminate or reduce the quantity of controlled waste at its source prior to treatment or in lieu of treatment. Several possible techniques exist, including improved housekeeping, process changes, material recovery and substitution, waste segregation and water recycle/reuse. Sometimes, with only partial purification, spent water can be reused in the industrial process. Water unsuitable for direct reuse may be serviceable for a different purpose in which quality requirements are less restrictive. Certain types of wastes should be kept separate until they reach the treatment plant, or even some advanced stage of treatment. For example, acid and cyanide wastes must be segregated for the sake of safety. On the other hand, the mixing of wastes may provide partial treatment, such as partial neutralization by mixing acid and alkaline wastes.

4. Preliminary estimates of additional staffing requirements for the proposed facility should be made as early as possible and furnished to the activity for budget and management purposes. Staffing estimates should be refined during the final design stage as discussed under III.A.1.

5. Often, there are a number of alternatives which can achieve the desired result. Therefore, the major objective of the PES should be to determine what combinations of actions will be the most cost-effective, safest, and technically and operationally feasible, including whether process or plant alteration, or remedial treatment, or both, is the best course of action.

6. The PES shall be comprised of the following:

a. Description of industrial shop or treatment plant including processes employed
   Location map
   Industrial shop or treatment plant layout
   Process flow sheets

b. Process and production data
   Raw materials, chemicals, etc.
   Production
     Present: average, maximum, minimum
     Future: average, maximum, minimum
     Production patterns: daily and seasonal

c. Water Supply Survey: Identify water quality and quantity used in the specific industrial activity, including description, and water supply piping system layout. Water quality requirements (if known) for this specific industry should also be reported. This information may be used for wastewater recycle/reuse planning.

d. Waste Source Survey: If possible, identify sources according to the Standard Industrial Classification (SIC) Code, as identified by the Clean Water Act and the Clean Air Act.

   (1) Waste sources.
       Description
       Flow sheets
       Industrial wastewater piping system layout

   (2) Waste volumes and variations.
       Survey data.
       Estimated volume under conditions of average, maximum and minimum production, present and future

   (3) Waste characteristics - physical, chemical, biological, radiological.
       Variations during a day, week, and season
       Present, future

AD-A165 087 INDUSTRIAL PROCESSES TO REDUCE GENERATION OF HAZARDOUS WASTE AT DOD FACIL..(U) CH2M HILL RESTON VA T E HIGGINS ET AL. DEC 85 DACA87-84-C-0076 3/3

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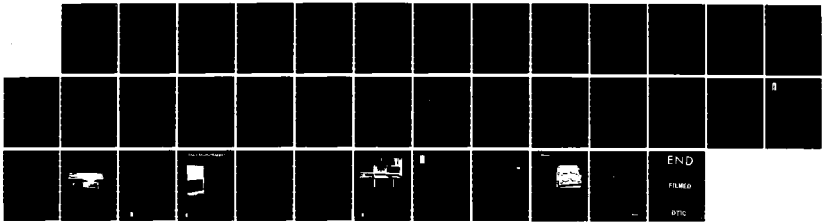
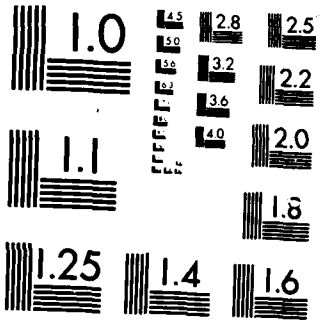




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

e. Air Emission Survey: Determine what air pollutants will be emitted by the proposed process and make a preliminary quantitative assessment of these emissions. Based on this data, establish the requirements of the preconstruction regulatory reviews, degree of emission controls needed and the monitoring/reporting requirements, if applicable.

f. Preliminary Hazard Analysis (PHA): See NAVFAC Instructions 5500.11 and 11010.32.

g. Existing treatment/disposal methods.
Description of methods now in use.
Evaluation of these methods.

h. Effluent/emissions criteria applicable to discharge from a proposed industrial shop or treatment plant. Document the effluent standards necessary to meet NPDES permit requirements, pretreatment limitations and air emission criteria. When state or local limitations are much more stringent than Federal standards, the Navy (EFD Code 114) and regulatory agency should negotiate to achieve limits which are essentially consistent with the Federal program. Any deviations from the Federal program must be justified and fully documented. A copy of the standards and any resulting agreements should be included in the project documentation.

i. Source Control. Describe results of the investigations into the following:

Improved housekeeping
Process change(s)
Operation change(s)
Materials substitution
Material recovery
Water re-use
Waste segregation

j. Alternatives - compare using life cycle costs. Discharge to the base or publicly owned wastewater treatment plant should consider pretreatment requirements. Also, an assessment of contracted O&M should be included. Possibilities of air emissions trading or the bubble concept should be investigated.

k. Recommended solution(s) with rationale. Describe alternatives evaluated. Sludge generation and disposal must be a part of and may be a key factor in the recommendation. Include staffing and other logistics requirements for the activity. State whether a solution can be recommended without conducting treatability (see Section B) studies.

7. Send copies of the draft final PES to NAVFACHQ Codes 04B and 112 for review. A 30 calendar day review period should be provided.

B. TREATABILITY STUDIES

1. It may be necessary to perform treatability studies (TS) to confirm the effectiveness of the proposed physical, chemical or biological unit processes. Pilot tests should be conducted prior to a chemical process design in order to determine the most cost-effective solution. The life cycle cost analysis for each viable alternative should include sludge handling, treatment and disposal requirements. More extensive TS, which may vary from bench-scale testing to on-site pilot plant operations, should be conducted when the PS justifies it. Justification for further TS may include:

a. When the PES recommended solution, or the feasible alternative is not a proven "off-the-shelf" process.

b. When more than one unrelated processes contributes pollutants to the effluent.

c. When unusual wastes are treated.

d. When wastes containing numerous interfering substances, such as stripping wastes, are to be treated.

e. When discharge limits are exceptionally restrictive.

C. PROJECT DOCUMENTATION

For Military Construction (MCON) projects, the PES, and TS if applicable, is to be included with the DD Form 1391 as a part of the "Facility Study". For non-MCON construction projects, the PES shall be included with the step II submission.

D. PROJECT DESIGN

1. Prior to design authorization the EFD project team members should review all project documentation for current applicability and to ascertain that the project scope is sufficient to meet the latest applicable discharge/emission requirements. If revisions of the PES and TS are necessary, or if cost limitations indicate that no acceptable solution can be provided within budget, EFDs should notify NAVFAC Code 05 and other project team members without delay.

2. The scope of work for subject projects will require optimum equipment redundancy and operation flexibility to provide continuing operation in case of equipment failure and to accommodate future changes resulting from new treatment standards, or variation in type, volume, and concentration of waste due to workload or process changes. Redundancy should be provided for all critical components, including reactors, tanks, valves, pumps, and piping. (Note NAVFAC DM-5.8, section 4.3). Holding and process tank sizing should provide capacity allowance for storage during process flow interruptions. Flexibility should be increased by adding appropriate bypass lines. Proven technology and batch treatment should be chosen over continuous

processes in accordance with NAVFAC DM-5.8, section 5.1.b.7. Air pollution control equipment should be provided in accordance with NAVFAC DM-3.15. Provisions shall be made for operator facilities such as lockers, male/female showers, lavatories, etc. All industrial shops and treatment plants should have office facilities, shop space, and assigned space for spare parts inventory and chemical storage. If necessary, the control/operations building at treatment plants should also include a laboratory. To ensure that the safety and health considerations as well as operational failures and problems are addressed all through the project from concept development to disposal of the facility, additional hazard analyses, as determined from the PHA, are to be conducted during the design phase. The design shall meet the applicable NAVOSH requirements and MIL-H-46855A, Human Engineering Requirements for Military Systems, Equipment and Facilities. As indicated in the basic instruction, the Best Available Technology (BAT) requirements apply to these facilities.

3. The design phase shall include preparation of conceptual design submission and project engineering documentation (PED) in accordance with NAVFACINST 11010.14N for projects in the MCON program. Submission of documentation, plans, estimates and specifications is required also at the pre-final and final submission of design.

4. At a minimum, EFD Code 114s should review the conceptual design, the 35%, pre-final and final submissions. Send the conceptual design, 35% and pre-final submissions (3 copies) to NAVFACHQ Code 04B. Allow a 30 calendar day review period.

E. POST CONSTRUCTION AWARD SURVEILLANCE AND SUPPORT

1. Construction support tasks for the design contractor should include all of the following:

a. Reviewing and providing comments on all proposed design changes to ensure consistency with process and material selection.

b. Conducting "change analyses" for all design changes, and for field changes, as applicable.

c. Providing assistance to ROICC during construction.

(1) Review and comment on shop drawings.

(2) Inspect field construction at least weekly during the critical phases of the project.

(3) Participate in acceptance tests for all major equipment items.

(4) Review change orders.

d. Observing and assisting the Construction Contractor in initial start-up of facility and providing necessary consultation to operating personnel for 90 days after start-up.

e. Assisting the activity in the selection of qualifications/numbers of operators, providing training, and assisting the activity with ordering initial stock of spare parts and chemicals.

2. In order to ensure that the plant meets design specifications and is operational before delivery to the activity, the EFD construction support tasks should include:

a. Assisting with construction.

(1) The project team will review and comment on all proposed significant engineering changes.

(2) The project team will assist the ROICC with setting up component testing during construction.

b. Assisting with final inspection and plant start-up using actual flows.

F. MONITORING

1. Industrial facilities which generate or treat controlled wastes shall be monitored for the following:

a. To insure proper operation.

b. To gather data to satisfy control agencies as to compliance with requirements.

c. To gather backup data to be used with performance certification of a treatment plant.

d. To collect information which forms the basis for future improvements/additions to the industrial shop or treatment plant.

e. To validate/revise design criteria.

2. Certain industrial facilities require monitoring to comply with pretreatment standards if discharging to publicly-owned treatment works.

3. During the first year of operation, the shake-down period, the cognizant EFD (Code 114) should request summaries of the operational problems and remedial actions taken at the industrial facility along with the monthly submittal of sampling and analysis data. This information will assist the EFD in providing corrective project justification, if required, and will also help NAVFACHQ during a post-occupancy evaluation. It may also provide the basis for development or revision of design criteria.

G. PERFORMANCE CERTIFICATION

1. In case of an Industrial Waste Treatment (IWT) plant, instead of the 90-day period, the design A/E shall provide observation and consultation to plant operating personnel for 365 days after start-up. After the 365 days, the A/E shall:

a. Provide revised Operations and Maintenance Manuals indicating all the changes made at the plant and reflecting actual operating experience during the first year of operation.

b. Provide Performance Certification to the plant owner stating that the plant will meet the applicable project performance criteria if the collected data so indicates.

c. Submit a corrective action report to the plant owner if the project is not capable of meeting applicable performance criteria. The report shall include a schedule for undertaking in a timely manner the corrective action necessary to bring the project into compliance.

II. ENGINEER QUALIFICATIONS - A/E SELECTION

A. Design of adequate industrial facilities, including cost-effective treatment of wastewaters, requires the services of a highly competent professional familiar with industrial processes, and possessing the specialized knowledge of chemical, physical and biological principles applicable to the project. In addition, the ability to translate these principles into engineering plans and specifications is needed in order to arrive at a cost-effective solution.

B. To ensure that the A/E conducting the required studies and performing the design has the above stated qualifications, the prospective A/E's must be screened for relevant experience and successful practice. The following steps are recommended, with selection to be in strict accord with NAVFAC P-68, 5-303.

1. Ascertain that the synopsis prepared for publication in the Commerce Business Daily adequately describes the proposed project and spells out all special qualifications, including system safety engineering, and performance data which will be used as important evaluation factors. Commerce Business Daily Note 62 prescribes general selection criteria only. The drafting of particular evaluation criteria must be carefully done, tailored to the specific project.

2. The final selection should be based on a review of qualifications including performance data; interviews with the best qualified firms; availability of key individuals who will be assigned to the work; canvassing of past customers to determine their facilities' actual performance; and other relevant factors.

III. LOGISTIC SUPPORT AND TRAINING

A. Integrated Logistic Support (ILS) is a systematic management approach to the early integration of support criteria into design. DOD Directive 4100.35 describes ILS as: "... a composite of elements necessary to assure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle ..." It includes responsibility for preserving continuity in the systematic planning, acquisition, and operation of the systems and equipment. Therefore, the ILS Plan for each industrial facility should include:

1. Activity ILS

a. Staffing Requirements. As described under Preliminary Engineering Studies, Section I.A.4., staffing requirements for the proposed facility shall be determined as early as possible so that the activity will have time to program for them. Staffing requirements (number and grade/job levels, training and certification requirements peculiar to the system) shall be modified/confirmed during the design stage.

b. ILS Funding Requirements. An estimate of ILS funding support required by the activity (required in addition to personnel support in order to operate and maintain the proposed facility) shall be made by the design A/E as early as possible and furnished to the activity for budgeting purposes.

2. Collateral Equipment List. Concurrent with the design, a collateral equipment list shall be developed by the design A/E.

3. Operator Manuals/Instructions. Draft Operator Manuals/Instructions shall be prepared during the design and construction stage and shall be available prior to initial start-up of the facility. The final detailed Manuals/Instructions will include sections on troubleshooting, emergency operations, taking samples, and identification of analysis procedures. The final Manuals/Instructions shall suit exact equipment furnished under contract.

4. Maintenance Manuals. Detailed Maintenance Manuals, including preventive maintenance procedures shall be prepared.

5. Operator Training. Hands-on operator training shall be provided to the extent needed.

6. Contingency Plans. Specific procedures shall be prepared by the design A/E to deal with the event of a chemical spill or plant shutdown and shall be incorporated into the operations manual and the local activity spill contingency plan.

7. Spare Parts List. A spare parts (equipment) list shall be part of the project specifications when stand-by duplicate equipment is determined to be required but will not be connected in place.

B. The O&M Manual, Collateral Equipment List, Spare Parts List and Operator Training requirements shall be identified in project development stage and specifically listed in the project documentation.

IV. OPERATING AND MAINTENANCE SUPPORT INFORMATION (OMSI) FOR MILITARY CONSTRUCTION PROJECTS

As stated by NAVFACINST 11013.39 of 17 January 1983: "OMSI is a product, developed during the design and constrauction of a facility, needed to promote and maximize the efficiency, economy, safety and effectiveness of life cycle operation and maintenance of that facility." Among other complex projects, OMSI should be considered for heating and power plants, drydocks, maintenance shops, POL facilities and industrial waste treatment facilities. As stated by the instruction, any requirement for OMSI should be clearly indicated in the Military Construction Project Data, DD Form 1391, for MCON projects.

V. FUNDING SUPPORT

Normally, the major claimant provides funding support for the Preliminary Engineering Study and for the treatability study which together define the project requirements. For some projects, pollution abatement funding may also be available for the PES and TS through the EFD. For MCON projects, MCON design funds are used to prepare plans and specifications after a project is included in a specific fiscal year program. Also, for MCON projects it is appropriate to use MCON project funds for any design effort required after construction contract award and for the preparation of operation and maintenance manuals where they are included in the project scope, and for specialized on-the-job operator training.

VI. APPLICABILITY

Certain projects may not require or lend themselves to all of the provisions as described above. Where doubt exists, guidance should be sought from NAVFACHQ Codes 04B and 112.

VII. PROJECT SCENARIO

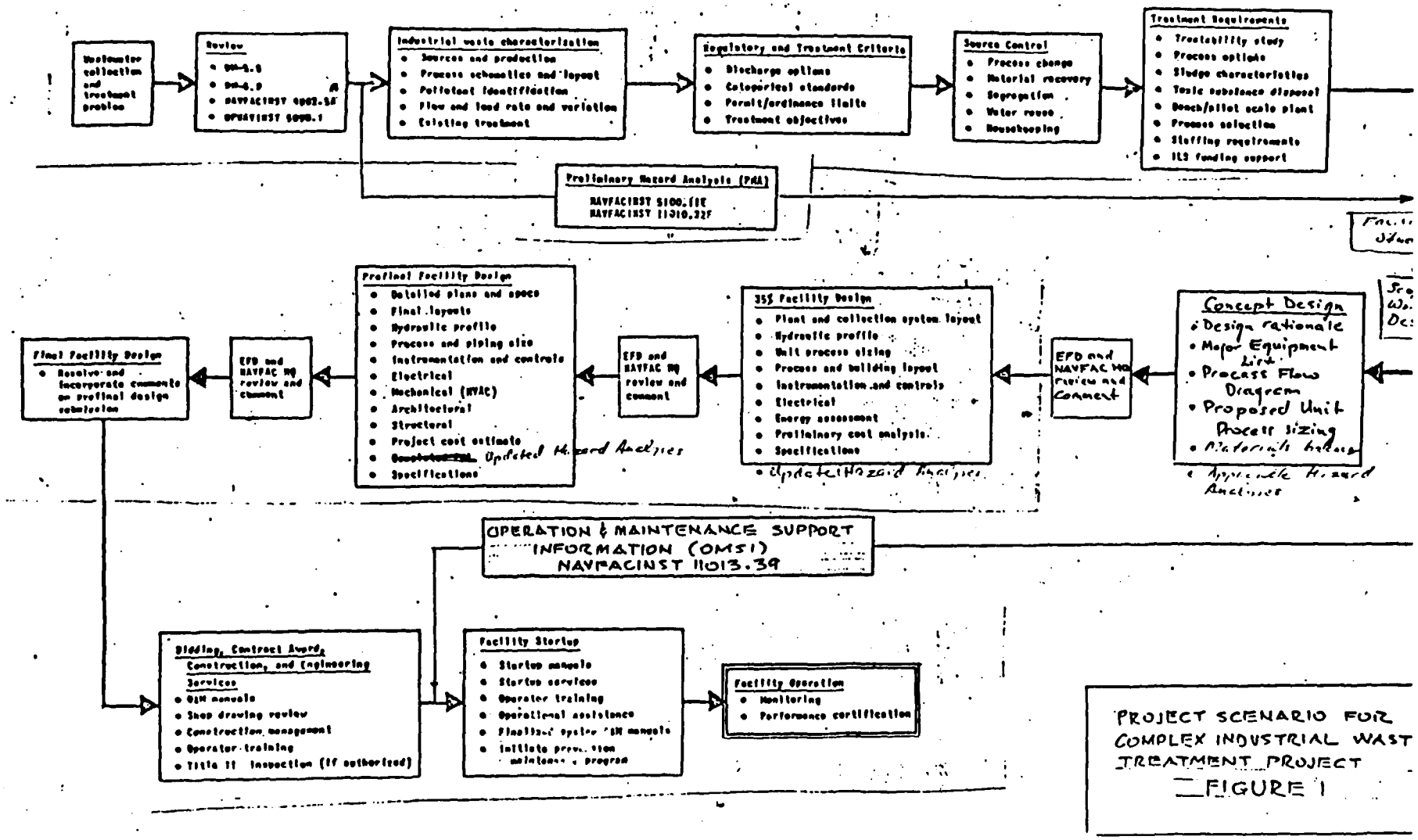
As an example, the project scenario, from conception to performance certification, is shown on Figure 1 for a complex industrial waste treatment project.

Milestones for Major Tasks

Task Description	Team Involvement				Schedule	
Planning Phase	04	114	09A2	05	Planned Compl.	Actual Compl.
Establish Project Team	*	**	*	*		
Prepare CBD Synopsis	*	**	*			
Prel. Hazard Analysis (PHA)	*	**	*	*		
Review PES and TS	*	**	*	*		
Forward PES to NAVFACHQ		**				
Resolve Comments	*	**	*	*		
Final PES Report		**				
Review Complete Facility Study	*	*	**	*		
Design Phase						
Review Project Documents	**	*	*	*		
Revise PES & TS	**	*	*	*		
Coordinate Site Approval	**					
Prepare CBD Synopsis	*	*	**	*		
A/E Selection	*	*	**	*		
Fee Negotiations	*	*	**	*		
Design Reviews	**	*	*	*		
(1) Concept						
(2) 35%						
(3) Prefinal						
NAVFACHQ Review	**					
Discuss CQC Reqmts.	**	*	*	*		
Prepare Constr. & Log. Sup. Amt.	**	*	*	*		
O&M Support Info.	**	*	*	*		
Construction Phase						
Brief Contractor & ROICC	**	*	*	*		
Review Proposed Changes	**	*	*	*		
Review Contract Subms.	**	*	*	*		
Field Inspections	**	*	*	*		
O&M Support Info	*	*	*	**		
Review Draft O&M Manuals	*	**	*	*		
Acceptance Tests	**	*	*	*		
Final Inspection	**	*	*	*		
Start-up and Shake-down Phase						
Review Final O&M Manual	*	**	*	*		
Operator Training	*	**				
Monitoring	*	**				
Review Contingency Plan	*	**				
Revise Final O&M Manual	*	**				
Consultation	*	**				

Task Description	Team Involvement				Schedule	
Planning Phase	04	114	09A2	05	Planned Compl.	Actual Compl.
Certification	*	**	*	*		
Corrective action report (if any)	*	*	*	**		
Review Revised Final O&M Manuals	*	**				

** Indicates responsible (lead) member
* Indicates participating (assisting) member



PROJECT SCENARIO FOR COMPLEX INDUSTRIAL WAST TREATMENT PROJECT

FIGURE 1

APPENDIX

2.0 Selected Project References

2.1 NARF Pensacola Report (C.H. Peger, Hard Chrome Plating Consultants, Ltd., 1984)

2.2 Innovative Hard Chrome Process Technical Briefing, Contractor's Report (G.C. Cushnie and C.G. Roberts, June 20-21, 1985)

APPENDIX 2.1

HARD CHROME PLATING CONSULTANTS LTD.

Where the impossible usually doesn't take any longer to do.

P. O. Box 44082
Cleveland, Ohio 44144
216 351 8297

C P LTD.

N.A.R.F. PENSACOLA REPORT

N62583/84 M R079

The hard chrome tank blower system is in a sad state. According to the platers it never did work right. It's been my experience that push pull systems never have worked right. I have seen several abandoned and 3 still working, but with fumes all over the shop. The only type of hood that does the job is a double lateral with the slots on the tank lip. Due to the crowded conditions in this shop, tanks too close together, the best type of blower system can not be easily installed.

Hard chrome plating the reversible rack way increases plating speed by about a factor of 3. It also increases the amount of mist that is produced by about the same figure. It is imperative that the system in this shop be modified and repaired on an emergency basis. To rebuild the system to it's former condition would be a waste of money. The following recommendations are a cheap, quick fix but at a early future date the two end tanks should be reworked. To bring them both up to standard, would cost about $20,000.00 or less. Only two reversible rack tanks, run properly, is all that is necessary for this shop, to fix the present blower system it is necessary to cut off the blower side duct and reroute it into the suction duct. This would be done at the wall riser end. The one side would have less suction than the other, but because of the tanks being narrow and blower so big, it should be ok.

SEE ATTACHED-EXAMPLE "A"

The present center section above the tank would be cut off and a fabricated slot section be installed in its place. The end view would look like this.

SEE ATTACHED-EXAMPLE "B"

To reduce the mist to large droplets, tower scrubber type balls can be installed as per drawing. This would prevent mist from collecting and drying on the duct walls.

SEE ATTACHED-EXAMPLE "C"

The large drops would fall to the bottom of the duct and run to the drain holes into the pan. The titanium screens can be fabricated in your shop.

A hard chrome shop should be operated as a closed loop, no chrome waste, no treatment! The employees that attended the school were amazed at how simple and low cost it can be done. Frankly, it makes me sick to see how much money was poured into this installation with such poor results. It could have been done at 1/10th the cost with superior results.

The chrome section is being poorly managed with disastrous results. Hard chrome platers are a special breed of people, because they have to know and do more than any other kind of plater. Their intelligence level and memory recall has to be better. Hard chrome plating involves a series of decisions and many of them are based on previous experience. Put your best people there and leave them there. Quit shifting them around to other departments! A good hard chrome plater is a waste doing anything else. A engineer that has not worked on the tanks for at least six months to a year is not a hard chrome plater and can't know what is or should be happening on the floor. Any books they may have read about the subject in college were obsolete, full of misinformation and seriously lacking in usefull information. If you are going to write up a procedure for a job it should be done with input from the platers. For one instance, they tell me they cause the engineering section to have fits if they run the part at one or two amps more than specified.

The truth is that the part at the beginning of the run, may have 10 sq. inches being plated. Depending on how long it's run and how much treeing occurs this plating area can increase 25%!! When people tell me it's more accurate to plate by amps. than volts it makes me laugh.

I would suggest that in the future if I work on other navy hard chrome installations we use this sequence. First I would visit the installation one or two days and identify and supply the fixes for the problems. Next all of the hard chrome platers would be sent to the school. At that point they should be able to make the conversion themselves if the higher ups don't chicken out. If it is necessary I can come back and make sure it is or was done right.

The first class from Pensacola N.A.R.F. tried to convert a tank but were stopped. From what I could see of their efforts they did an excellent job. There are some experienced hard chrome platers working here. They may not have the answers for every problem but who does? Even I may get stumped once or twice a year. Pay attention to them. There is something wrong when things that break are not fixed 3 months to a year later. Not enough maintenance people or too many gold bricks? Need a list ask the platers.

The micrometers by the tanks are something else! The 1st one I picked up was off .012 and the next had the barrel numbers on the back side. I suppose it's readable if you stand on your head! Job shops usually issue three or five mikes to each plater and they are responsible for them. They are measuring IDs. with a caliper which are usually accurate to ±.003. At least telescoping, snap gages, inside mikes and small hole ball gages should be on hand as they are needed every day.

The hard chrome shop should have some basic tools or the cost of plating goes out of sight. There is a certain amount of cut and try when making anodes and set-ups. The shop must have it's own 10 inch band saw and a drill press. In the industry, platers lead burn their own anodes for the same reason. You wouldn't restrict your tool and die makers to one machine. Hard chrome platers are in the same class it is necessary for them to make their own plating tools.

I see parts being copper and nickel plated under the chrome. These parts when designed and made new had only chrome on the base material. Copper and nickel plating only have a chemical bond, while hard chrome usually has both a mechanical (due to the etch cycle) and chemical bond. The bond of chrome on nickel isn't all that good. It makes me wonder if deviations were obtained and testing was done to permit this. Copper and nickel are not the answer to poor hard chrome plating practices.

When conversion to the reversible rack system is complete you will have too many platers. Each platers output should increase at least 100% so keep an eye on them and keep the best. Hard chrome plating is an absolute necessity to keep aircraft flying, ships sailing, atomic reactors operational. In many applications there is no viable alternative.

I could write a book about whats wrong with the hard chrome shop. To correct everything would mean pull everything out and start over again. Example, the rectifiers are too far away from the tanks. This wastes huge amounts of labor time and the meters don't tell you whats happening in the chrome tank. There is about a 1/2 to 1 volt drop between the tank and the rectifier and this will vary with the load. Whether plating by amps. or volts, this excessive bus bar resistance can change the actual plating rate. To make plating by volts accurate, a meter wire will have to be installed from the tanks main bus bars to the volt meter located at the rectifier.

Even large reversible rack shops use a 55 gallon drum at the end of the tank for rinsing reversible racks. Larger pieces are spray rinsed over the tank. All of the rinse water is returned to the chrome tank. The reversible racks are also spray rinsed in the 55 gallon drum. Filling the drum with fresh water will result in too much water to return to the chrome tank. The only way this system of rinsing will work, in this shop, is to pull the existing rinse tanks as there is too many of them and they are too deep.

Solution temperature regulation is bad in this shop. The temperature control valves are of the proportional type and the hot and cold are overlapping. The chilled water valve should not start to open until 145° F. My experience with this type of valve was not good. They are subject to sticking, short service life and expensive to repair. There is also the possibility they won't open enough to clear condensation out of deep tank coils. On one tank you have a electric temperature controller as an experiment. Experiment no longer as that is the best way to go. Sollenoid valves will also stick open if dirt is trapped between the valve seat. A steam line strainer should be installed before each valve to prevent this. If the plastic balls are removed from the converted tanks, it will not be necessary to use the chillers. Cooling will only be necessary in midsummer and only when the tanks are fully loaded.

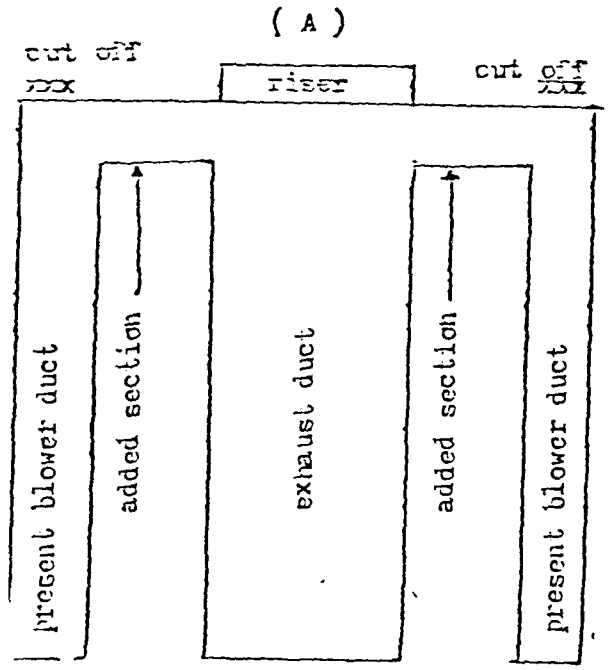
I have been told there is a contract out to rebuild the ventilation system for the whole plating shop. The push pull system is not working properly on any of the other types of plating tanks either, so it should be abandoned. Use double latteral hoods throughout with dampers. Do not try to control air flow by changing slot size.

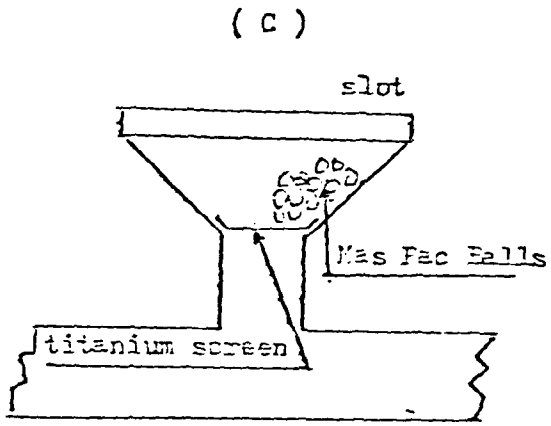
Every mistake in the book was made in the design, layout, and construction of this whole shop, plus many mistakes not in the books. Most of them are now built in and can't be changed. Even the minor ones cost money and add to the cost of doing business every day.

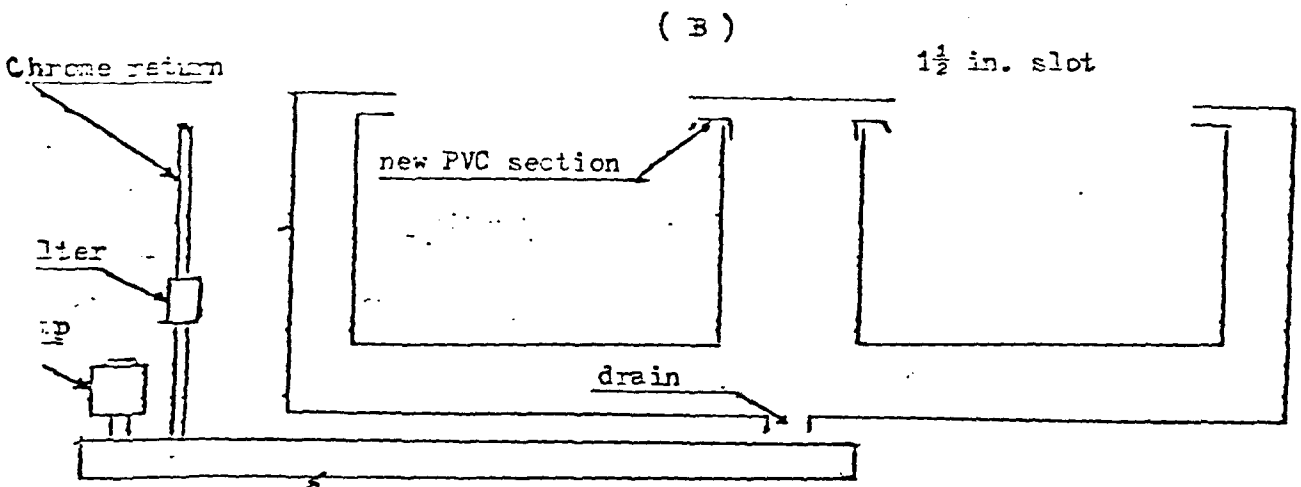
Some of the connecting bus bars are 50' long and the wrong size. For 3,000 amp. rectifiers, three 1/4 x 4 bars should be used not 1/4 x 3. The bars are coated which derates them even more. Because of the large I.R. drop in these bars, it's a wonder the platers have done as good a job as they have.

Stainless steel parts are not being stripped in the electric strip, because it damages them. It's time to throw out the proprietary solution now being used and change over to caustic soda at the rate 10 oz. per gallon of water. This strip is not being run correctly, because no one is responsible for checking it. There should be a strip board with the checking time on it. It should be checked every hour or at most two hour intervals.

Have used a plain caustic soda electric strip for many years without damaging stainless steels or any other type of steel. You can damage them if the caustic concentration falls to less than 6 oz. per gallon. The only way this can happen is that someone puts a hose in the strip tank and runs half of it down the drain. The caustic strip can be checked with a Baume stick to make sure its not too dilute.







top: PVC pan

you have any questions please call.

Clarence H. Pager

Clarence H. Pager

APPENDIX 2.2

INNOVATIVE HARD CHROME PROCESS TECHNICAL BRIEFING

WASHINGTON, D.C.

JUNE 20 & 21, 1985

CONTRACTOR'S REPORT

Presented by:

George C. Cushnie, Jr.
Charles G. Roberts
L. I. Dimmick Corporation
Washington Operations
Herndon, Virginia

OUTLINE OF DISCUSSION

1. Background Information

   a. Previous Research
   b. Navy Hard Chrome Plating Problems
   c. Project Overview

2. Process and Design Information

   a. Conventional Process Sequence/Equipment
   b. IHCP Equipment/Effect on Process Sequence Steps

3. Environmental Impact

   a. Treatment Cost Savings
   b. Air Quality
   c. Lead Exposure

4. Plating Quality

   a. Adhesion
   b. Porosity
   c. Hydrogen Embrittlement

5. Production Rate

   a. Units of Measure
   b. Labor Requirements: Conventional System vs. IHCP
   c. Plating Rates and Plating Times
   d. Grinding Requirements

6. Rinse Quality

   a. Units of Measure
   b. Test Procedure
   c. Test Results and Interpretation

7. Power Considerations

   a. Voltage Sensitivity
   b. Voltage and Anode Spacing
   c. Current Draw and Limitations
   d. Power Consumption

8. Human Factors

   a. Willingness/Ability
   b. Training

Pretreatment Standards for Existing Sources(PSES) - Electroplating Category

Pollutants	Plants Discharging >10,000 gal/d		Plants Discharging <10,000 gal/d	
	Daily Maximum (mg/l)	4-Day Average (mg/l)	Daily Maximum (mg/l)	4-Day Average (mg/l)
Cadmium	1.2	0.7	1.2	0.7
Chromium (T)	7.0	4.0	NR	NR
Copper	4.5	2.7	NR	NR
Nickel	4.1	2.6	NR	NR
Lead	0.6	0.4	0.6	0.4
Silver	1.2	0.7	NR	NR
Zinc	4.2	2.6	NR	NR
Total Metals (Cr,Cu,Zn)	10.5	6.8	NR	NR
Cyanide	1.9*	1.0*	5.0**	2.7**
Total Toxic Organics (TTO)	4.57	NR	2.13	NR

NR=Not regulated
*Total cyanide
**Cyanide amenable to chlorination
Note: Compliance date for TTO is July 15, 1986. Compliance dates for metals and cyanide are April 27, 1984 for non-integrated facilities and June 30, 1984 for integrated facilities.

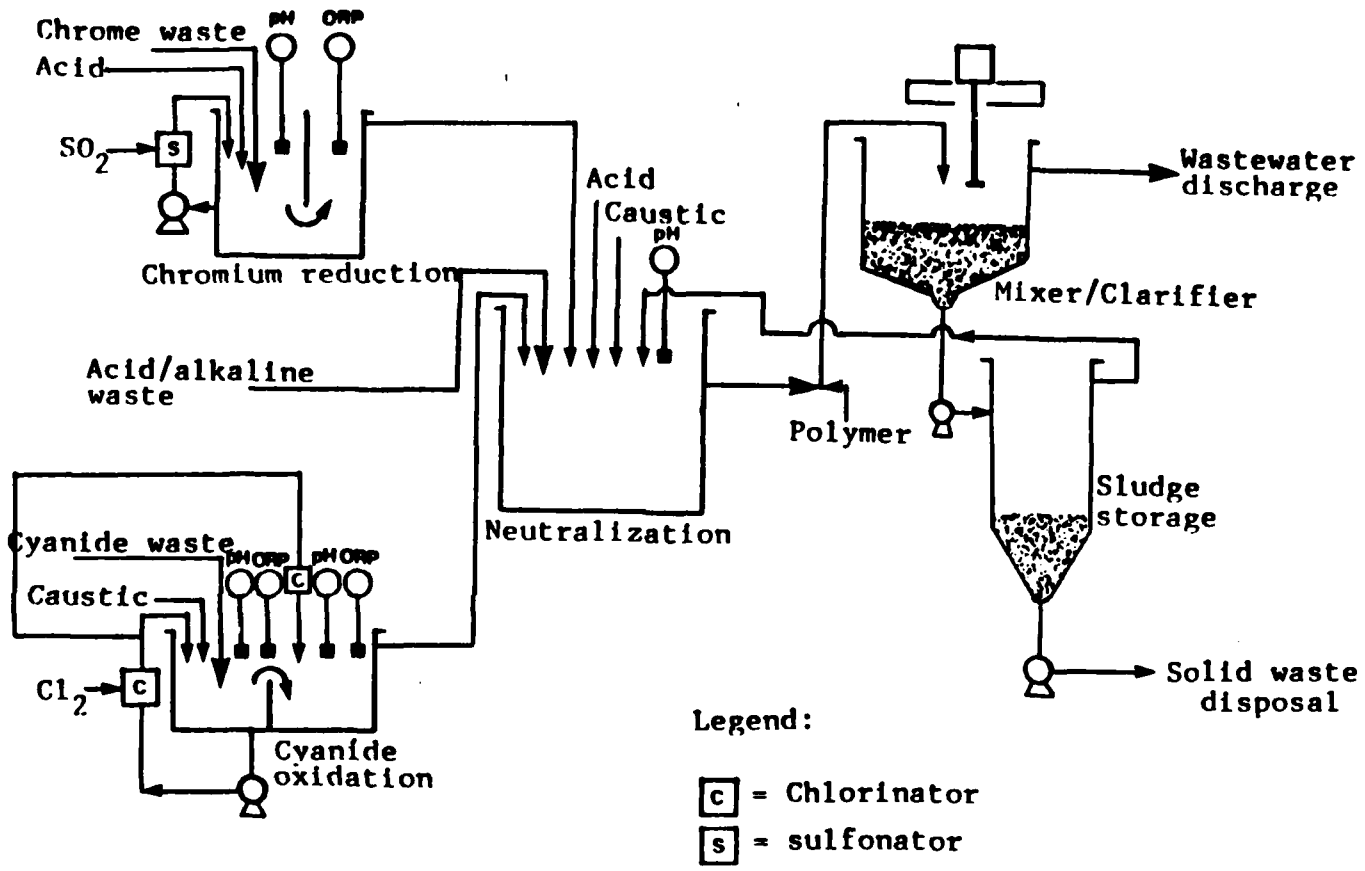


Diagram of a Conventional Treatment System for Metal Finishing Wastewaters

Pretreatment Standards for the Metal Finishing Category

Pollutants	Daily Average (mg/l)	Monthly Maximum (mg/l)
Cadmium	0.69	0.26
Chromium (T)	2.77	1.71
Copper	3.38	2.07
Nickel	3.98	2.38
Lead	0.69	0.43
Silver	0.43	0.24
Zinc	2.61	1.48
Cyanide (T)	1.20	0.65
Total Toxic Organics (TTO)		
Interim	4.57	NR
Final	2.13	NR

NR=Not regulated
Note: Compliance date for interim TTO is June 30, 1984.
Compliance date for metals, cyanide and final TTO is February 15, 1986.

RCRA Hazardous Wastes Generated by Naval Electroplating Operations

EPA Hazardous Waste Number	EPA Description of Waste	Description of Generation from Navy Hard Chrome Plating Operations
F006	Wastewater treatment sludges from electroplating operations	Dragout, spills, etc. of plating solution are combined with rinsewater. At the IWTP the rinsewater is treated by chemical precipitation to remove metal salts. A metal hydroxide sludge is formed from the precipitation process
F007	Spent plating bath solutions from electroplating operations	Often chrome plating baths become unusable due to a build-up of inorganic impurities. Many Navy activities discard such solutions.
F008	Plating bath sludges from the bottom of plating baths from electroplating operations	Impurities and electroplating by-products settle in the plating tank and accumulate as sludge. Periodic filtering is required to remove the sludge.
F009	Spent stripping and cleaning bath solutions from electroplating operations	Stripping and cleaning solutions have a limited life and are discarded after they become unusable.

Projected Wastewater Treatment Savings from IHCP

at Louisville NOC

Summary

Investment Savings: $32,500
O&M Savings: $50,600 per year

Investment Cost Savings

1. The chrome wastewater flow rate from the Louisville plating shop is approximately 30 gpm or about one fifth of the total flow. The hard chrome area accounts for approximately two-thirds of the chrome flow. Two rinse tanks are used in the hard chrome area each having a flow rate of approximately 10 gpm.

2. From Reference 8 the capital cost of a 30 gpm chromium reduction unit is $70,000 (updated to 1985 costs).

3. The installation of the ZDR reduced the flow rate 95% on the installed rinse tank. Assuming the same reduction for the other tank the chrome flow would be reduced to 15,840 gpd or 11 gpm.

4. From Reference 8 the capital cost of a 11 gpm chrome reduction unit is $37,500.

5. The treatment system investment savings is therefore $32,500. This does not include savings for building space.

O&M Cost Savings

1. Using costs from Pensacola NARF, the cost of treating chrome bearing wastewater is $5.37 per 1000 gal.

2. Annual maintenance costs for waste treatment systems are typically 20% of investment costs.

3. At 30 gpm the cost of treatment is $69,595 and maintenance is $14,000 for a total O&M cost of $83,595.

4. Using the IHCP system (11 gpm) the treatment cost would be $25,518 and the maintenance cost $7,500 for a total O&M cost of $33,018.

5. The annual O&M savings with the IHCP rinse is $50,577.

Quality of Air: Comparison of Phases I and II

Sample Point	Average Chromic Acid Concentration Micrograms/Liter of Air		Percent Change, %
	Phase I	Phase II	
1	0.045	0.08	+ 77.8
2	0.105	0.45	+328
3	0.06	0.045	- 25.0
4	0.07	0.35	+400
5	0.20	0.33	+ 65.0
	Conventional	IHCP	

PLATING QUALITY TEST RESULTS

Process	Thickness (inches)	Hardness (KHN)	Adhesion	Porosity	Embrittlement Relief
Conv. (5 hr)	.0002 to .0005	945 to 1015	Pass	Fail	Pass
IHCP (5 hr)	.0076 to .0103	1100 to 1215	Pass	Pass	Pass
Conv. (30 hr)	.0039 to .0056	905 to 945	Fail	Pass	----

APPENDIX

3.0 Manufacturers' Literature

3.1 Innova, Inc.

Catnapper - 10
ChromeNapper

3.2 Pfaudler Co.

Electrolytic Purification Cell

APPENDIX 3.1

INNOVA, INC.

Engineered Production Systems Environmental Sciences

August 22, 1985

RECEIVED AUG 2 6 1985

Mr. Brian Higgins
Peer Consultants
1160 Rockville Pike
Suite 502
Rockville, MD 20852

Dear Brian:

Thank you for your call yesterday expressing an interest in our company and product line. Enclosed are thirty each brochures pertaining to both the CatNapper™ and ChromeNapper™ systems. I have also included a write-up on our new copper recovery system which may be of some interest.

The following general rundown should give you a better understanding of the implementation and operation of the systems.

For the past six years, ChromeNapper™ systems have been well-received and successfully implemented in a variety of applications to completely treat chromic acid rinse waters generated by plating wastes.

The advantages of the ChromeNapper are both economic and environmental in nature:

1. Enables completely closed-loop rinsing techniques, therefore:

   a. Greatly reduces water use consumption. The only water used is what needs to be added to make up for evaporation.

   b. No hauling and normally associated disposal costs.

   c. No sewer charges.

2. Since all chrome that is not plated out on parts is recovered, raw chrome consumption will be reduced. Factors as high as 90% are typical.

5170 - 126th Avenue North ● Clearwater, Florida 33520 ● Telephone (813) 577-3888

3. Very little energy is required to operate the ChromeNapper. The costs incurred in recovering the chromic acid to return to the plating bath are comparable to the original cost of the chrome.

4. Hydraulically inert membrane assures no plugging or fouling problems.

5. No additional labor is required. The system is designed to be maintenance-free and is self-regulating.

With the system offering these advantages, platers in the past have reduced operating costs and significantly increased their savings to achieve typical amortization schedules of 8-14 months, depending upon the size and operating volume. Furthermore, Innova guarantees the ChromeNapper from manufacturing defects for two years. The system utilizes no chemicals, resins, or thin membranes, and can be scaled to fit any size of plating operation.

Another product Innova has specifically developed for the electroplating industry is the CatNapper™. The CatNapper removes cation impurities from the plating bath, thereby extending the life of the bath and eliminating the need to increase future chrome concentration or increase plating voltages. Like the ChromeNapper, the CatNapper uses no chemicals and also operates automatically, requiring no technically trained personnel or constant attention.

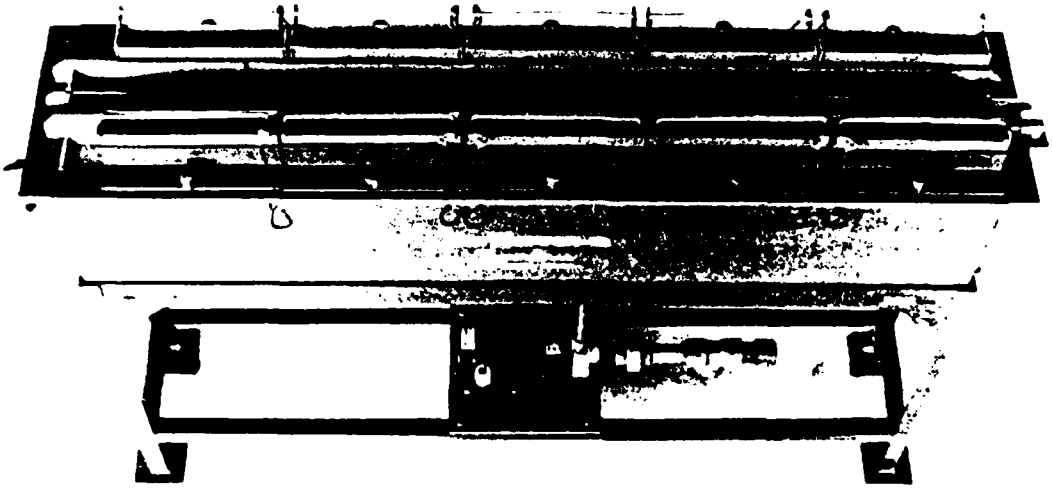
Thanks again for your interest. If I can be of any further assistance, please do not hesitate to contact me.

Yours truly,

INNOVA TECHNOLOGY, INC.

Ted Nohren
Director of Marketing

TN/clm
Enclosure: ChromeNapper/CatNapper Brochures
Copper Recovery System Leaflet



Hexchrome plating bath stabilization through removal of cation impurities.

Reduced Plating Costs

The CatNapper-10™ by Innova Technology Sales, Inc. reduces plating costs for hard chrome platers and for decorative chrome platers who have rapid cation build-up, by removing impurities such as iron, copper and chrome III from Hexchrome plating baths. Removing these impurities reduces costs in two ways:

(1) It extends the life of the bath, reducing disposal and replacement costs.
(2) As the CatNapper™-10 limits the concentration level of the cation impurities in the bath, there is no need to increase the chrome concentration or to increase plating voltages.

This can mean large savings, especially in those applications where plating baths are used until the cations reach high concentrations.

Reduced Plating Worries

The CatNapper™-10 uses no chemicals, eliminating any worries about contaminating the bath. It also operates automatically, requiring no technically trained personnel or constant attention. And, since the rate of cation removal increases as the concentration of cation impurities in the bath increases, the CatNapper™-10 brings the bath to a point where there is a balance between cation introduction to the bath and removal from the bath -- achieving a stabilization within acceptable cation levels. Additionally, the CatNapper™-10 also will oxidize trivalent chrome to hexavalent chrome.

Simple Installation

The CatNapper™-10 recirculates solution directly from the plating bath, requires no plumbing other than the piping to and from the bath, and uses only a 2' x 6' floor space. The only other installation requirements are a 220v, single phase, 15 amp electrical source for the rectifier and one 110v outlet for the pump.

Minimal Operating & Maintenance Requirements

The only routine operating procedure the CatNapper™-10 requires is to lift out the cathodes, scrape off the easily removed cation precipitates, and replace the cathodes. The dense form of the removed deposits results in an insignificant amount of waste, typically amounting to one-tenth of a cubic foot per week. The frequency of cleaning depends on the rate the cation impurities are introduced into the bath, but for most applications the cleaning should not require more than 30 minutes per week. Alternatively the cathodes may be cleaned in muriatic acid.

Design

The CatNapper™-10 uses a specially designed membrane in conjunction with electromigration principles to remove cation impurities found in chrome plating baths. The unit is designed for maximum bath operating temperatures of 140°F. and up to 50 oz./gal. CrO_3.

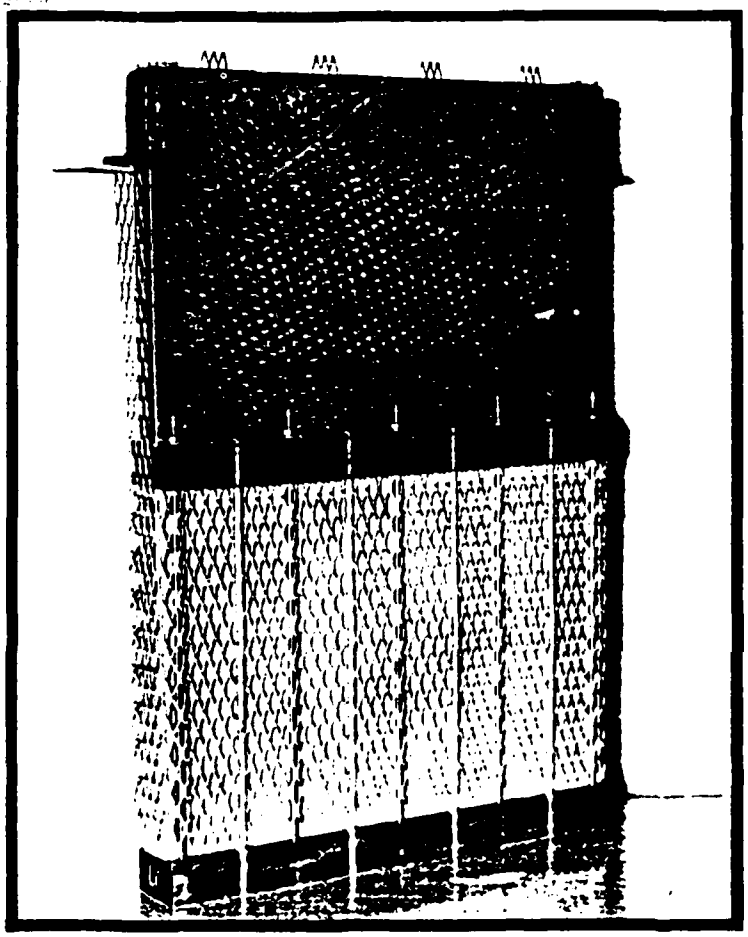
Minimal Operating Costs

The CatNapper™-10 does its work in a cost-efficient manner. In a typical application, the CatNapper™-10 uses 80amps at 7v D.C., and uses no other chemicals or supplies, needs minimal operator time, maintaining a stabilized plating bath at low costs.

INNOVA TECHNOLOGY
5170 126TH AVENUE NORTH
CLEARWATER, FLORIDA 33520
(813) 577-3888

The ChromeNapper™

Now . . . a truly economical chromium plating waste treatment system.



Ideal for:

Decorative Platers . . . both large and small

Hard Chrome Platers . . . can operate on single rinse or common sump

Fume Scrubbers . . . recovers only the bath ingredients — leaves impurities behind

This new ion transfer membrane is the keystone of Innova's advanced recovery technology.

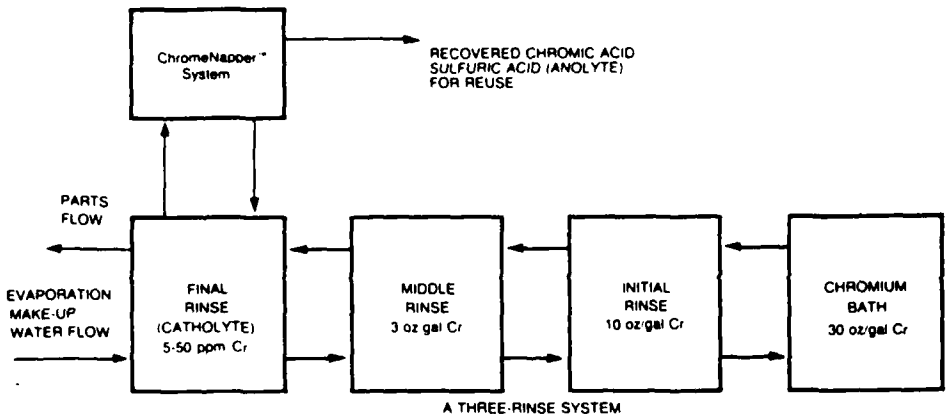
This innovative chromate recovery technology provides a completely closed-loop system for recovering hexavalent chromium and recycling rinse water. The Innova system, which we have named ChromeNapper™, eliminates normal discharge; so you'll save money on the chrome previously lost, while avoiding the normal compliance requirements of the new EPA regulations on waste discharge.

The ChromeNapper™ System is based on a newly developed, patented modular membrane which represents a dramatic breakthrough in the state-of-the-art for rinse water treatment. By permitting ionic transfer (not exchange), and the concentration and recovery of chromate and sulfate out of the rinse waters, the plating chemicals are regained and may be reintroduced into the plating bath. During the treatment process, trace impurities such as iron, chrome III and other cation impurities are precipitated for easy removal.

This advanced new system utilizes no chemicals, resins or thin films; as a result, the usual complications and fouling associated with membrane technology do not occur. The only essential operating cost is minimal electric power, which allows for the chrome to be recovered at values equal to approximately twice the cost of expended electricity, depending on operating variations.

The ChromeNapper™ System can be scaled to fit any size plating operation because of the modular nature of the membranes. The system cost represents complete installation, and includes any necessary ancillary equipment such as power supply, pumps and air blowers. The plater's only requirement is power outlets — and the desire to find a simple solution to the discharge problem.

INNOVA Over a decade in developing high technology.



Typical integration of the ChromeNapper™ System in a three-rinse operation.

Advantages of the ChromeNapper™ System.

COMPLETELY ELECTROLYTIC

ChromeNapper™ is a simple electrolytic concept requiring only 15-25 volts to operate.

RECOVERY OF PLATING CHEMICALS

Chromic acid can be recovered and concentrated for reuse in the plating bath (typically 10-15 oz/gal Cr).

RECIRCULATION OF RINSE WATER

A constant level of rinse water purity is maintained, requiring only the addition of water to make up for ordinary evaporation. The closed-loop system permits substantial savings in sewerage, water use and surcharges. If required, it can be adapted to deionize make-up water, further enhancing rinse purity.

ELIMINATION OF WASTE TREATMENT CHEMICALS

Since no chemicals, resins or pH controls are needed, the ChromeNapper™ System eliminates the highest single waste treatment cost facing the plater today if chemical destruction is used.

NO SLUDGE REMOVAL

By recovering the hexavalent chromium (and other desirable anions), the ChromeNapper™ System virtually eliminates the substantial costs of sludge removal and disposal. The only possible disposal requirement may be the periodic removal of small quantities of precipitated trace metals.

NO OPERATORS

The system runs by itself continually, with no skilled labor or analyses required. Just integrate the system, plug it in and let it run.

LONG MEMBRANE LIFE

The ChromeNapper™ membranes are sturdy, durable barriers and possess a minimum life of at least two years with virtually no maintenance. Other membrane technologies can last only a fraction of that time, even with practically continuous attention. The ChromeNapper™ is provided with a two-year performance warranty when operating under normal service conditions. No other technology will guarantee that in chromic acid applications.

NO MEMBRANE FOULING OR PLUGGING

The membranes do not significantly foul or plug, regardless of the presence of organics. They are essentially impermeable barriers which permit only ions to pass through along with small amounts of bound water. No filtration is necessary.

COST EFFECTIVE EVEN FOR THE SMALL PLATER, WHILE ADAPTIVE TO LARGE REQUIREMENTS AS WELL

The smaller the plating operation, the fewer membranes required. The tankage is standard 2'x4', allowing for up to 8 membranes a tank. The smaller plater uses less than tank capacity, which allows for future growth. The larger plater couples multiple, modular tanks to solve his rinse treatment requirements.

MINIMUM FLOOR SPACE NEEDED

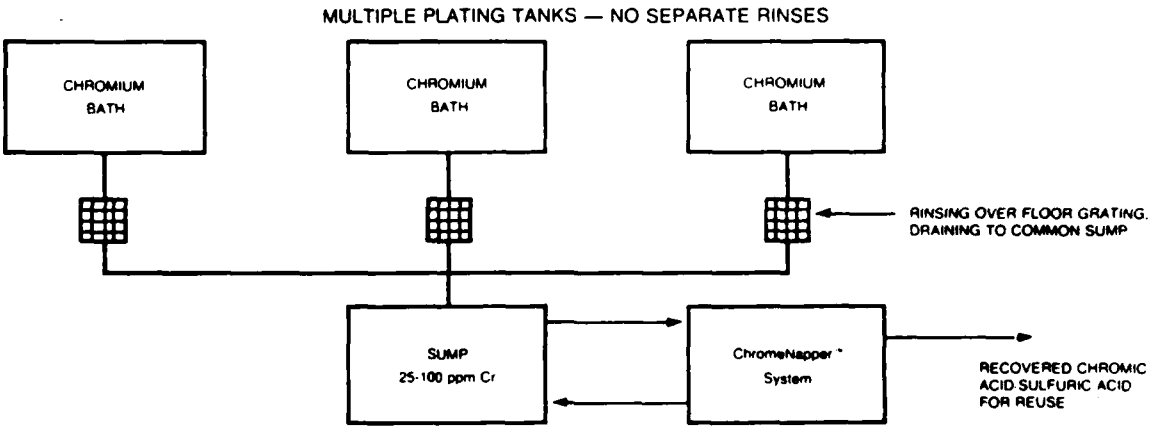
Each system is custom engineered from standard modules for the individual plater. Utilizing the 2'x4' tanks in a configuration best suited to available space, the average plater will require from 16 to 32 square feet of floor space for the ChromeNapper™ unit, complete with power supply and ancillary equipment.

Good news for hard chrome platers.

Innova's affordable recovery system can eliminate your chromium discharge.

The ChromeNapper™ can operate easily and effectively on a single rinse as well as on multiple rinses. Or it can operate on a common sump which receives the chromium rinse waste from any number of floor drains.

Typical ChromeNapper™ installation in a hard chrome plating operation.



ChromeNapper™ removes and concentrates bath ingredients from the sump, thus eliminating discharge.

Advantages of the ChromeNapper™ for the hard chrome plater.

BENEFITS FROM HIGHER PLATING TEMPERATURES

Most hard chrome plating occurs in bath temperatures of 130-140° F, thus causing substantial evaporation. Rinsing of parts over the plating bath to make up for evaporation reduces actual chrome dragout. And the smaller the amount of dragout, the fewer the number of ChromeNapper™ cells required to recover chromic acid, along with sulfuric acid and fluorides, if present.

CAN WORK ON SINGLE RINSE OR SUMP

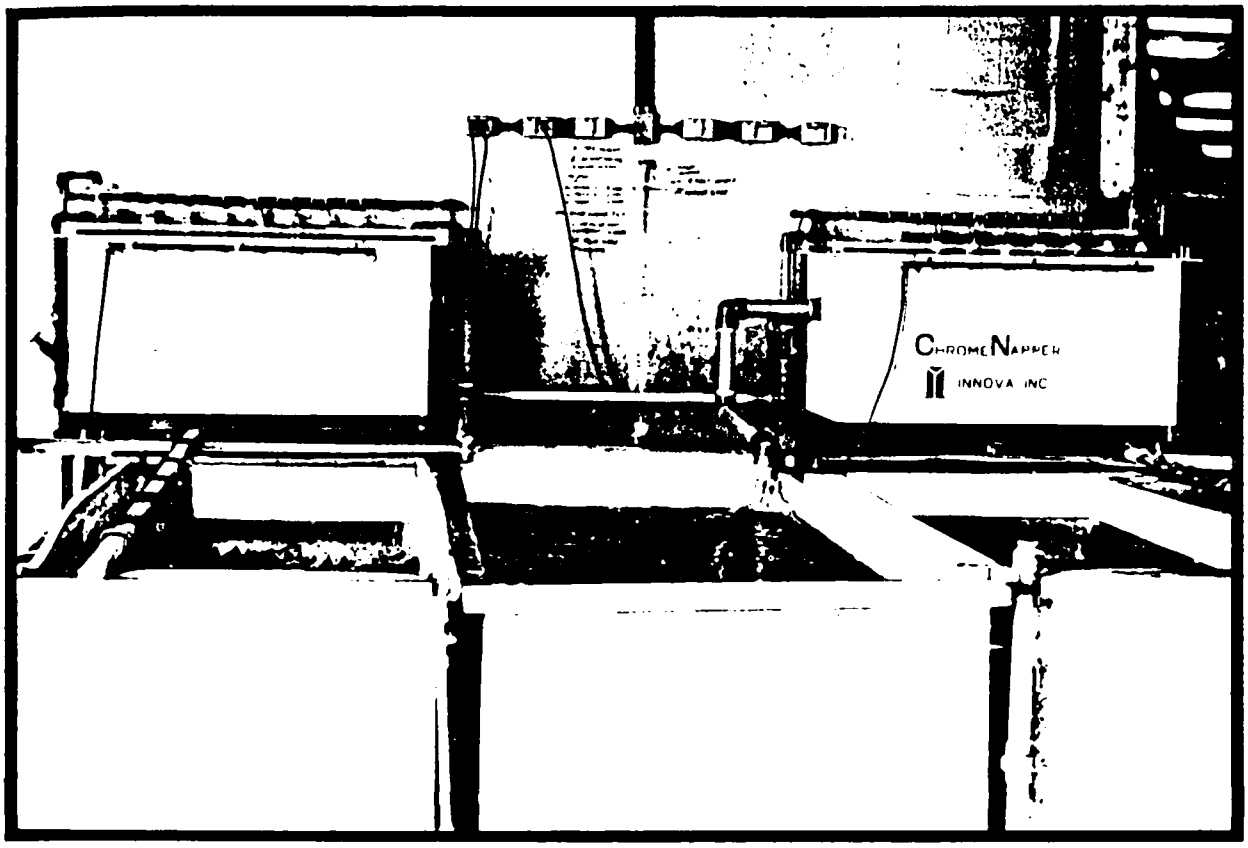
The ChromeNapper™ can operate in very dilute solutions and still concentrate to 10-15 oz/gal. Consequently, it can recover the chrome as it is dragged into the rinse or flows to a sump, and keep the rinse or sump clean enough for closed-loop rinsing. By keeping the rinse or sump clean enough for rinsing (typically 25-100 ppm Cr), the ChromeNapper™ eliminates the need for discharge.

SUBSTANTIALLY REDUCES WATER USAGE

The ChromeNapper™ can elminate the loss of thousands of gallons of water a day with its closed-loop integration. With ever-increasing sewer use surcharges, water savings are an additional economic benefit which will become more and more important.

CAN RECOVER AND PURIFY CHROMIC ACID BATH PREVIOUSLY LOST THROUGH FUME SCRUBBING

Scrubbing solution can be fed by the rinse system or sump, if desirable. Closed-loop recovery eliminates fume scrubber discharge, reducing the waste of chromium and the loss of large volumes of water. Since the ChromeNapper™ recovers only the bath ingredients, it leaves behind any impurities or suspended solids, preventing them from being continually returned to the bath. If substantial chrome losses occur through scrubbing, it may be desirable to have two separate ChromeNappers™, one for the rinses or sump, the other to work only on the fume scrubber.



Rinse water from tank, center foreground, is circulated to the two ChromeNapper™ units, background, which recover chromic acid and sulfuric acid for reuse in plating bath

NEW INNOVA PROCESSES

While the chromium recovery system is the first to be put into commercial use, Innova is adapting the same technology for the treatment and recovery of nickel and other metals from their respective rinses as well as for bath and etchant reclamation. We will soon have available a cation bath purficiation system, and we also have an electrolytic cyanide destruction system under development.

INNOVA
TECHNOLOGY, INC.
5170 126th Avenue North • Clearwater, Florida 33520 • 813/577-3888

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INNOVA TECHNOLOGY, INC.

METAL RECOVERY SYSTEMS FOR COPPER, ZINC AND CADMIUM

The various metals are removed by electrodeposition. In the absence of evaporation, the system generally consists of two cells, the first one operating on the dragout and the second cell operating on a subsequent rinse solution. The mode of operation lends itself to optimization in terms of system size (cost), quantity of material removed and ultimate effluent concentration. Closed loop operation is normally not achieveable without evaporation because of a build-up of inerts in the various rinse tanks. Destruction of cyanides must be accomplished in the normal manner after removal of the metal ions.

The electrodeposition system is of novel design in that it permits operation at low current densities on the cathode without the use of graphite fiber electrodes. In other words, cathode/anode surface area is maximized to permit effective removal without a prohibitive cost due to expensive stable anodes for oxygen evolution. The cathode is basically a screen or expanded metal for amminous structure.

Special designs at marginally higher cost are available for operation on chloride containing solutions. Chloride in acidic solutions are responsible for chlorine evolution, generally resulting in very low efficiencies, corrosion problems and health hazards. These problems are significant when removing large quantities or higher chloride levels. ITI's design inherently prevents chlorine evolution at all concentrations. Thus, the efficiency is inherently high, corrosion problems are eliminated and health hazards are non-existent. This provides substantial advantage over some competitive systems. Other approaches are to effect continuous neutralization of the solution from which the plating occurs.

Removed metals may be recycled. Whether or not this is worthwhile depends upon the specific circumstance.

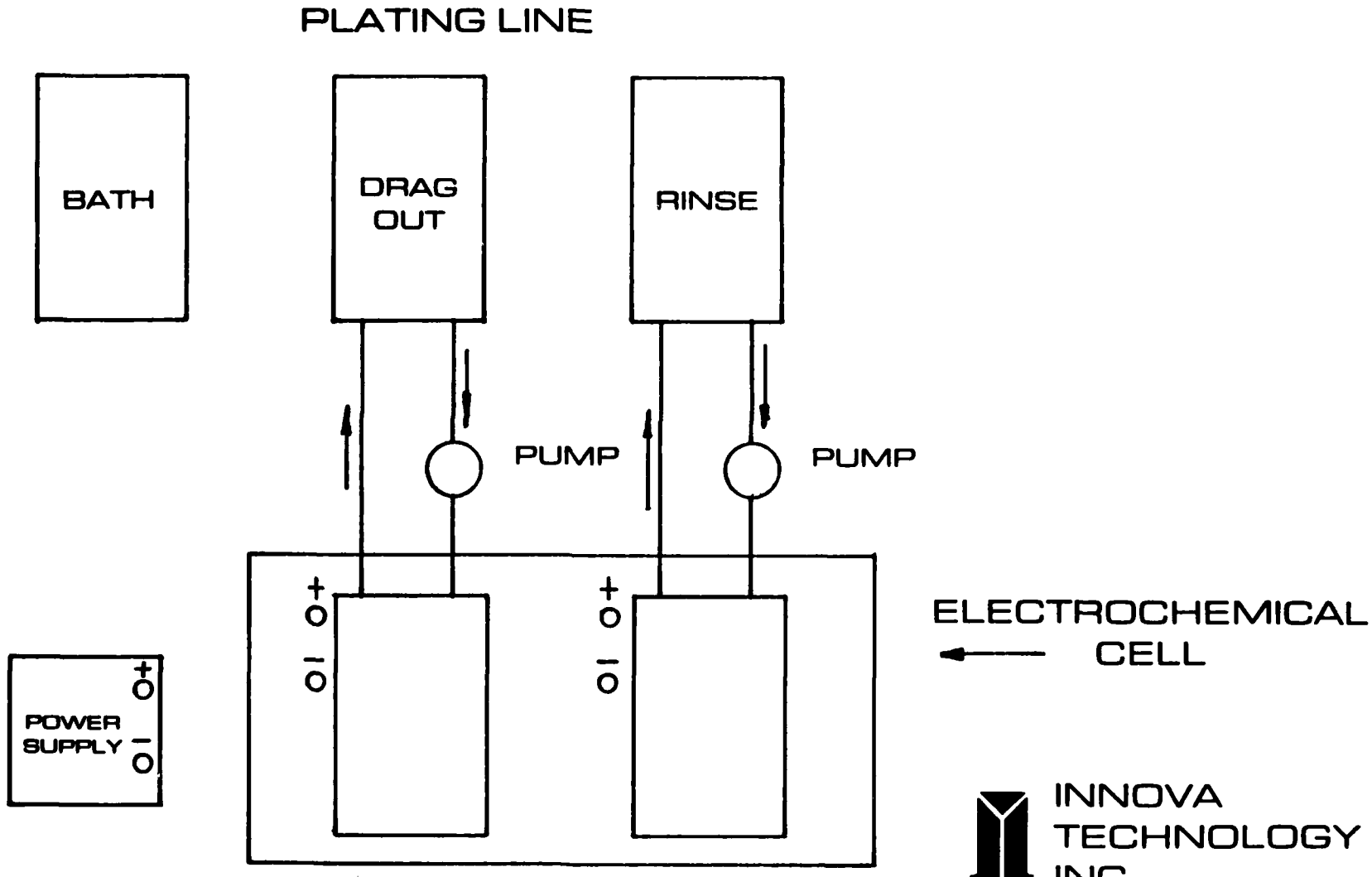
Systems designed by Innova Technology, Inc. (ITI) may be used independently or in conjunction with ambient temperature evaporation. The evaporative part permits direct return of a portion of the plating chemicals to the bath, thereby conserving chemicals and reducing pollution problems. The extent to which evaporation is used depends upon the temperature of the operating bath, the volume of dragout and the concentration of the bath.

The use of evaporation combined with electrodeposition permits optimization of capital and operating costs. In some instances, i.e., with ambient temperature baths, use of low temperature evaporation is not effective. In that instance, removal by electrodeposition is used to remove all the metal ions.

ITI develops an optimum configuration for each application. In this manner, we attempt to meet the needs of the customer in terms of both operating and capital costs.

5170 - 126th Avenue North ● Clearwater, Florida 33520 ● Telephone (813) 577-3888

METAL REMOVAL SYSTEMS
GENERAL LAYOUT



INNOVA TECHNOLOGY INC.

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Electrolytic Purification Cell

Data Sheet DS35-300-1

APPENDIX 3.2

Purifies chrome plating or chrome etch solutions

The buildup of contaminants in chromic acid plating solutions and chromic acid etch solutions affects their efficiency and in many instances limits their service life. Recovery and recycle of drag-out accelerates the buildup of impurities and requires their removal in order to be viable.

In chrome plating solutions, the principal contaminants to be controlled are the cations, such as iron, nickel, copper and trivalent chromium. For chrome plastic-etch solutions, the primary need is to regenerate the trivalent chromium to the hexavalent state.

Money-saving advantages

The Pfaudler® Electrolytic Purification Cell uses ceramic cells and proven technology to purify and/or regenerate the chromic acid solution, which is circulated continuously through the EP cell from the process (plating or etch) tank. The EP cell can supplement a recovery system by extending the useful life of the recovered process solution. In realistic terms, it cuts costs and helps you save money in several ways:

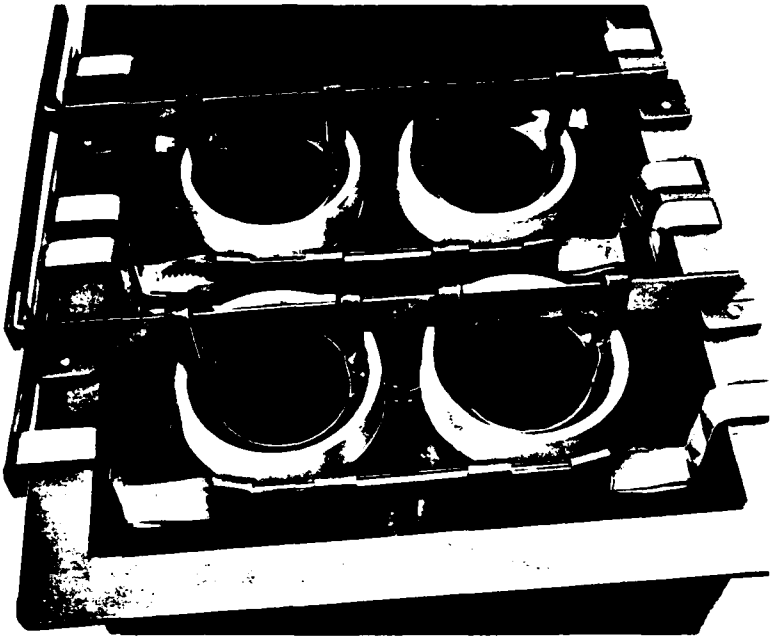
- Purifies/regenerates chromic acid solutions, plating or etching.
- Provides continuous removal of metallic impurities and/or reoxidizes trivalent chromium to hexavalent state.
- Improves efficiency of solution, reduces product reject rate.
- Reduces sludge formation and disposal costs.
- Independent closed-loop operation around the chromic acid plating or etch tank.

Using the Pfaudler Electrolytic Purification Cell

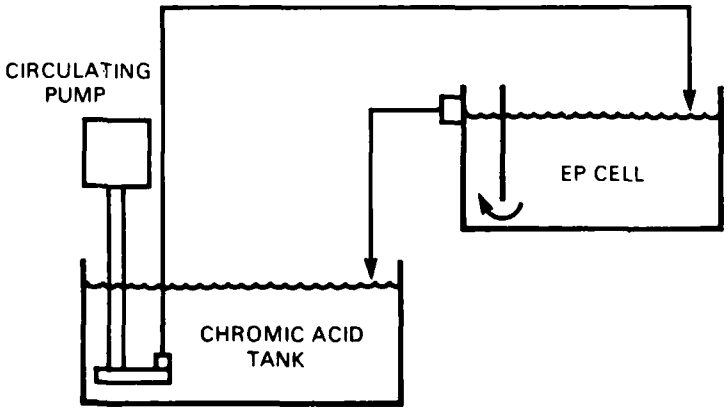
The EP cell employs a set of cylindrical, unglazed ceramic cells holding electrolyte and a cathode, sandwiched between a pair of external anodes. Each pair of cells, regardless of number, are connected in parallel.

The size of the tank and the number of cells required are based on the size of the process tank and the level of contaminants to be removed from the process solution. Standard sizes are given in the table on the next page.

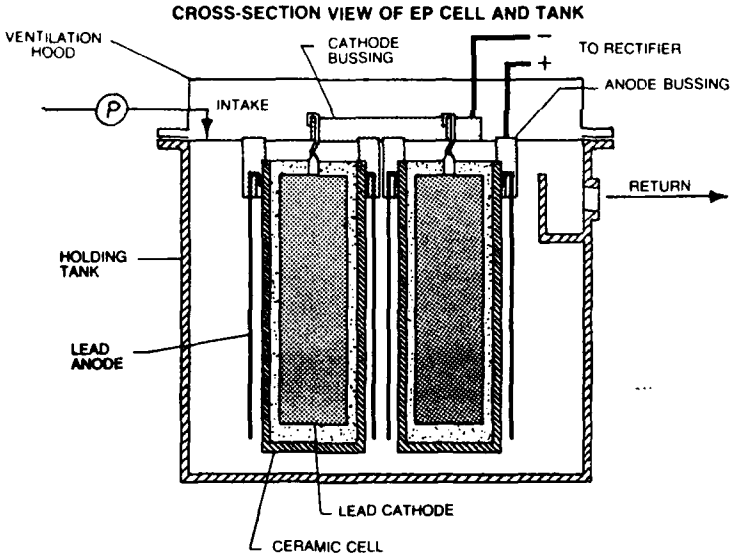
In use, the circulating pump is mounted in the plating or etch tank. The EP cell is installed at a height that allows gravity return of the regenerated chromic acid solution to the process tank. This is a continuous circulation of the solution and the cell can be operated 24 hours a day, 7 days a week.



The Pfaudler Electrolytic Purification Cell is available with or without the required DC rectifier. Either version is shipped as a complete package, ready for installation.



CROSS-SECTION VIEW OF EP CELL AND TANK



Tank Size and Cell Count

Standard Tank Size (inches)	No. of Ceramic Cells
24 x 36 x 30	2-4
24 x 48 x 30	4-6
24 x 60 x 30	6-8
24 x 72 x 30	8-10
24 x 98 x 30	10-12

Standard Components of EP Cell

- PVC-lined steel tank
- Lead-tin alloy anodes and cathodes
- Titanium-clad copper bus bars
- CPVC circulating pump
- Porous ceramic cells
- PVC vent hood

Optional Equipment

- Air or water-cooled DC rectifier with tap switch control
- Titanium-lined steel tank
- PVDF circulating pump for etch solution
- Dolly stand

Operating Parameters

Chromic Acid Plating Solution	
Ceramic cell solution	Same as process solution, without sulfate.*
Voltage	6 to 8 volts
Current density	200 amps/cell
Circulating solution rate	10 to 15 gpm

Chromic Acid Etch Solution	
Ceramic cell solution	32 oz/gal chromic acid
Voltage	6 to 8 volts
Current density	200 amps/cell
Circulating solution rate	5 to 7 gpm

*Spent solution is replaced periodically when cells are cleaned.

The information, recommendations, and opinions set forth herein are offered solely for your consideration, inquiry and verification and are not, in part or total, to be construed as constituting a warranty or representation for which we assume legal responsibility. Nothing contained herein is to be interpreted as authorization to practice a patented invention without a license.

Ask your plating equipment supplier for more information about the Pfaudler Electrolytic Purification Cell.

Or, contact:
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