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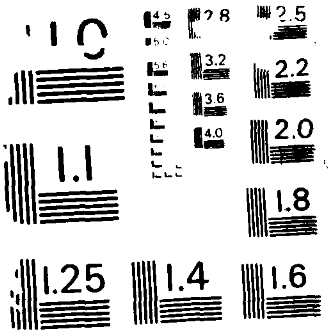

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DEPARTMENT OF THE AIR FORCE
UNITED STATES OF AMERICA
MCMXLVII

Waste Minimization Program
Air Force Plant 4

Prepared for:

U.S. Air Force System Command
Aeronautical Systems Division/PMD
Wright-Patterson, AFB, OH 45433

Contract -F09603-84-G-1462-SC01

The Earth Technology
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This report presents the findings of an assessment of hazardous waste minimization opportunities at Air Force Plant 4. This assessment was based upon a site investigation at the manufacturing plant, disucssions with operators and subsequent analyses. Recommendations are made regarding methods to reduce the volume of hazardous waste disposed.

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Waste Minimization Program

Air Force Plant 4

Prepared for:

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The Earth Technology Corporation
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This report was prepared by the Earth Technology Corporation under Contract Number F09603-84-G-1462-SC01 for the AFSC, Aeronautical Systems Division (ASD/PMD). Mr. Charles H. Alford was the Project Officer for ASD/PMD. Mr. Richard R. Pannell was Program Manager and Mr. Brian J. Burgher, P.E., Mr. Douglas Hazelwood and Mr. Eric Hillenbrand were principal investigators for The Earth Technology Corporation.

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1.0 INTRODUCTION

This report presents the findings of an assessment of waste minimization opportunities at Air Force Plant 4 in Ft. Worth, Texas. It is part of the Waste Minimization Program being conducted by the Air Force Systems Command, Aeronautical Systems Division/Facilities Management Division (ASD/PMD) for eight (8) Government-Owned, Contractor-Operated (GOCO) facilities to promote prudent waste management by exploiting opportunities to reduce costs and conserve resources.

A project team completed a site investigation of General Dynamics operations during the week of July 22-26, 1985 to review facility operations and discuss opportunities for waste reduction with plant engineering staffs. Based upon this investigation and subsequent analyses, this report presents the status of current waste generation and minimization programs and recommends other potential methods for reducing current waste volumes. Tables of waste volumes before and after minimization have been prepared to provide an indication of planned and projected waste reduction through system modifications. Finally, recommendations for implementation of opportunities which could further reduce waste generation and disposal are provided.

1.1 BACKGROUND

Interest in waste minimization has long been promoted by Federal legislation, such as the Federal Water Pollution Control Act Amendments of 1972, the Energy Policy and Conservation Act of 1975 and the Used Oil Recycling Act as well as DOD directives such as AFR 78-22 and DODD 19-14. More recently, the impetus for waste minimization has become even stronger. The reauthorization of RCRA includes bans on landfilling of certain waste types and a requirement for certification that waste minimization is being conducted by hazardous waste generators. Similarly, DOD has issued directives requiring zero land disposal of solvents by October, 1986 through its Used Solvent Elimination Program.

ASD/PMD anticipated these developments and initiated programs in 1983 to address these issues. A preliminary identification of resource conservation and recovery activities and opportunities was included in an environmental audit program conducted in 1983 for fifteen (15) facilities. ASD/PMD contracted a further study of resource conservation and recovery opportunities at eleven (11) GOCO facilities in 1984. This effort resulted in a preliminary assessment of opportunities for industrial and non-industrial (i.e., solid or municipal waste streams).

The methodology for this effort relied primarily on data acquired during the environmental audit program conducted in 1983 supplemented with conversations and information exchanges between the study team and GOCO contractor personnel. The results of this investigation were an indication of the areas where resource conservation and recovery opportunities appeared to be most substantial, and the areas where opportunities were not promising. Through application of a consistent methodology, facilities with substantial opportunities and measures, so that opportunities warranting further investigation were identified.

The 1984 study demonstrated that plant operators were implementing methods that could substantially reduce waste generation volumes and raw material requirements to reduce their waste management costs and potential liabilities associated with waste land disposal. However, other opportunities for waste minimization were identified which appeared technologically and economically feasible but were not being implemented.

In light of the findings of these studies and the new certification requirements of RCRA, ASD/PMD is adopting a Waste Minimization Program. This program is promoting prudent waste management by exploiting opportunities to reduce costs and conserve resources. It is intended to establish for ASD/PMD the status of progress in this area, and to demonstrate facility advances in alternative waste management methods. In addition, it is expected that opportunities determined to be infeasible in the past will be identified for possible implementation.

1.2 OBJECTIVES

The ASD/PMD Waste Minimization Program is designed to promote waste management opportunities which reduce the reliance on land disposal by GOCO facilities and which result in increased efficiency in the utilization of resources. As part of this program this study has the following objectives:

1. Define the status of waste generation and existing minimization measures at AFP 4.
2. Support feasible alternatives identified at AFP 4 by General Dynamics.

3. Identify and evaluate new opportunities not being implemented at AFP 4.

4. Stimulate technology transfer between AFP 4 and other Air Force GOCO facilities as well as with other DOD installations.

5. Continue to increase the awareness of the importance of waste minimization.

6. Provide information needed to confidently certify that waste minimization is being employed at AFP 4 to satisfy RCRA requirements and DOD directives.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Air Force Plant 4, located in Fort Worth, Texas is operated by General Dynamics-Fort Worth Division. Operations at AFP 4 cover 556 acres with approximately 6.5 million square feet of building space. General Dynamics currently has approximately 18,600 employees engaged in F-16 production, F-111 repair and spare parts production.

General Dynamics generates significant quantities of wastes as a result of machining, surface preparation, surface coating, testing and maintenance operations. In 1984, General Dynamics generated 12 million pounds of waste requiring off-site disposal or treatment at an approximate cost of $653,000. Recent measures incorporated by General Dynamics have achieved significant reductions in waste generation rates. Additional measures are being investigated and implemented by General Dynamics to further reduce waste generation at AFP 4 and reliance on waste land disposal.

A summary of the conclusions, recommendations and economics resulting from an investigation of waste minimization opportunities at AFP 4 is provided below.

2.1 CONCLUSIONS

This section presents a summary of the waste minimization measures being incorporated by General Dynamics, as well as alternatives being considered as part of waste minimization initiatives at AFP 4 and alternatives requiring further investigation, development or capital resources prior to incorporation. General Dynamics has an active program directed at minimizing waste generation and land disposal where practical and feasible. This program is part of a Corporate Environmental Resource Management program that has as a long term goal zero land disposal of waste from manufacturing operations. This commitment is evidenced by the level of effort being expended by General Dynamics at AFP 4 to investigate alternative waste technologies.

A summary of 1984 waste disposal volumes, currently planned reductions and additional potential reductions being considered by General Dynamics is provided in Table 2-1. A brief description of reduction methods is provided in Table 2-2. An analysis of these data results in the following conclusions:

1. Recent measures have resulted in a four percent reduction in the quantity of waste being sent off-site between 1984 and 1985. General Dynamics has achieved this reductions by instituting on-site

TABLE 2-1
APP 4: GENERAL DYNAMICS
PROJECTED WASTE DISPOSAL

WASTE STREAM	1984 GENERATION (POUNDS)	1984 LAND DISPOSAL (POUNDS)	PROJECTED LAND DISPOSAL W/PLANNED MINIMIZATION(1) (POUNDS)	PROJECTED LAND DISPOSAL W/PROPOSED MINIMIZATION (POUNDS)
1. Machine Coolant Waste	1,910,000(2)	1,910,000	190,000	34,400 (0)[3]
2. Waste Hydraulic Oil	415,000(2)	191,000	191,000	41,500 (0)[3]
3. Waste Motor Oil	203,000(2)	203,000	203,000	77,000
4. Waste JP-4	84,800	0	0	0
5. Paint Sludge	161,000	161,000	161,000	161,000
6. Dry Paint Waste	109,000	109,000	109,000	109,000 (43,400)[3]
7. Miscellaneous Paint Waste	83,600	83,600	83,600	83,600 (33,400)[3]
8. Paint and Thinner Waste	576,000(2)	576,000	444,000	222,000 (0)[3]
9. Degreasing Solvent Waste	239,000(2)	239,000	239,000	239,000
10. Naptha Waste	15,700(2)	15,700	15,700	300 (0)[3]
11. Isopropyl Alcohol Waste	3,920(2)	3,920	3,920	3,920 (0)[3]
12. Turco Cleaner Waste	8,680(2)	8,680	8,680	100
13. Mixed Solvent	563,000(2)	563,000	563,000	282,000 (0)[3]

---

(1) Includes approved and/or funded minimization measures.

(2) Generation rates are 1985 projections. Data were not available for these wastes for 1984.

(3) Figures in parenthesis represent volumes and reduction achievable through on-site hazardous waste incineration.

TABLE 2-1 (Continued)
AFP 4: GENERAL DYNAMICS
PROJECTED WASTE DISPOSAL

WASTE STREAM	1984 GENERATION (POUNDS)	1984 LAND DISPOSAL (POUNDS)	PROJECTED LAND DISPOSAL W/PLANNED MINIMIZATION(1) (POUNDS)	PROJECTED LAND DISPOSAL W/PROPOSED MINIMIZATION (POUNDS)
14. Fiberglass Resin Waste	16,200(2)	16,200	16,200	16,200 (0)[3]
15. Sealant Waste	14,300	14,300	14,300	14,300
16. Spent Caustic Waste	3,060,000	3,060,000	3,060,000	0
17. Mixed Acid Waste	545,000	545,000	0	0
18. Heavy Metal Sludge	1,780,000	1,780,000	1,780,000	4,000,000
19. Cyanide Waste	91,300	0	0	0
20. Mercury Contaminated Waste	100	100	100	100
21. Contaminated Groundwater	4,170,000	4,170,000	4,170,000	0
22. Dirt, Oil and Solvent Waste	224,000	224,000	224,000	224,000 (89,500)[3]
23. Empty Drums	16,800	16,800	16,800	4,670
24. Masking Solvent	512,000(4)	512,000(4)	512,000(4)	25,600(4)
TOTALS	14,802,400	14,402,300	13,715,300	5,323,590 (4,458,670)[3]
% REDUCTION	--	--	5%	63% (69%)[3]

(1) Includes approved and/or funded minimization measures.
(3) Figures in parenthesis represent volumes and reduction achievable through on-site hazardous waste incineration.
(4) Volatile losses are not included in totals.

TABLE 2-2. SUMMARY OF CURRENT, PLANNED AND RECOMMENDED WASTE MANAGEMENT METHODS AT AFP 4

WASTE STREAM	PRESENT METHOD(1)	PLANNED CHANGES(2)	RECOMMENDED CHANGES
1. Machine Coolant Waste	Deep well injection	Improved on-site recycling	1) Further recycling capability improvements 2) Ultrafiltration of wastes 3) Incineration of tramp oil
2. Waste Hydraulic Oil	Off-site recycle and deep well injection	None	1) On-site oil reclamation 2) Increased sales to recyclers
3. Waste Motor Oil	Deep well injection	None	Segregation and off-site recycle
4. Waste JP-4	Off-site recycle	None	Candidate incinerator fuel
5. Paint Sludge	Landfill disposal	None	Evaluate on-site treatment methods
6. Dry Paint Waste	Landfill disposal	None	Potential incineration candidate
7. Miscellaneous Paint Waste	Landfill dispoal	None	Potential incineration candidate
8. Paint and Thinner Waste	Deep well injection	None	1) Evaluate on-site solvent recovery 2) Evaluate sale for off-site recycling
9. Degreasing Solvent Waste	Deep well injection	None	1) On-site recovery 2) Sale to off-site recyclers
10. Naptha Waste	Deep well injection	None	1) On-site recovery 2) Sale to off-site recyclers
11. Isopropyl Alcohol Waste	Deep well injection	None	Potential incineration candidate
12. Turco Cleaner Waste	Deep well injection	None	1) Consider alternate cleaner 2) On-site treatment

(1) "Present Method" listed is as of December 1984.
(2) "Planned Changes" are approved, funded or already implemented measures.

TABLE 2-2. SUMMARY OF CURRENT, PLANNED AND RECOMMENDED WASTE MANAGEMENT METHODS AT AFP 4 (Continued)

WASTE STREAM	PRESENT METHOD(1)	PLANNED CHANGES(2)	RECOMMENDED CHANGES
13. Mixed Solvent Waste	Deep well injection	None	1) Evaluate on-site recovery 2) Evaluate sale for off-site recycling
14. Fiberglass Resin Waste	Deep well injection	None	Potential incineration candidate
15. Waste Sealant	Landfill disposal	None	None
16. Spent Caustic Waste	Deep well injection	On-site neutralization	On-site recovery
17. Mixed Acid Waste	Deep well injection	On-site neturalization	None
18. Heavy Metal Sludge	Landfill disposal	Increase generation from WTP renovation	1) Recover caustic; 2) Treat acids separately 3) Recover chromic acid
19. Cyanide Waste	Off-site CN destruction	Evaluating on-site destruction	Evaluate economics of available alternatives
20. Mercury Contaminated Waste	Landfill disposal	None	None
21. Contaminated Groundwater	Deep well injection	On-site treatment	None
22. Dirt, Oil and Solvent Waste	Landfill disposal	None	Potential incineration candidate
23. Empty Drums	Landfill disposal	None	On-site salvage
24. Masking Solvent	Vapor losses	Evaluate VOC controls	Implement VOC controls

---

(1) "Present Method" listed is as of December 1984.
(2) "Planned Changes" are approved, funded or already implemented measures.

neutralization of 545,000 lb/yr of mixed acids previously disposed off-site through underground injection.

In addition, waste JP-4 and 54 percent of AFP-4 hydraulic oils are currently recycled off-site, further reducing land disposal requirements. Significant reductions in land disposal requirements are also being achieved through the on-site recycling of coolants in the CNC machining area and hydraulic oil purification measures.

2. The following measures planned for implementation have already been approved and/or funded and will result in an additional decrease in waste generation of approximately one percent from 1984 levels:

   - A second centrifuge being added to the CNC coolant system to improve performance is expected to reduce waste generation by 11,400 lb/year.

   - Water-based primers are being substituted for solvent based primers in all F-16 production to achieve a projected waste reduction of 132,500 lb/year.

3. Additional opportunities for minimization of wastes at AFP 4 have been identified which could further reduce generation by 58 to 64 percent. Several of these measures have already been submitted to the Air Force for funding or are in various stages of development by General Dynamics. These opportunities are as follows:

   - Completion of IRP efforts would allow a facility-wide reduction in land disposal rates of almost 30 percent by providing on-site treatment of contaminated groundwater.

   - Collection and centralized recycling of all waste coolants would allow a 90 percent reduction in this waste stream from 1984 levels.

   - On-site hydraulic oil maintenance could achieve a 90 percent reduction in the quantities of oil now sent off-site for disposal or recycling.

   - Segregation of motor oils and hydraulic fluids generated in the servicing of vehicles would allow off-site recycling of 62 percent of the oils contained in these wastes.

- Valuable solvents present in the paint and thinner waste stream could be recovered for reuse through distillation to achieve a 50 percent reduction in this stream.
- Up to 90 percent of discarded degreasing fluids could be recovered for reuse on-site through distillation.
- Virtually all waste naptha could be recovered for reuse through distillation.
- Spent Turco cleaner wastes could potentially be treated on-site in the chromium reduction system.
- An estimated 50 percent of the solvents present in the mixed solvent waste stream could be recovered for reuse through distillation.
- Spent caustic could be regenerated on-site eliminating waste disposal and producing a saleable aluminum product.
- Off-site disposal of cyanide wastes could be reduced 100% by on-site destruction or 80% through alternate metal finishing techniques.
- Treatment plant sludge generation increases expected from system renovation could be contained to under 125 percent by system design modifications, on-site caustic recovery, and chromic acid recovery.
- Empty drums could be recovered for salvage through washing and/or crushing to achieve a 72 percent reduction from 1984 levels.
- Vapor losses from solvent masking operations could be reduced by 95 percent through installation of a recovery system.
- An additional decrease in total waste disposal requirements of 6 percent from 1984 rates could be realized by on-site incineration of organic wastes not amenable to other minimization measures.

2.2 RECOMMENDATIONS

Based on the findings of this waste minimization investigation of operations at AFP 4, the following is an inventory of reccomendations made with the objective of minimizing current waste disposal.

1. <u>Machine Coolant Waste</u>
    1. Implement a contractor owned and operated arrangement for on-site recovery of coolants until a dedicated system is completed.
    2. Continue with development of plant-wide coolant recovery program.
    3. Investigate use of flash pasturization to prolong coolant life and reduce biocide usage.
    4. Evaluate on-site coolant waste treatment using ultrafiltration.
    5. Evaluate use of tramp oil as an incinerator fuel.
2. <u>Waste Hydraulic Oil</u>
    1. Acquire a mobile system for purification of hydraulic oils at all AFP 4 units.
    2. Install storage capacity to allow accumulation of recovered oils.
    3. Develop an oil testing program to determine when oil requires replacement.
    4. Sell all unserviceable oil to an off-site recycler.
    5. Investigate the use of unserviceable hydraulic oil as an incinerator fuel.
3. <u>Waste Motor Oil</u>
    1. Provide clearly marked accumulation containers for segregation of recycleable oils from coolants.
    2. Train employees in the importance of waste segregation.
    3. Sell all recovered oils to an off-site recycler.

4. Waste JP-4

   1. Evaluate the use of waste JP-4 as an incinerator fuel.

5. Paint Sludge

   1. Evaluate the use of detackification chemicals to produce a treatable waste stream.

   2. Evaluate filterability of detackified paint/sludge.

   3. Evaluate the on-site incineration of paint sludge.

6. Dry Paint Waste

   1. Evaluate the on-site incineration of dry paint wastes.

7. Miscellaneous Paint Waste

   1. Evaluate the on-site incineration of paint waste solids.

8. Paint & Thinner Waste

   1. Investigate generation rates and use requirements to identify recoverable solvents.

   2. Provide clearly marked containers in sufficient number to allow proper segregation of recoverable solvents.

   3. Provide paint booth cleanup stations.

   4. Educate workers as to the importance of waste segregation.

   5. Delegate responsibility for waste segregation to line management.

   6. Conduct testing to determine if proper segregation is being accomplished.

   7. Where nonsegregation is detected, employ management initiatives to correct problems.

   8. Acquire appropriately-sized distillation systems.

9. Identify reliable, cost-effective solvent quality control analyses.

10. Assign at least one employee full time to the AFP 4 solvent recovery program.

9. Degreasing Solvent Waste

1. Acquire a system for the distillative recovery of degreaser solvents.

2. Adjust solvent additive levels as needed to allow continued reuse.

10. Naptha Waste

1. Evaluate naptha purity requirements and identify economical quality assurance techniques for recovered naptha.

2. Utilize the system acquired for distillation of mixed solvent waste to recover naptha.

11. Isopropyl Alcohol Waste

1. Evaluate the feasibility of IPA recovery using the system acquired for distillation of mixed solvent wastes.

2. Identify economical quality assurance techniques for recovered IPA.

3. Evaluate the use of IPA as an incinerator fuel.

12. Turco Cleaner Waste

1. Evaluate feasibility of on-site treatment using either the existing chrome reduction system.

2. Determine feasibility of using recoverable solvents in operations now employing Turco 3878.

13. Mixed Solvent Waste

1. Determine purity requirements for recovered solvents and identify inexpensive quality assurance techniques for recovered solvents which must meet mil specs.

2. Provide clearly marked containers to allow proper waste segregation at the points of generation.

3. Educate workers as to the importance of solvent segregation.

4. Delegate responsibility for waste segregation to line management.

5. Conduct routine checks to identify any areas where proper segregation is not practiced.

6. Employ management initiatives to correct nonsegregation problems.

7. Acquire one or more suitably sized distillation systems.

8. Assign at least one employee full time to AFP 4 solvent recovery operations.

14. Fiberglass Resin Wastes

1. Evaluate the on-site incineration of waste fiberglass resins and acetone.

15. Spent Caustic

1. Determine the purity requirements for recovered chem mill solution.

2. If current operations require less than 5.4 oz Al/gal in the chem mill solution, evaluate the feasibility of altering chem mill operations to increase bath concentrations and allow full solution recovery.

3. Conduct detailed engineering studies to determine the feasibility and economics of solution recovery through either crystallization or lime precipitation.

4. If recovery by crystallization appears feasible, attempt to locate a purchaser for recovered aluminum trihydrate crystals.

16. Mixed Acid Waste

1. Continue with planned waste treatment system modifications.

17. Heavy Metal Sludge

1. Continue with implementation of planned chromic acid recovery system.
2. Include the goal of sludge minimization in ongoing waste treatment system redesign efforts.
3. Evaluate utilization of caustic and acid waste to achieve all pH adjustments required during treatment.

18. Cyanide Waste

1. Conduct an economic analysis of alternative surface treatment techniques and on-site cyanide destruction.

19. Empty Drums

1. Evaluate the technical and economic feasibility of an on-site drum salvage operation.
2. If determined to be viable, obtain drum salvage equipment, including a drum washer, deheader and crusher.

20. Masking Solvent

1. Continue evaluations of VOC control technologies.

21. Waste Incineration

1. Conduct preliminary engineering and economic studies of on-site incineration of organic wastes not amenable to recovery for reuse.
2. Consider incinerating only organic, low-chlorine and nonchlorinated wastes to minimize sludge production and capital costs.
3. Consider including heat recovery measures in the design evaluations to reduce net operating costs.
4. Consider operation of incinerator in a nonhazardous waste mode with plant trash to recover additional heat and utilize excess capacity, with emphasis on the regulatory acceptability of this approach.

5. Evaluate scrubber water treatment in the AFP 4 waste treatment system.

2.3 ECONOMICS

Table 2-3 summarizes the projected economics of the recommendations for potential waste minimization alternatives not yet approved or funded for implementation. It should be noted that implementation of some of these options would change the economics shown for other alternatives or totally eliminate them from consideration. Hence, the expenditures and savings tabulated are not additive.

The costs and economics summarized in Table 2-3 and presented throughout this report are preliminary, order-of-magnitude estimates unless otherwise noted. These costs should not be used in place of detailed engineering estimates which consider system design, engineering and administration costs. Where costs were not available from General Dynamics, estimates are based on standard cost references, vendor quotes or experience with similar capital projects.

TABLE 2-3
SUMMARY OF ECONOMICS OF RECOMMENDED CHANGES AT AFP 4

WASTE	OPTION	CAPITAL COST	ANNUAL O&M COST	INCREASED ANNUAL SAVINGS	PAYBACK
1. Machine Coolant Waste	a) Contracted coolant recovery	$ 40,000	$105,000	$ 38,500	1.0 years
	b) Chip wringer	$ 233,542	N/A*	$ 259,500	0.9 years
	c) Coolant analyzer	$ 5,000	N/A	$ 7,040	0.7 years
	d) Coolant recovery	$ 84,000	N/A	$ 45,400	1.9 years
	e) Ultrafiltration	N/A	N/A	N/A	N/A
2. Waste Hydraulic Oil	a) Oil maintenance	$ 30,000	$ 8,080	$ 79,200	0.4 years
	b) Off-site recycling	$ 25,000	$ Negl.	$ 22,000	1.1 years
3. Waste Motor Oil	Segregation and sale of oils	Negl.	Negl.	$ 10,400	Immediate
4. Paint Sludge	On-site treatment and dewatering	N/A	N/A	N/A	N/A
5. Paint & Thinner Waste	a) Segregation and distillative recovery	$ 75,000	$ 28,840	$ 75,400	1.0 year
	b) Off-site recycling	$ 5,000	$ Negl.	$ 42,400	0.1 years
6. Degreasing Solvent Waste	a) On-site distillative recovery	$ 40,000	$ 4,020	$ 80,400	0.5 years
	b) Off-site recycling	$ 0	$ Negl.	$ 20,700	Immediate

*N/A indicates data not available.

TABLE 2-3
SUMMARY OF ECONOMICS OF RECOMMENDED CHANGES AT AFP 4
(CONT'D.)

WASTE	OPTION	CAPITAL COST	ANNUAL O&M COST	INCREASED ANNUAL SAVINGS	PAYBACK
7. Mixed Solvent and Naptha Wastes	a) Segregation and distillative recovery	$ 50,000	$ 31,050	$ 79,850	0.6 years
	b) Off-site recycling	$ 5,000	$ 0	$ 27,000	0.2 years
8. Turco Cleaner Wastes	On-site treatment	$ 0	Negl.	$ 500	Immediate
9. Spent Caustic	a) Crystallization	$ 554,000	$ 39,600	$ 220,200	2.5 years
	b) Crystallization w/Al resale	$ 623,000	$ 14,800	$ 245,000	2.5 years
	c) Lime precipitation	$ 800,000	$138,600	$ 121,000	6.6 years
10. Cyanide Waste	a) On-site desctruction	$ 20,000	$ 2,000	$ 4,000	5.0 years
	b) Ion Vapor Deposition	$ 472,000	N/A	$ 16,000	30 years
	c) Acid Cadmium Plating	N/A	N/A	N/A	N/A
11. Empty Drums	On-site salvage	$ 15,000	$ 2,800	$ 6,900	2.2 years
12. Masking Solvent	VOC recovery	$ 1-2 million	$ N/A	$ 130,000	7-14 years
13. Unrecoverable Organic Wastes	On-site incineration	$ 2-8 million	$250,000	$0 to $125,000 (increased costs)	None

*N/A indicates data not available.

3.0 WASTE MINIMIZATION PROGRAM
AFP 4 - GENERAL DYNAMICS

This section provides a description of current waste generation and management practices by waste stream at AFP 4 - General Dynamics. A summary of these current practices is provided in Table 3-1. The following subsections present detailed descriptions of each waste stream and current management methods; waste stream material balances (where appropriate); opportunities for waste minimization; system economics; and recommendations for system implementation. Section 3.25 presents an evaluation of on-site incineration of several of the AFP 4 waste streams. This information is provided in support of the conclusions and recommendations summarized in Section 2. Work sheets for each waste stream are included in Appendix B.

3.1 MACHINE COOLANT WASTE

3.1.1 Waste Description and Management Practices

Machining operations at AFP 4 require soluble oil/water emulsion coolants for lubrication and cooling of aluminum parts during metalworking. After prolonged use of the coolant, it is degraded, as evidenced by ineffective lubrication, rancidity and free-floating tramp oils. These spent coolants are removed by Gibralter Wastewaters, Inc. in Winona, Texas for underground injection.

General Dynamics currently operates a centralized coolant recovery program for six large machines located in the CNC area. Coolant is continuously pumped from the machines to a screen separator where aluminum chips are recovered for resale. The coolant then enters a high-speed Westfalia centrifuge where tramp oils and solids are removed. The clean coolant is stored in a 12,000-gallon holding tank for return to the machine sumps. Biocide is added to the holding tank to keep the coolant from becoming rancid. The frequency of biocide addition varies greatly and is the key factor in determining when to dump the coolant tank. Freshly mixed coolant requires biocide addition approximately once every 17 days. However, after six to seven months of use, biocide must be added every three days. At this point it becomes cost-effective to replace the used coolant with new coolant. The used coolant is removed in bulk from the storage tank for deep well injection by Gibralter. Approximately 10 percent of the AFP 4 waste coolant (22,800 gal/yr) is from the CNC central coolant system.

TABLE 3-1
AFP# 4 WASTE GENERATION RATES AND MANAGEMENT PRACTICES

WASTE	SOURCE/CONTENT	1984 GENERATION RATE	CURRENT MANAGEMENT PRACTICES	CURRENT* COSTS	CHANGES PROJECTED/COMMENTS
1. Machine Coolant Waste	Machine Tooling Coolants -98% Water -4% Cutting Oil -Hydraulic Oil -Varsol	1.907×10^6 lbs** (228,870 gal)	10% from internal recycle to bulk storage Bulk transport Underground injection by Gibralter 90% accumulated in drums Drum transport Underground injection by Gibralter	$121,200	Funding requested for improved recycle/ treatment program
2. Waste Hydraulic Oil	Machining Operations	414,500 lbs (54,600 gal)	54% collected in tank Bulk transport Recycle by Cooks Oil 46% accumulated in drums Drum transport Underground injection	$ 3,000 (net)	1985 generation rates are running 33% higher than 1984
3. Waste Motor Oil	Vehicle Maintenance -60% Motor Oil -38% Antifreeze -2% Hydraulic Fluid	202,600 lbs** (26,700 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 14,150	
4. Waste JP-4	Aircraft Fueling	84,800 lbs (13,600 gal)	Accumulated in drums Drum transport Recycle by Cooks Oil	$ 4,760 (revenue)	
5. Paint Sludge	Paint Booth Water Curtains -Water -Paint Solids -Chrome	161,000 lbs (19,300 gal)	Accumulated in drums Drum transport Landfill disposal by Chem Waste	$ 10,060	
6. Dry Paint Waste	Paint Booth Scrapings -Paint Solids -Chrome	108,490 lbs	Accumulated in drums Drum transport Landfill disposal by Chem Waste	$ 6,780	
7. Miscellaneous Paint Waste	Paint Solids -Rags -Paint Booth Filters -Paint Containers	83,600 lbs	Accumulated in drums Drum trasnport Landfill disposal by Chem Waste	$ 5,230	

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*Unit costs are provided in Appendix A.

**Projected rate for 1985 based on 22-week survey (1984 generation rates are not available for these wastes).

TABLE 3-1
AFP0 4 WASTE GENERATION RATES AND MANAGEMENT PRACTICES

WASTE	SOURCE/CONTENT	1984 GENERATION RATE	CURRENT MANAGEMENT PRACTICES	CURRENT* COSTS	CHANGES PROJECTED/COMMENTS
8. Paint & Thinner Waste	Painting Cleanup -Acrylic Paints -Urethane Paints -MEK -Toluene -Xylene -MIBK -Mil-C Cleaner -Other Solvents	576,600 lbs** (82,370 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 43,700	Changeover from acrylic to water-based primers anticcipated
9. Degreasing Solvent Waste	Vapor Degreasers -70% Trichloroethylene -30% 1,1,1-Tri-chloroethane	238,700 lbs** (20,120 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 10,660	
10. Naptha Waste	Hand Cleaning	15,700 lbs** (2,500 gal)	Accumulated in drums Drum transpoort Underground injection by Gibralter	$ 1,320	
11. Isopropyl Alcohol Waste	Electrical Contact Cleaning	3,920 lbs** (600 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 320	
12. Turco Cleaner Waste	Part Cleaning -Turco 3878 -Water	8,680 lbs** (1,000 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 530	
13. Mixed Solvent Waste	Hand Cleaning -MEK -Toluene -Mil-C Cleaner -Methanol -Ethanol -Methylene Chloride	563,000 lbs** (80,400 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 42,600	
14. Fiberglass Resins Waste	Fiberglass Preparation	16,200 lbs** (2,450 gal)	Accumulated in drums Drum transport Underground injection by Gibralter	$ 1,230	
15. Sealant Waste	Fuel Tank Sealing -Containers -Hardened Sealant -Contaminated Solids	14,250 lbs	Accumulated in bins Drum transport Landfill disposal by Chem Waste	$ 890	

*Unit costs are provided in Appendix A.

**Projected rate for 1985 based on 22-week survey (1984 generation rates are not available for these wastes).

TABLE 3-1
APP0 4 WASTE GENERATION RATES AND MANAGEMENT PRACTICES

WASTE	SOURCE/CONTENT	1984 GENERATION RATE	CURRENT MANAGEMENT PRACTICES	CURRENT* COSTS	CHANGES PROJECTED/COMMENTS
16. Spent Caustic Waste	Aluminum Etching -Sodium Aluminate -Sodium Hydroxide -Sodium Sulfide -Copper	3,055,300 lbs (250,440 gal)	Bulk storage Bulk transport Underground injection by Gibralter	$ 87,000	Rates for 1985 are running 14% higher than 1984. Up to 6% now used in neutralizing acid wastes on-site
17. Mixed Acid Waste	Metal Treating -Chromic Acid -Nitric Acid -Hydrofluoric Acid -Sulfuric Acid	545,000 lbs (59,200 gal)	Bulk storage Bulk transport Underground injection by Gibralter	$ 17,170	Now neutralizing on-site with spent caustic wastes
18. Heavy Metal Sludge	IWWT Plant Sludge -75% Water -25% Solids	1,779,680 lbs (213,400 gal)	Bulk pad storage Bulk transport Landfill disposal by Chem Waste	$ 56,000	Renovation will increase sludge production significantly
19. Cyanide Waste	Mostly Cd Plating Waste Some Silver Plating and Stripping Wastes	91,300 lbs (11,400 gal)	Collected in drums Drum transport Cyanide destruction by Gilbrater	$ 5,570	Planned 1988 construction of Ion Vapor Deposition system would eliminate 80% of CN wastes. On-site CN destruction also in planning, would eliminate 100% of CN wastes
20. Mercury Contaminated Waste	Cleanup of Hg Spills -Washwater -Sorbents -Gloves -Mops	100 lbs	Accumulated in drums Drum transport Landfill disposal by Chem Waste	$ 10	

*Unit costs are provided in Appendix A.
**Projected rate for 1985 based on 22-week survey (1984 generation rates are not available for these wastes).

TABLE 3-1
AFP0 4 WASTE GENERATION RATES AND MANAGEMENT PRACTICES

WASTE	SOURCE/CONTENT	1984 GENERATION RATE	CURRENT MANAGEMENT PRACTICES	CURRENT* COSTS	CHANGES PROJECTED/COMMENTS
21. Contaminated Groundwater	French Drain Outfall South Storm Basin	4,166,000 lbs (500,000 gal)	Bulk storage Bulk transport Underground injection by Gibralter	$204,200	Stopped pumping in 1985. Subject of IRP cleanup evaluation
22. Dirt, Oil & Solvent Waste	Floor Sweepings -Dirt -Metal Shavings -Sorbents w/oil & solvents	223,810 lbs	Accumulated in drums Drum transport Landfill disposal by Chem Waste	$ 16,560	
23. Empty Drums	Damaged/Contaminated Steel Drums	16,790 lbs (280 drums)	Direct transport for landfill disposal by Chem Waste	$ 9,450	Considering drumwasher, deheader and crusher to allow on-site treatment
24. Masking Solvent	Vapor Losses from Aluminum Masking -39% Toluene -39% Xylene Isomers -22% Maskant	512,000 lbs	Losses occur when covers are opened to mask parts	$145,000***	Methods for limiting losses are being investigated

*Unit costs are provided in Appendix A.

***Costs are for product vapor losses only.

The remainder of the AFP 4 waste coolant (206,000 gal/yr) is collected from the sumps of approximately 500 machines located throughout the main building. These sumps are drained using a portable vacuum truck as requested by operators. The waste coolants are drummed for removal and deep well injection by Gibralter. Figure 3-1 presents a flow diagram for coolant management operations at AFP 4.

Trimsol is the primary coolant used at AFP 4. An estimated 20,615 gallons of Trimsol are used annually in machining operations. The Trimsol is mixed with water to form a 25:1 (water:oil) emulsion. Thus, approximately 515,000 gallons of emulsion coolant are used at AFP 4 each year. A mass balance for coolant use is presented in Figure 3-2. It is noted that the losses shown in Figure 3-2 may be substantially less than indicated. Significant amounts of coolant may have been disposed as "Mixed Organic Wastes" but interpretted to be system losses. Based on available data, total annual waste coolant disposal is estimated to be 228,900 gallons. At the current disposal cost of $0.53/gal, total coolant disposal costs are estimated to be $121,200/yr. As shown in Figure 3-2, total coolant management costs are approximately $306,000/yr.

3.1.2 Waste Minimization Opportunities

General Dynamics is currently conducting detailed engineering evaluations of coolant waste minimization measures. Based on similar operating experiences at other industrial facilities, it appears that extensive waste reduction can be accomplished economically at AFP 4.

3.1.2.1 Near-Term Minimization Opportunities

As a near-term waste reduction measure, General Dynamics is currently investigating contracted, on-site coolant recovery using a portable system transported to the site, as needed, by the recycling contractor. The contractor, Lormar Reclamation Service of Noble, Oklahoma, estimates that 75 percent of the waste coolants currently disposed through underground injection can be recovered for reuse. Based on minimum batches of 4,000 gallons, a recovery cost of $0.46/gal has been quoted to General Dynamics. An annual savings of $38,500 is projected for utilization of contracted, on-site coolant recovery, based on the following assumptions,

1. Treatment of all waste coolant generated;
2. Treatment costs of $105,300/yr (per the vendor quote);
3. Recovery of 171,700 gal/yr of coolants suitable for reuse (per vendor projections);
4. Avoided purchase costs of $52,800/yr for recovered coolants (based on current coolant purchase costs); and

FIGURE 3-1
AFP 4 COOLANT MANAGEMENT OPERATIONS

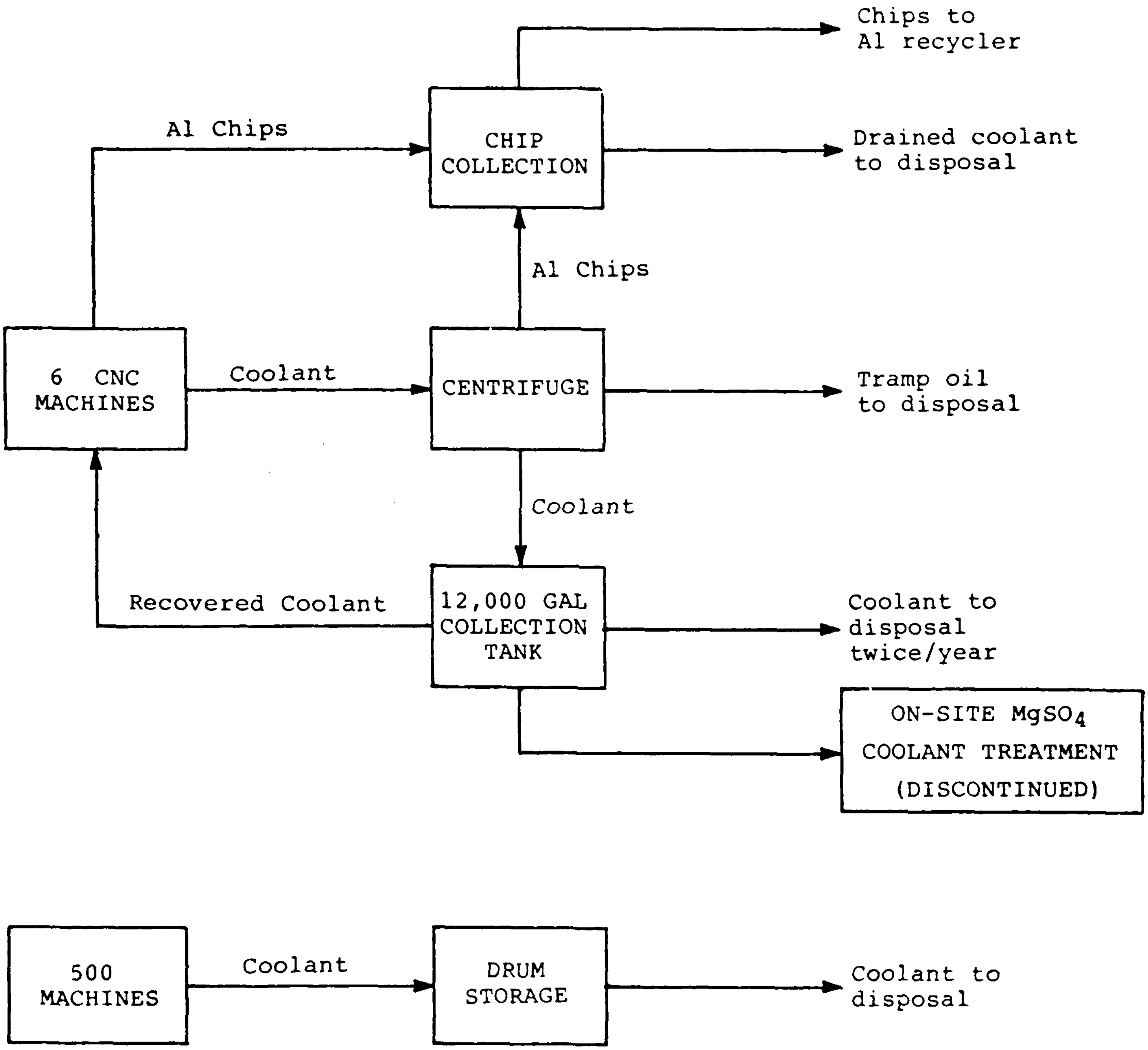
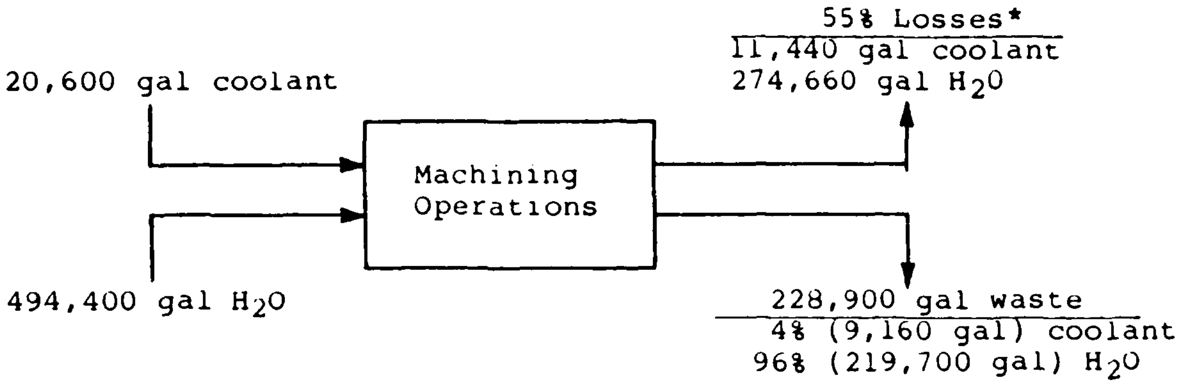


FIGURE 3-2
ANNUAL MACHINE COOLANT USE



System Costs

Disposal:	228,900 gal @ $0.53/gal	=	$121,200/year
Coolant:	20,615 gal @ $7.69/gal	=	158,500/year
Water:	494,400 gal @ $0.65/1000-gal	=	320/year
Biocide:	486 gal @ $5.32/gal	=	25,900/year
TOTAL ANNUAL COST			$305,920

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*Actual losses may be less as they are based on estimated waste disposal volumes

5. Avoided disposal costs of $91,000/yr from reduced coolant waste volumes (based on current off-site disposal costs).

Although recovery of coolants removed from the central CNC coolant system could be implemented almost immediately, additional waste handling systems would be required to allow recovery of coolants generated throughout the remainder of the plant. Vacuum collection wagons would be required for collecting coolants from approximately 500 generation points throughout AFP 4. Assuming the purchase of a portable, compartmented waste removal/coolant delivery unit at $20,000 (based on Lockwood Green estimates) and the estimated expenditure of $20,000 for construction of coolant storage tanks and associated plumbing (based on Earth Technology estimates), implementation costs could be recovered in approximately one year. Further, the coolant collection vehicle and coolant tankage should be useable in the plant-wide coolant recovery system described in the following subsection.

3.1.2.2 Long-Term Minimization Measures

Drawing on a 1984 study conducted by Lockwood Greene Engineers, General Dyanmics is currently developing long-term improvements to existing waste coolant management practices to maximize on-site coolant recovery and reuse. These improvements, itemized in Table 3-2, should allow a reduction in current coolant waste generation and losses of approximately 90 percent. These improvements consist of the following measures:

1. Additional CNC Centrifuge and Recovered Tramp Oil Pumping to Existing Boiler. A second high-speed Westfalia centrifuge will be added to the existing CNC coolant system to reduce down-time and improve recovery efficiency. Recovered tramp oil will be used as a supplemental boiler fuel.

2. Chip Wringer at CNC Main Hopper. The chip wringer will remove excess coolant from the aluminum chips recovered in the CNC coolant system. In addition to reducing coolant losses, aluminum resale value will increase.

3. Coolant Analyzer. The coolant analyzer system will allow the on-site determination of coolant degredation and accurate calculation of makeup requirements.

4. Coolant Recovery System. A centralized system for coolant recovery and reuse will employ a centrifugation system. This unit will service all machines not on the CNC main coolant system.

5. Sump Pumps at CNC Machines. The 6 CNC machines not connected to the CNC coolant system would be hooked into this system, providing for automatic coolant collection and recovery throughout the CNC area.

TABLE 3-2
COOLANT RECOVERY IMPROVEMENTS UNDER CONSIDERATION AT AFP 4

Item	Estimated Cost	Payback*	Remarks
1. Additional CNC centrifuge and recovered tramp oil to existing boiler	$126,113	3.08 years	In progress
2. Chip wringer at CNC main hopper	$233,542	0.90 years	Improves resale value of recovered aluminum and reduces coolant dragout.
3. Coolant analyzer	$ 5,000	0.71 years	Reduces unnecessary coolant changes.
4. Coolant recovery system	$ 84,000	1.85 years	To service coolant not in main CNC system.
5. Sump pumps at CNC machines	$100,423	1.76 years	To connect remaining 6 CNC machines to central coolant system.
6. Coolant collection vehicle*	$ 20,000	--	To collect waste and deliver recycled coolant througout plant.
TOTAL IMPROVEMENTS	$570,028	0.72 years	

Source: General Dynamics.
*Being considered as part of the plant-wide coolant recovery system, Item #4.

6. Coolant Collection Vehicle. This vehicle will allow collection of coolant from approximately 500 machines not on the CNC coolant system for recovery. The unit will also have the capability to deliver recovered coolant to the machines.

The total cost of these improvements has been estimated to be approximately $570,000. The net savings resulting from these systems was estimated to be $410,000/yr. Based on these projections, system payback could be realized in 1.4 years.

It is estimated that implementation of a maximum coolant recycle program would reduce coolant waste generation to approximately one-tenth of current rates, or 23,000 gal/yr. Approximately 4,000 gal/yr of these residues would be tramp oils which could be incinerated on-site, as described in Section 3.25. The remainder of the residues, 19,000 gal/yr, would be a dilute emulsion that may be amenable to on-site treatment using ultrafiltration techniques. Ultrafiltration residues should be amenable to on-site incineration while the treated effluent should be suitable for discharge with other plant wastewaters. Economic projections have not been prepared for ultrafiltration owing to the uncertainty of future capacity requirements. However, it appears that ultrafiltration O&M costs would only represent a fraction of land disposal costs, allowing capital investment payback with two to three years.

3.1.3 Recommendations

It is recommended that General Dynamics utilize contracted on-site recovery of coolants until a centralized recovery system can be acquired. This will require acquisition of a collection/delivery vehicle, provision of an on-site processing area, and improvement of storage and piping as needed to allow for coolant management.

It is recommended that General Dynamics continue to pursue the improvements listed in Table 3-2 (numbers 1-5) as long-term waste minimization measures. If preliminary projections are correct, substantial cost savings and waste reductions can be achieved through these measures. It is also recommended that General Dynamics evaluate the utilization of flash pasturization as a process step in all coolant recovery operations. Flash systems, such as those supplied by Sanborn Associates of Wrentham, Massachusetts, have reportedly achieved superior performance when coupled with centrifugal recovery systems and have reduced biocide addition requirements by 90 percent or more. Finally, it is recommended that General Dynamics evaluate on-site coolant waste treatment with ultrafiltration as an alternative to land disposal of unrecoverable coolants.

3.2 WASTE HYDRAULIC OIL

3.2.1 Waste Description and Management Practices

Waste hydraulic oil is generated by approximately 500 mills, lathes, stretchers and other metalworking machines at AFP 4. Hydraulic oil, used as an internal lubricant in the machines, becomes contaminated with water and particulates after extended use, leading to a loss of antioxidants and critical lubricating properties. The used oil is drained and replaced with new oil every 6 to 12 months..

Approximately 54 percent of the waste hydraulic oil generated at AFP 4 (29,500 gal/yr). comes from four large machines in the CNC area. This oil is drained to holding tanks for sale to an off-site recycler, Cooks Oil. General Dynamics receives $0.35/gal of oil sold to Cooks, resulting in an annual revenue of $10,325.

The remaining 46 percent of the waste hydraulic oil drained from machines (25,100 gal/yr) is collected in drums for removal and deep well injection by Gibralter Wastewaters. At the current disposal fee of $0.53/gal, hydraulic oil disposal costs are approximately $13,300/yr. Combined off-site recycle and disposal costs for hydraulic oil are estimated to be $3,000/year.

Hydraulic oil purchases in 1984 totaled 57,970 gallons. The actual purchase cost of these replacement oils was $117,890.

3.2.2. Waste Minimization Opportunities

3.2.2.1 On-Site Recovery

On-site recovery of hydraulic oils to prolong their useful life is a viable option for implementation at AFP 4. Significant reductions in off-site disposal and recycling can be achieved through a hydraulic oil maintenance program consisting of filtration, water removal and antioxidant replacement. Portable recovery systems that are brought to each machine and utilized to purify its hydraulic oil are commercially available for under $10,000. When used on a routine, preventative oil maintenance program, hydraulic oil life can reportedly be extended to over 10 years with such systems.

General Dynamics currently operates three portable oil recovery systems at AFP 4. These units, produced by Phoenix Oil Refiners of Tennessee, are used primarily in the CNC area to maintain oils from a few large machines. However, a significant portion of the waste oil generated in the drop hammer area is not currently recovered, as no tankage exists for storage of recovered oils. Further, these units cannot be effectively used throughout the plant as they must be transported by crane.

A maximum oil recovery program could probably be implemented at relatively low cost. Two mobile oil recovery units, similar to those now in use at AFP 4 but equipped with wheels to facilitate plant-wide use, could be used to routinely purify oil in all 500 machines throughout the plant. Tankage could be installed to facilitate the management of oil recovered from larger machine sumps. These modifications are estimated to cost approximately $30,000 to implement, based on acquisition of two purification systems and the addition of $10,000 worth of tankage/plumbing modifications.

Assuming a 90 percent recovery efficiency for AFP 4 hydraulic oil, avoided purchase and disposal costs of $108,800/yr could be realized. Based on quoted operating costs of $0.01/gal and estimated oil analysis costs of $0.50/gal, net savings of $79,200/yr are projected, resulting in a payback period of approximately 5 months. As the quality of oil purified with such systems is documented to be higher than purchased hydraulic oil, reductions in machine maintenance costs have been widely reported after implementation of oil maintenance programs.

3.2.2.2 Increased Off-Site Recycling

The hydraulic oil now disposed through deep well injection could potentially be accumulated for resale with other hydraulic oils from AFP 4. Compartmented mobile storage units could be employed to deliver new oil to the 500 machines throughout AFP 4 and to collect used hydraulic oil. The used oils could be delivered to a central holding tank for eventual resale to an off-site recycler.

Assuming a capital investment of $20,000 for two collection/delivery vehicles and $5,000 for a new used oil storage tank, it is estimated that 25,100 gal/yr of oil could be diverted from land disposal to an off-site recycler. Based on avoided disposal costs of $0.53/gal and increased resale revenues of $0.35/gal, approximately $22,000/yr could be saved through an expanded off-site recycling program. Capital payback of $25,000 would occur in about one year.

3.2.3 Recommendations

It is recommended that General Dynamics acquire portable oil purification systems for use with all AFP 4 machines and place excess oil storage tanks at convenient locations within AFP 4. A program of periodic oil testing and purification should be employed to minimize oil degradation. When hydraulic oil is found to be unservicable, it should be transferred to a central waste oil holding tank for sale to an off-site recycler. (Note that waste oil may also be used as an incinerator fuel source, as described in Section 3.25).

3.3 WASTE MOTOR OIL

3.3.1 Waste Description and Management Practices

Waste motor oil is generated during the maintenance of vehicles at AFP 4. Motor oils, together with antifreeze, hydraulic fluids, safety solvent and gear oils, are collected in drums at the vehicle service center and removed by Gibralter Wastewater, Inc. for deep well injection. Based on Transportation Department purchase records, the combined waste stream is estimated to contain the following proportions of materials:

- 60% Used motor oils
- 38% Coolant (antifreeze) and water
- 2% Hydraulic fluids

An estimated 26,700 gallons of mixed oils and coolant are disposed in this manner each year. At the current cost of $0.53/gal, annual disposal fees are estimated to be $14,200.

3.3.2 Waste Minimization Opportunities

The motor oil, hydraulic oil and transmission fluids generated during vehicle maintenance are potentially amenable to recycling. As an alternative to disposal as hazardous wastes, these oils could be sold to an off-site recycler, such as Cooks Oil which currently purchases over 50 percent of the hydraulic oils generated at AFP 4 during machining operations. However, current waste accumulation practices would have to be improved to provide for segregation of recyclable oils from other wastes, and allow recovery of a saleable product.

Assuming that all waste motor and hydraulic oils can be segregated for resale at $0.10/gal (estimated based on common motor oil resale values), $1,600/yr could be recovered. Reduced disposal costs would increase the potential savings to $10,400/yr.

3.3.3 Recommendations

It is recommended that General Dynamics contract for the sale of waste motor oil and hydraulic fluids to a local off-site recovery firm. Based on vendor requirements, waste engine coolant should be segregated from waste oils and, if required, motor oils segregated from waste hydraulic fluids. The waste accumulation station should be upgraded to provide the required segregation capability and garage staff should be instructed in the importance of proper waste segregation.

3.4 WASTE JP-4

Approximately 13,600 gal/yr of waste JP-4 jet fuel are generated at AFP 4. The waste JP-4 is generated during aircraft fueling and defueling operations, and typically contains trace water and solids contamination which renders it unsuitable for use as an aircraft fuel. The waste JP-4 is accumulated in drums and sold to Cook's Oil for reuse as a boiler fuel. At the current selling price of $0.35/gal, General Dynamics receives approximately $4,760/yr from waste JP-4 sales.

No recommendations for alternative waste management methods are made. Current off-site recycling methods appear to be sound, cost-effective measures to minimize land disposal of wastes. It is noted, however, that waste JP-4 would serve as an excellent source of auxiliary fuel for an on-site incinerator as described in Section 3.25.

3.5 PAINT SLUDGE

3.5.1 Waste Description and Management Methods

Paint sludge is generated at 12 paint booths throughout AFP 4 from the operation of air pollution control devices. These paint booths are equipped with water curtain air scrubbers which remove solids from the booth exhaust by providing intimate air/water droplet contact. The solids form a tacky, skimmable sludge which is removed from the water curtain sump and accumulated in drums for landfill by Chemical Waste Management of Carlyss, Texas.

AFP 4 generates approximately 80.5 tons/yr of paint sludge. The sludge, which is estimated to contain 70% water, is disposed at a cost of $125/ton. Annual waste disposal costs are estimated to be $10,060.

3.5.2 Waste Minimization Opportunities

Paint booth sludge could potentially be dewatered to reduce the volume requiring disposal as a hazardous waste. However, conventional dewatering methods, which utilize pressure or vacuum filtration, would not perform adequatly on the paint sludge currently produced at AFP 4, owing to the tacky nature of the sludge. The use of detackification chemicals could potentially allow the on-site dewatering of the sludge to achieve a 30 to 60 percent reduction in paint sludge volumes.

Detackification chemicals are typically fed on a continuous or semi-continuous basis to the water curtain circulation system. Additional benefits achievable through the use of spray booth chemicals include:

1. Detackified paint will be less likely to plug eliminator sections and nozzles, filter screens or stacks;
2. Maintenance cleaning costs may be reduced because the detackified paint is less likely to form deposits;
3. The booth remains cleaner and thus works more effectively to remove paint and odors from the air; and
4. Corrosion is better controlled through moderation of pH, thus prolonging spray booth life.

The detackified paint sludge could potentially be pumped with the paint booth wastewater to the AFP 4 treatment plant for chrome reduction and dewatering. Alternately, the sludge may be dewatered using a small vacuum filtration system connected to the sludge collection system. The latter option has the advantage of eliminating the need for transporting sludge to the IWTP.

The capital and operating costs associated with booth water chemical treatment and sludge dewatering are highly variable and must be determined through contact with system vendors. However, assuming that the sludge's water content can be lowered to 30 percent, a 60 percent reduction in sludge waste volume is achievable. This would reduce off-site waste disposal by 32 tons/yr resulting in avoided disposal costs of approximately $4,000/yr.

3.5.3 Recommendations

It is recommended that General Dynamics explore the technical feasibility and impacts of utilizing detackifying chemicals in water curtain spray booths with accompanying sludge dewatering. Although operating costs may increase through the implementation of such a program, off-site waste disposal rates and accompanying long-term liabilities could be reduced significantly.

3.6 DRY PAINT WASTE

In 1984, approximately 54 tons of dry paint waste were disposed by AFP 4. The dry paint is generated during the routine cleaning and scrapedown of paint booths. Dry paint shavings are collected in drums and removed by Chemical Waste Management for disposal in a secure chemical landfill at a cost of $125/ton.

No alternatives have been identified which would reduce the quantity of paint overspray requiring disposal. The dry paint, however, may be a suitable candidate for incineration, as described further in Section 3.25.

3.7 MISCELLANEOUS PAINT WASTE SOLIDS

Miscellaneous paint waste includes used air filters removed from dry paint booths as well as rags, empty containers and other solid material contaminated with paint. Approximately 42 tons these of paint waste solids were accumulated in drums in 1984 for land disposal by Chemical Waste Management. At the current cost of $125/ton, disposal costs are estimated to be $5,230/yr.

No viable alternatives have been identified to reduce the quantitites of paint waste solids generated at AFP 4. However, as noted in Section 3.25, high temperature incineration may be a viable on-site treatment technique.

3.8 PAINT & THINNERS WASTE

3.8.1 Waste Description and Management Practices

Approximately 82,400 gallons of paint and thinner wastes are generated annually during the painting of aircraft and parts. Waste generation occurs primarily from cleanup operations. Unused acrylic and polyurethane paints together with thinners are combined with paint gun cleanup solvents at the point of generation. Exact determination of the quantities of paints and solvents present in these wastes is not possible. However, it appears that the following materials are typical constituents:

- Acrylic paints
- Urethane paints
- Methyl ethyl ketone
- Toluene
- Xylene
- Methyl isobutyl ketone

The paint and thinner wastes are accumulated in drums for removal and deep well injection by Gibralter Wastewaters. At the current rate of $0.53/gal, disposal costs are approximately $43,700/yr.

3.8.2 Waste Minimization Opportunities

3.8.2.1 Change to Water-Base Primers

The Air Force has recently approved a changeover to water-based primers for the F-16 program. The water-based acrylic primer (MIL-P-85582) will be used in lieu of the solvent-based acrylic primer now in use (MIL-P-23377).

The primary purpose of the changeover is to reduce volatile organic carbon (VOC) emissions. The acrylic primer now used contains 4.7 lbs VOC/gal and is used at a rate of approximately 11,100 gal/yr. The water-based primer contains only 2.8 lbs VOC/gal and should, therefore, lower VOC emissions by over 10 tons/yr. Further, General Dynamics estimates significant decreases in VOC emissions and waste generation due to related decreased use of thinners, strippers, cleaners and other materials. Current consumption of paints and related solvents averages 194 gal/day with a weighted, average content of 6.1 lbs VOC/gal. This is expected to fall to 45 gal/day with an average weighted content of 3.3 lbs VOC/gal. Based on 302 days/yr operation, a total decrease in VOC emissions of approximately 19 tons/yr is expected to result from switching to water-based primers at AFP 4.

Based on material use records, it is estimated that the application of urethane top coatings generates 70 percent of the paint and thinner wastes; the remaining 30 percent being attributable to the use of acrylic primers. As the changeover to water-based primer is expected to reduce primer material usage by 77 percent, a total reduction of 23 percent or 19,000 gal/yr in the paint and thinner waste stream is also expected.

3.8.2.2 On-Site Solvent Recovery

A significant portion of the solvents utilized in cleaning painting equipment could potentially be reclaimed for reuse through distillation. However, to achieve economic recovery it is essential that the painting wastes be segregated at the point of generation. This can be achieved by placing a sufficient number of clearly-marked accumulation containers in generation areas and training employees in their proper use.

Determination of the solvents amenable to recovery within each generation area can be accomplished through reviews of use records and identification of use patterns. If successful, segregation would allow either sale of waste solvents to an off-site recycler (as discussed in Section 3.8.2.3) or on-site distillative recovery.

In general, paints and thinners present in a concentrated paint stream are not amenable to economic on-site recovery for reuse. In addition, recycled solvents may not be economically recoverable for use as a paint thinner. This is due, in large measure, to the need to assure that recovered materials used as a surface coating constituent meet rigid military specifications (mil specs). However, solvents used to clean paint spray guns and lines can typically be economically recovered on-site for reuse in equipment-cleaning operations not impacted by mil specs.

General Dynamics has requested FY 1986 funding for installation of an on-site solvent distillation system. The system(s) acquired with this funding could be utilized for recovery of paint cleanup wastes as well as naptha (Section 3.10) and other solvents (Section 3.12).

Although a large capacity system could potentially be acquired and used to recycle more than one type of solvent, extra care would be required to prevent cross-contamination of solvents during distillation. The use of several smaller systems, each dedicated to a single solvent type, would minimize cross-contamination potential, but may prove too costly to implement. For these reasons, the development of a properly sized system of stills would require additional detailed generation rate data beyond that which is currently available.

A listing of distillation systems which may be appropriate to AFP 4's needs is presented in Table 3-3. Of the systems identified in Table 3-3, the Recyclene and Finish Engineering Systems are better suited to handling more than one solvent, as both utilize a disposable bag liner in the boiling sump. This liner can be replaced when changing solvents to further reduce cross-contamination potential.

TABLE 3-3
SOLVENT DISTILLATION SYSTEM SPECIFICATIONS

MANUFACTURER	UNIT	MAX. SOLVENT BOILING POINT	CAPACITY	COST
Finish Engr.	LS-55	320°F	55 gal/shift	$ 12,800
	2LS-55IV	500°F	110 gal/shift	-
Recyclene	R-70	400°F	70 gal/shift	$ 20,200
	R-110	400°F	110 gal/shift	-
Venus	SRS-5	320°F	56 gal/shift	$ 10,600
	SRS-20	320°F	100 gal/shift	$ 20,600
Brighton	7.5 GPH	350°F	60 gal/shift	$ 17,500
	25 GPH	350°F	200 gal/shift	$ 22,000
Crest Ultrasonics	CRS-10H	250°F	80 gal/shift	$ 4,160
Baron Blakeslee	HRS-20	250°F	160 gal/shift	$ 6,370
Detrex	FC-6EW	250°F	80 gal/shift	$ 5,840
	FC-6EW (insulated)	250°F	136 gal/shift	$ 6,600

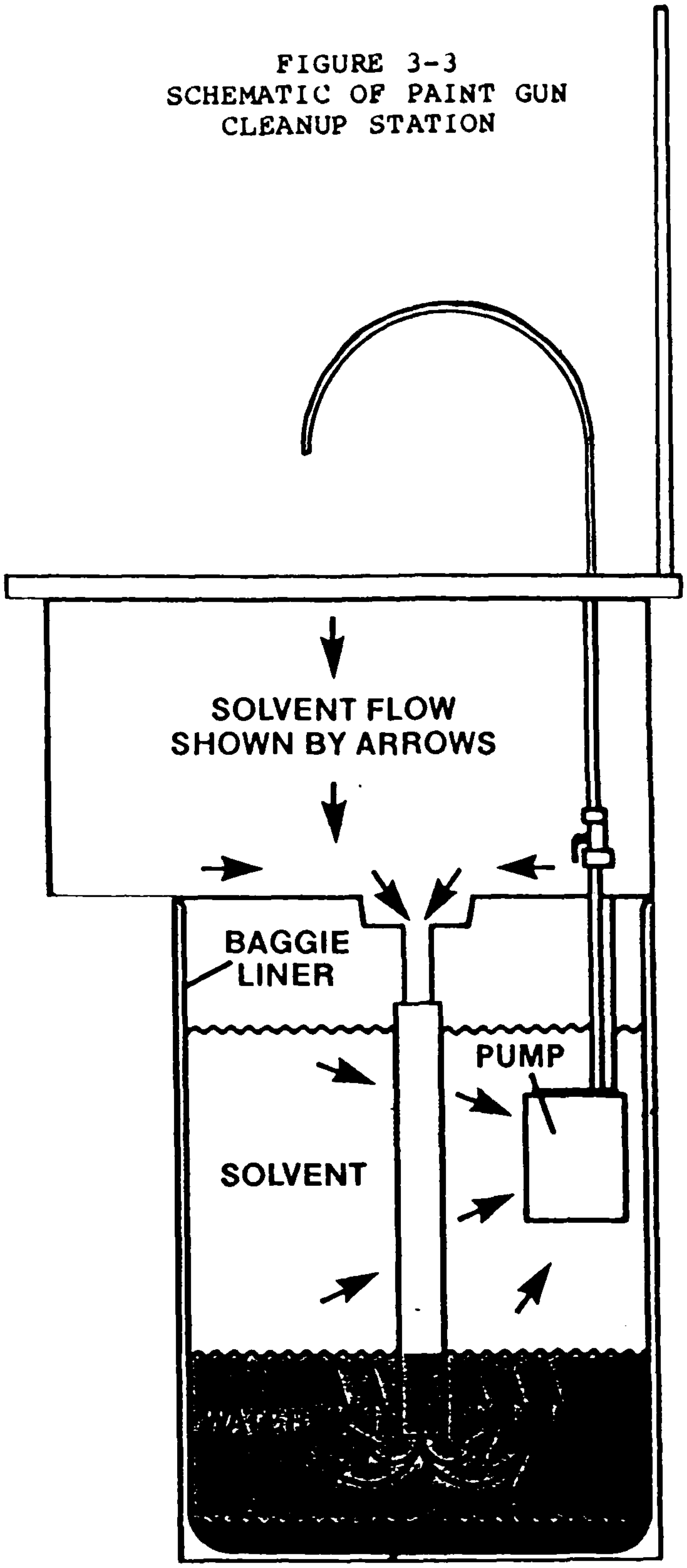
Some solvents may have uses which require a high purity, such as paint thinning, as well as secondary uses which do not require high purities, such as spray gun cleanup. Two recovery options are available in these circumstances: (1) test recovered solvents to assure that appropriate mil specs are achieved, thus allowing their unrestricted reuse; or (2) presume that recovered solvents do not meet mil specs and restrict their reuse to cleanup or other noncritical operations. The first option requires testing of each batch of recovered solvents for purity indicators, such as specific gravity. With the second option, care must be taken to avoid the use of recovered solvents in critical operations. The use of clearly marked containers for restricted-use solvents can effectively minimize the potential for misuse of recovered solvents. In addition, cleaning stations similar to those shown in Figure 3-3 provide a convenient station for spray gun cleanup and cleaning solvent storage. These systems can reduce volatile losses and prevent inadvertent use of recovered solvents intended for use in multiple equipment washings in operations requiring a high purity.

As the portion of the paint and thinner waste stream amenable to distillative recovery is unknown at this time, the necessary size of a distillation system dedicated to painting cleanup wastes cannot be accurately projected. However, for estimating purposes, assuming that 50 percent of the paints and thinners waste stream is suitable for recovery and reuse, a projected annual savings of $96,000 has been calculated. This is based on:

- Avoided disposal costs of $0.53/gal or $21,800/yr (from current disposal costs);
- Avoided solvent purchase costs of $2.00/gal or $82,400/yr (based on typical bulk purchase costs); and
- O&M costs of $0.20/gal recovered or $8,240/yr (based on vendor estimates).

Based on estimated implementation costs of $75,000, (for two distillation units and 12 work stations/segregation stations), payback is projected to occur in less than one year. If solvent quality assurance analysis costs can be maintained at $2.33/gal recovered or less, system operating costs will be less than current disposal and solvent replacement costs. For an estimated quality assurance cost of $0.50/gal recovered, net savings of $75,400/yr and a payback of one year are projected.

FIGURE 3-3
SCHEMATIC OF PAINT GUN
CLEANUP STATION



Drawing courtesy of
Build-All Corporation
Menomonee Falls, WI

3.8.2.3 Off-Site Recycling

If segregated from other solvents and paints, a significant portion of the used painting solvents may be suitable candidates for sale to off-site solvent recyclers. The feasibility of off-site solvent recycling will depend on several factors, including the degree of contamiantion, the nature of contamination, the distance to the recycler's facility and the availability of local markets for resale of recycled solvents. Although it is technically feasible to recover solvents contaminated with paints, many recyclers may not wish to attempt recovery of the AFP 4 paint wastes, as residual paints will tend to foul distillation towers, resulting in higher than normal maintenance costs.

To implement a successful off-site recovery program, it would be necessary for General Dynamics to implement a segregation program similar to that described for on-site recycling of solvents. The segregated waste solvents could be accumulated in drums for sale to the off-site recycler. The implementation costs for such a program are estimated to be $5,000 for the improvement of existing waste accumulation points to allow segregation.

Based on avoided disposal costs of $0.53/gal, an estimated average revenue of $0.50/gal for recovered solvents (typical for MEK resale to off-site recyclers) and an assumed 50 percent recovery rate for solvents, savings of $42,400/yr are projected. Payback of capital expenditures to improve segregation would occur within the first two months of operation.

Although off-site recycling does result in significant reductions in liability exposure compared to current land disposal practices, it does not eliminate liabilities. AFP 4 may still be liable for damages caused by improper management practices at the off-site recycling facility.

3.8.3 Recommendations

It is recommended that General Dynamics investigate waste solvent generation rates to determine the quantities and uses of thinners and cleanup solvents. Based on the results of these investigations, cleanup solvents with high generation rates should be targeted for recovery. To assure proper segregation of recoverable solvents, it is recommended that AFP 4 institute a program containing the following key elements:

1. Provide clearly-marked containers at accumulation points for every recoverable solvent which may be utilized in the area being serviced as well as other wastes;
2. Provide paint gun cleanup stations similar to Figure 3-3 in each paint booth;
3. Educate workers as to the importance of waste segregation;
4. Delegate responsibility for waste segregation practices to line management;
5. Conduct routine checks to identify accumulation points where proper segregation is not being practiced; and
6. Where nonsegregation is detected, employ management initiatives to correct problems.

One or more appropriately sized distillation systems should be acquired for on-site recovery of cleanup solvents. To assure long-term quality control in the solvent recovery program, at least one employee should have full-time responsibility for management of accumulation and recovery operations.

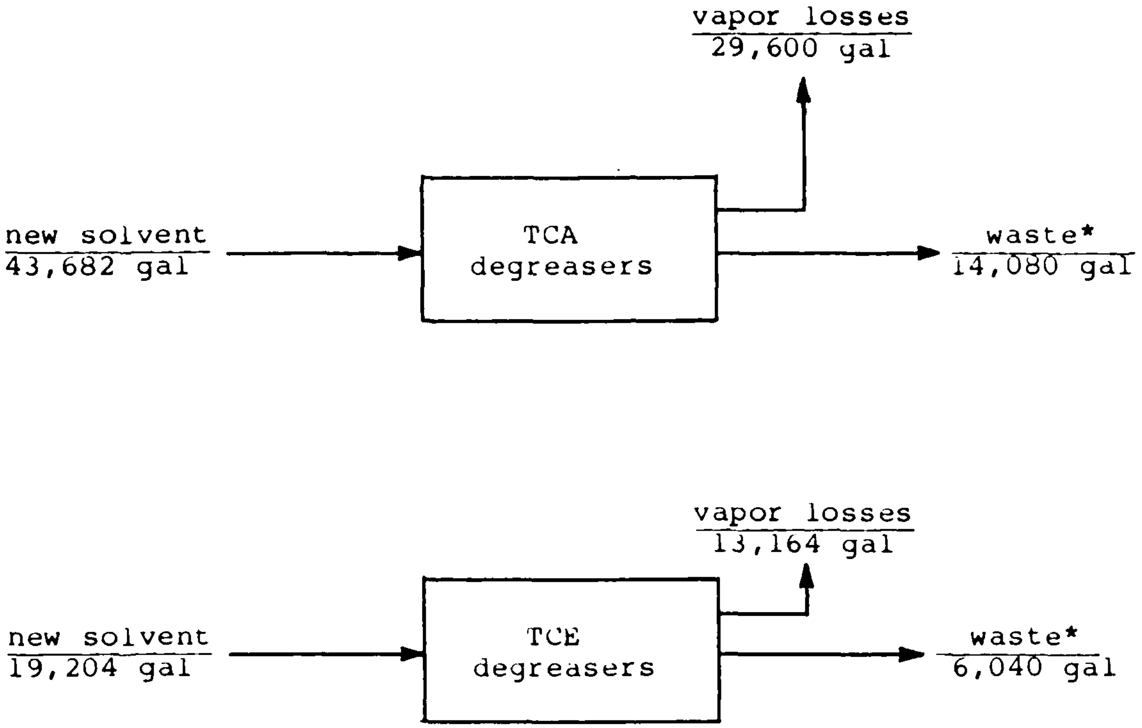
3.9 DEGREASING SOLVENT WASTE

3.9.1 Waste Description and Management Practices

General Dynamics operates several vapor degreasers at AFP 4 which are utilized to remove surface contamination from aircraft parts and tools. Approximately 70 percent of the vapor degreaser solvent used is trichloroethylene (TCE); the remainder being 1,1,1-trichloroethane (TCA). The degreaser units are equipped with side stills which continuously cleanse the solvent while producing a side-stream of contaminated solvent. Periodically, the degreaser solvents are drained when their pH becomes too low or their oil levels become too high.

Used degreasing solvents are accumulated in drums for deep well injection by Gibralter Wastewaters, Inc. Approximately 10,120 gallons of solvents are disposed in this manner annually. Figure 3-4 presents a mass balance for TCE and TCA based on General Dynamic's purchase and disposal records. Unit disposal costs are $0.53/gal, resulting in annual disposal costs of $10,660.

FIGURE 3-4
ANNUAL DEGREASING SOLVENT MASS BALANCE



Annual System Costs

TCE purchases:	43,682 gal @ $3.45/gal =	$150,703
TCA purchases:	19,204 gal @ $4.34/gal =	83,345
Waste disposal:	20,120 gal @ $0.53/gal =	10,660
	TOTAL ANNUAL COST	$244,708

*Waste quantities assume 100% of waste to be solvent . Actual solvent quantities will be lower owing to contamination

3.9.2 Waste Minimization Opportunities

3.9.2.1 Distillation and Reuse of Waste Solvents

Both TCE and TCA are ammenable to on-site distillative recovery. It is estimated that over 60 percent of the TCE and TCA wastes now disposed off-site could be recovered in this manner and reused for AFP 4 degreasing operations.

General Dynamics has requested FY 1986 funding for a distillation system to allow recovery of waste solvents, including TCE and TCA. The feasibility of distillative recovery of solvents other than TCE and TCA is discussed in other sections of this report, specifically 3.8, 3.10, 3.11 and 3.13.

Some uncertainties exist regarding the applicability of military specifications (mil specs) to solvents recycled on-site for continued use. While it appears that available distillative recovery systems may not be able to continuously produce products which meet rigid mil specs for new solvents, they can serve to bring solvent quality back within acceptable operating ranges, thereby extending the solvent's useful life. Some facility operators have interpreted the mil specs as applicable to solvents recycled on-site and, therefore, have not instituted on-site recycling. Other facilities, however, recycle solvents on-site utilizing purity standards which, although lower than mil specs, have allowed significant reductions in solvent waste volumes with no compromise of solvent use patterns or applicability.

As an example, General Electric (GE) has been utilizing a simple distillation system for 7 years to extend the useful life of TCA in its vapor degreasers at AFP 59. Solvent is removed from the degreasers when pH or specific gravity analyses show that the solvent is outside established acceptance limits. These same limits, which are less stringent than mil specs for new solvents, are applied to the solvents after on-site recycling. If the recycled solvents fail to meet the minimum acceptance limits they are discarded. Otherwise they are reused in AFP 59 vapor degreasers. A similar approach appears feasible at AFP 4.

Several distillation systems are available which could meet AFP 4's needs. These range in capacity from 55 gal/shift to 200 gal/shift. Data on eleven such systems were provided in Table 3-3 (Section 3.8). Of the systems described, the Recyclene and Finish Engineering systems utilize a bag liner between the waste solvent and the heating surfaces to eliminate fouling, thereby decreasing maintenance costs over unlined systems.

Currently, waste TCE and TCA generation rates at AFP 4 average approximately 80 gal/day. The units described in Table 3-3 can typically be managed so as to operate for two 8-hour shifts per day. Provided the still is equipped with an automatic cut off, it can be left unattended to process one batch at the end of the first shift in addition to processing a full batch of solvent during the shift. Thus, a unit with a 55 gal/shift capacity could readily process 110 gal/day. (Such an arrangement is currently used at AFP 59.) Alternately, either a still with the capacity to process over 80 gal/shift could be acquired or, if holding tanks and transfer pumps are also installed, a lower capacity unit which is operated continuously could be utilized.

Operation and maintenance costs for distillation systems are typically in the range of $0.15/gal to $0.20/gal. As these systems are highly automated, very little labor is required for their operation. Simple quality control analyses are generally sufficient to assure the quality of recycled solvents. As an example, GE recycles TCA at AFP 59 utilizing only pH and specific gravity measurements. It should be noted, however, that GE does not attempt to reconstitute spent acid acceptors or metal stabilizers in their recycled solvents. As a result, their recycling program allows an average of three use cycles for degreaser solvents before acid buildup precludes further use. To further extend solvent life, it would be necessary to periodically rejuvinate solvents with new acid acceptor and metal stabilizers. A maximum reuse program of this type would require additional solvent analyses to determine the necessary additive makeup levels.

The economics of on-site solvent recycling and reuse appear quite favorable. Annual savings of $51,300/yr are projected based on the following assumptions:

1. Degreaser solvent wastes contain approximately 70 percent recoverable solvent (based on General Dynamics test data);

2. Solvent recovery rates of 90 percent are achieved (based on vendor data);

3. Avoided disposal costs of $0.53/gal are realized (current underground injection costs);

4. Avoided new TCE and TCA purchase costs of $3.45/gal and $4.34/gal, respectively, are realized (current bulk costs charged by General Dynamics' supplier); and

5. System O&M costs average $0.20/gal (based on vendor estimates).

Based on system acquisition costs of $40,000 (for the purchase of two distillation system at $20,000 each), payback would be realized in less than one year.

3.9.2.2 Off-Site Recycling

Waste TCE and TCA may be suitable for direct sale to an off-site recycler as currently accumulated. The feasibility of resale of the waste solvents will depend on several factors, including the degree of contamination, the distance to the recycler's facility and the availability of local markets for resale of recycled solvent. The revenue received for chlorinated solvents typically varies from $0.15/gal to over $1.00/gal. Assuming an average revenue of $0.50/gal and avoided disposal costs of $0.53/gal, cost savings attributed to off-site recycling are estimated to be $20,700/yr. An accurate determination of the feasibility of selling spent degreaser solvents and estimated revenues can only be acquired through direct contact with recyclers in the Forth Worth area.

3.9.3 Recommendations

It is recommended that AFP 4 acquire a solvent recovery system dedicated to the recovery of TCE and TCA. Solvent additive levels should be tested and adjusted, as necessary, during recovery to provide maximum solvent life.

3.10 NAPTHA WASTE

3.10.1 Waste Description and Management Practices

Approximately 2,500 gallons of waste naptha are generated annually at AFP 4. Naptha is used primarily for hand-applied cleaning operations in laboratories and production areas. Waste naptha is accumulated in drums for underground injection by Gibraltar Wastewaters. At the current charge of $0.53/gal, disposal costs average $1,320/yr.

3.10.2 Waste Minimization Opportunities

Waste naptha is amenable to distillative recovery for reuse on-site. The distillation systems described for other AFP 4 nonchlorinated solvent wastes (Section 3.13) could also be used to recover waste naptha. Although the bulk of the naptha waste currently disposed at AFP 4 could probably be recycled to a purity level meeting mil specs, the costs of testing to verify the purity of the recovered material may outweigh the potential savings. Based on current purchase costs of $1.02/gal for new naptha and an assumed recovery efficiency of 98 percent, avoided purchase costs would total $2,500/year. Adding avoided disposal costs of $0.53/gal and subtracting distillation system operation/maintenance costs of $0.20/gal, net savings of $3,300/year are projected.

If inexpensive quality assurance analyses can be identified (e.g., specific gravity or pH) it may be possible to recover and reuse naptha with minimal operating cost changes from current levels. For an estimated analysis cost of $0.50/gal annual savings of $2,200 are projected.

3.10.2.2 Off-Site Recycling

Waste naptha could potentially be sold, as generated, to an off-site firm for recycling. The feasibility of resale of waste naptha will depend on several factors, including the degree of contamination, the nature of the contamination, the distance to the recycler's facility and the availability of local markets for resale of recycled naptha. Based on an estimated revenue of $0.25/gal of naptha sold to a recycler and avoided disposal costs of $0.53/gal, savings of $1950/yr are projected.

3.10.3 Recommendations

It is recommended that General Dynamics explore the economic and technical feasibility of naptha recovery. The investigation of naptha recycling potential should focus on the ability of the selected system to recover a product which meets mil specs and the identification of inexpensive methods to verify the purity of the recovered naptha. It is anticipated that the distillation system recommended for recovery of AFP 4's mixed solvent wastes (Section 3.13) may also be suitable for naptha recovery.

3.11. ISOPROPYL ALCOHOL WASTE

3.11.1 Waste Description and Management Practices

Isopropyl alcohol (IPA) is used to hand clean electrical contacts on aircraft equipment during fabrication and assembly. It is estimated that over 85 percent of the 4,360 gal/yr of IPA used at AFP 4 is lost to the atmosphere during the cleaning processes. Approximately 600 gal/yr of waste IPA is collected in drums for deep well injection by Gibralter Wastewaters. Based on unit disposal costs of $0.53/gal, annual disposal costs are approximately $320.

3.11.2 Waste Minimization Opportunities

Distillative recovery of IPA does not appear viable owing to the azeotropic nature of IPA with water and its hygroscopic nature. It may not be economically feasible to recover IPA of a quality sufficient to meet mil spec. For these same reasons, off-site recovery does not appear feasible. However, waste IPA may be a suitable fuel for use in an on-site incineration system, as described in Section 3.25.

3.11.3 Recommendations

Using the distillation system acquired for mixed solvents (Section 3.13), General Dynamics should evaluate the feasibility of IPA recovery. If IPA can be readily recovered to a purity meeting mil specs and a low-cost quality assurance method can be identified, IPA should be recovered for on-site reuse on a routine basis. If IPA cannot be economically recovered in this manner, its use as an incinerator fuel should be considered, as described in Section 3.25.

3.12 TURCO CLEANER WASTE

3.12.1 Waste Description and Management Practices

Turco 3878 is used to clean certain aircraft parts prior to chem film and anodize processing. The Turco 3878, an emulsion containing sodium chromate and potassium hydroxide, is washed from the parts with water and the waste is accumulated in drums for underground injection by Gibralter Wastewaters. Approximately 1000 gallons of Turco cleaner and water are disposed in this manner each year at a cost of $0.53/gal or $530/yr.

3.12.2 Waste Minimization Opportunities

Turco 3878 is an emulsion and is not economically recoverable for reuse. It could potentially be treated on-site to render it nonhazardous through chrome reduction and pH adjustment. This could be accomplished through treatment in the AFP 4 industrial waste treatment (IWT) system. (Additional details concerning the IWT system are provided in Section 3.18). If the Turco wastes can be treated on-site, savings of approximately $500/yr could potentially be recovered through avoidance of current disposal costs.

Alternately, the use of Turco 3878 could be discontinued and a different cleaning method, such a vapor degreasing, used to clean the parts. This approach could result in substantially less waste generation if the substitute cleaning solvent is one which is recycled on-site per the recommendations in Sections 3-9, 3-10 and 3-13.

3.12.3 Recommendations

It is recommended that General Dynamics determine the feasibility of substituting a recoverable solvent for the applications now requiring Turco 3878. Alternately, General Dynamics should assess the feasibility of treating the Turco 3878 in the AFP 4 IWT system.

3.13 MIXED SOLVENTS WASTE

3.13.1 Waste Description and Management Practices

An estimated 80,400 gal/yr of waste solvents are generated at AFP 4 from the hand-applied solvent cleaning of parts and tools. A breakdown of total generation by solvent type is not available, however, an indication of the types and relative proportions of solvents making up the mixed solvents stream can be gained by examining material purchase records. Table 3-4 presents a tabulation of solvent usage at AFP 4 in 1984. This listing does not include acetone, TCE, TCA, IPA or naptha, as these solvents are covered separately in other sections of this report. Nor does it include toluene and xylene which are used primarily in masking and painting operations. Although methyl ehthyl ketone (MEK) is included in this listing, it appears that a significant portion of the MEK waste is generated during painting operations and may be included in the generation figure for the paint and thinner waste stream (Section 3-8). The solvent used in the greatest quantities, "Air Force Cleaner", represents very little of the actual mixed solvents waste stream. Air Force Cleaner (a blend of isoproprly alcohol, methyl ethyl ketone, ethyl acetate and naptha) is used almost exclusively in hand-applied cleaning during which it is lost in vapor form to the atmosphere.

These Solvent wastes are collected in drums at several accumulation points throughout AFP 4. At present, no segregation by solvent type is practiced, hence wastes are received as mixtures which may include any of the solvents listed in Table 3-4 as well as hydraulic oils, coolants, water and other materials. The drummed wastes are removed by Gibralter Wastewaters for disposal by underground injection at a cost of $0.53/gal. Disposal costs are estimated to be $42,600/year.

3.13.2 Waste Minimization Opportunities

3.13.2.1 On-Site Recycling

The opportunities for minimization of the mixed solvent waste stream parallel those described for paints and thinners in Section 3.8. Distillative recovery for on-site reuse may be feasible for many of the solvents listed in Table 3-4. Solvents used in multiple cleaning operations, such as safety solvent, are typically good recycling candidates, as a higher degree of impurities may be acceptable in multiple use operations than in high-precision cleaning operations. Where recovered solvents must meet mil specs to allow their reuse, inexpensive quality assurance testing procedures must be available to allow their economic recovery and reuse.

TABLE 3-4
AFP 4 SOLVENT USAGE IN 1984

SOLVENT TYPE	QUANTITY (GAL)*
Safety Solvent	11,226
Methyl Ethyl Ketone	20,240
Methyl Isobutyl Ketone	28
Methanol	566
Ethanol	167
Dichloromethane	2,370
Air Force Cleaner	31,093
Cellosolve Acetate	469

*Note that 1984 use data are presented in this table. Total solvent usage in 1984 was considerably less than the projected 1985 disposal rates which form the basis for the study projections.

Improved solvent segregation is necessary for a solvent recovery program to succeed. This would require placing a sufficient number of clearly-marked accumulation containers in generation areas to allow for thorough segregation and training all employees in proper segregation practices. Based on an assumed 50 percent recoverability for the 80,400 gal/yr of mixed solvents generated, annual savings of $98,000 (the sum of avoided purchase and disposal costs minus O&M costs) could be realized. For a system cost of $50,000 (2 distillation systems plus segregation centers), payback would be realized in approximately 6 months. If quality control costs can be maintained at $2.44/gal or less, recovery system operating costs would not exceed current disposal costs. For an estimated quality assurance cost of $0.50/gal recovered, annual savings of $77,900 and a payback period of 8 months are projected.

3.13.2.2 Off-Site Recycling

Based on their rate of use in 1984, it appears that safety solvent, methyl ethly ketone and dichloromethane may be viable candidates for sale to an off-site recycler. To enable sale of these solvents for recycling, it is essential that they be segregated from other materials at the point of generation. This could be accomplished through a program of accumulation facilities improvements, employee training and management oversight, as described previously.

As data concerning individual waste solvent generation rates and contaminants are not available, accurate prediction of the economics of off-site recycling is not possible. However, based on the following assumptions, a savings of $25,000/yr is projected:

1. Approximately 30 percent of the mixed solvents stream is saleable (Earth Technology estimates);
2. Revenues average $0.50/gal recovered for sale (based on typical recycler purchase prices); and
3. Avoided disposal costs are $0.53/gal recovered for sale (per current disposal costs).

Assuming that improvement of waste accumulation points to allow proper solvent segregation costs $5,000, payback could be realized within 3 months.

3.13.3 Recommendations

It is recommended that General Dynamics implement a recycling program for all solvents amenable to economic recovery. Those solvents which are recoverable should be completely segregated at the point of generation. To assure proper segregation, a program containing the following key points is recommended:

1. Provide clearly-marked containers at accumulation points for every recoverable solvent which may be utilized in the area being serviced as well as other wastes;
2. Educate workers as to the importance of waste segregation;
3. Delegate responsibility for waste segregation practices to line management;
4. Conduct routine checks to identify accumulation points where proper segregation is not being practiced; and
5. Where nonsegregation is detected, employ management initiatives to correct problems.

To assure that proper quality control is maintained, it appears that at least one employee should be assigned full-time responsibility for solvent accumulation and recovery operations. Low cost analysis techniques should be identified for quality assurance testing of solvents to be used in high-precision cleaning operations.

One or more distillation systems should be acquired for use. A bag-lined unit such as the Recyclene or Finish Engineering units identified previously in Table 3-3 may be better suited to the recovery of multiple solvent streams, as cleaning requirements when switching solvent types are considerably lower than most other systems.

3.14 FIBERGLASS RESIN WASTE

3.14.1 Waste Description and Management Practices

The fiberglass resins waste stream is generated during the production of fiberglass aircraft components and molds. The waste consists primarily of unhardened resins and solid scrapings from molds and parts. The waste typically contains 5 to 6 percent acetone. Wastes are collected in drums for underground injection by Gilbrater Wastewaters at a cost of $0.53/gal. Approximately 2,450 gal/yr are generated, resulting in a disposal cost of $1,230/yr.

3.14.2 Waste Minimization Opportunities

Although acetone recovery via distillation is technically feasible, the low quantity of acetone present in this waste stream (approximately 120 gal/yr) renders its recovery uneconomical. Although other waste minimization opportunities have not been identified, fiberglass wastes appear to be a suitable candidate for high temperature incineration.

3.14.3 Recommendations

It is recommended that on-site incineration of fiberglass wastes be considered, as described in Section 3.25.

3.15 SEALANT WASTE

Two-part sealants used in fuel tank sealing contain hexavalent chromium and are considered toxic. Approximately 7 tons/year of cans, applicators, rags and other solid materials contaminated with solidified sealant are generated at AFP 4. These wastes are disposed in a secure chemical landfill by Chemical Waste Management at a cost of $125/ton or approximately $890/year.

No alternatives to current waste management practices are recommended. Although a significant degree of volume reduction could be achieved by crushing the contaminated metal containers which constitute a major portion of the wastes, actual waste mass would remain constant. Size reduction does have the advantage, however, of reducing the total number of drums requiring disposal. Sealant wastes do not appear amenable to significant volume reduction or detoxification through incineration.

3.16 SPENT CAUSTIC WASTE

3.16.1 Waste Description and Management Practices

Spent caustic is generated from the chemical milling of aluminum parts. The caustic chem mill solution, primarily sodium hydroxide, reacts with the aluminum to form relatively insoluble sodium aluminate. When excessive amounts of sodium aluminate sludge are formed, the chem mill solution becomes ineffective and must be replenished.

Spent caustic is removed in bulk for underground injection by Gibralter Wastewaters at a cost of $57/ton. Approximately 250,440 gallons were disposed in this manner in 1984 at a cost of $87,080.

Small amounts of spent caustic, up to approximately 15,000 gal/yr or 6 percent of the AFP 4 generation rate, are being used to neutralize acidic plant wastes on-site (refer to Section 3.17).

3.16.2 Waste Minimization Opportunities

Spent caustic could be neutralized on-site to produce a sodium aluminate sludge. However, this approach has several drawbacks, noteably:

- Large quantities of purchased acid would be required, resulting in substantial operating costs;

- A high volume of sludge would be produced which is not amenable to dewatering and must be landfilled; and

- The large amounts of hydrogen sulfide gas produced might require treatment prior to discharge and present an operational hazard.

An alternative approach to waste minimiation which is receiving increasing attention at aerospace production facilities is recovery of chem mill solutions. Two processes for spent caustic recovery have been developed, crystallization and lime precipitation. Use of these processes has been studied at several Air Force GOCOs and a lime precipitation system is currently being installed at AFP 3 in Tulsa, Oklahoma by McDonnell Douglas.

The crystallization process operates by removing aluminum as aluminum trihydrate through crystallization at reduced temperature. The aluminum trihydrate settles and is removed in a slurry form with some chem mill solution, while the clarified chem mill solution is returned to the etch tank. The slurry is centrifuged and the centrate chem mill solution is returned to the crystallizers and recycled. Chem mill solution is essentially 100 percent recovered. A limitation of this process is the degree of removal of aluminum; without excessive cooling and reheating of recovered solution, aluminum can not be removed below 5 oz/gal. The process does produce a relatively small amount of sludge at high solids content which, in some cases, can be resold.

The lime process operates by reacting lime and aluminum to form tricalcium aluminate. Chem mill solution and lime are flash mixed and then clarified to remove the precipitated tricalcium aluminate. The chem mill solution is returned to the chem mill tank and sludge is filter pressed to achieve 30 percent solids; recovered filtrate is also returned to the chem mill tanks. The process can produce a better chem mill solution (as low as 3 oz Al/gal) than the crystallization process, but produces much more sludge. It has been determined in pilot scale testing that greater than stoichiometric amounts of lime are required; as a result, the sludge product contains unreacted lime, which may result in a pH of over 12 (i.e., the sludge may be a hazardous waste due to corrosivity unless further neutralization is provided). Lime precipitation produces roughly 4 times as much dry sludge mass as the crystallization process. Additionally, lime sludge does not dewater as well as crystallization sludge, so its moist mass is roughly 7-9 times that of crystallization sludge.

Lime precipitation was employed for a limited period of time at AFP 4 several years ago. Although its use was discontinued owing to unfavorable economics, higher current disposal costs may render this approach attractive for use at AFP 4. Both processes may produce hazardous sludge due to free sulfide content if not processed by centrifugation to remove suspended sulfides prior to aluminum removal. Additionally, lime sludge may be hazardous due to untreated lime unless neutralized. Applicability of either of these processes to a particular milling operation and process economics are highly dependent upon bath operating parameters. Process economics also are dependent on costs for disposal of sludge residue and the type of sludge desired (i.e., the degree of sludge processing required).

Process economics and waste reduction efficiencies have been estimated assuming that either recovery process is feasible for use at AFP 4. Crystallization is the prefered process as it affords the greatest possible degree of waste reduction. The crystallization process requires a feed from the chem mill tanks of 5.4 to 6.0 oz/gal of aluminum, as determined by atomic absorption. This corresponds to approximately 7.3 to 8.2 oz/gal as determined by titration.

Table 3-5 presents the economics for a lime precipitation system and two crystallization systems; one which produces alumina crystals which may be resold and a second which produces a nonhazardous sludge suitable for disposal in a sanitary landfill. All three systems were costed including a smut removal centrifuge to assure generation of a nonhazardous product.

As shown, both crystallization systems have payback periods of approximately 2.5 years as compared to 6.6 years for lime precipitation. The system producing saleable crystals appears most attractive as it virtually eliminates waste generation and has lower annual operating expenses. The feasibility of utilizing the high-purity recovery system versus the low-purity crystallization system is dependent on the availability of a regional customer for purchase of recovered aluminum trihydrate ($AL_2O_3.3H_2O$) crystals. In calculating the economics shown in Table 3-5, it was estimated that two to three barrels per day of crystals could be recovered and sold at approximately $100/ton.

3.16.3 Recommendations

It is recommended that General Dynamics evaluate the feasibility of chem mill solution recovery. Required solution purity should be examined to determine if the chem mill system can be effectively operated at 5.4 to 6.0 oz Al/gal (by atomic absorption), the required input concentration for the crystallization process. If this operating range is acceptable, General Dynamics should institute a design study to develop detailed engineering specifications and costs for

TABLE 3-5
ESTIMATED ECONOMICS FOR CHEMICAL MILLING SOLUTION RECOVERY (ANNUAL BASIS)

	Crystallization Systems			
Parameter	Non-hazardous Waste Product	Saleable Product	Lime System	Existing System
Sludge Disposal	$ 8,200	--	$ 56,400	$ 87,100
Caustic Replacement	Negl.	Negl.	1,700	170,300
Utilities and Chemicals	31,400	$ 33,000	80,500	2,400
TOTAL EXPENSES	$ 39,600	$ 33,000	$138,600	$259,800
REVENUES	--	$ 18,200	--	--
NET EXPENSES	$ 39,600	$ 14,800	$138,600	$259,800
SAVINGS	$220,200	$245,000	$121,200	$ 0
Construction	$437,000	$490,000	$629,000	
Engineering	117,000	133,000	167,000	
TOTAL COST	$554,000	$623,000	$796,000	
PAYBACK	2.5 years	2.5 years	6.6 years	

implementation of a crystallization system. Concurrently, investigations should be conducted to identify a purchaser of recovered aluminum trihydrate. The availability of a purchaser will determine which crystallization technique may be best suited to AFP 4.

If the chem mill solution cannot feasibly be operated at concentrations of 5.4 to 6.0 oz Al/gal, engineering studies for implementation of a lime precipitation system should be conducted. Although preliminary economic estimates for a lime system are less favorable, it would eliminate the generation of a hazardous sludge. Assuming removal of smut during processing and neutralization of excess unreacted lime in the final sludge, the lime precipation system would produce a nonhazardous sludge approximately equivalent in volume to the quantity of spent caustic now disposed through underground injection by AFP 4. As a result, long term liability exposure and disposal costs could be significantly reduced.

3.17 MIXED ACID WASTE

3.17.1 Waste Description and Management Practices

A variety of strong and dilute acid wastes are generated at numerous points throughout AFP 4. These include:

- Sulfuric acid used in ion exchange resin regeneration;
- Alodine from chemical film operations
- Chromic acid from bond cleaning and plating lines
- Various nonchromic mineral acids from other plating and cleaning operations.

Total acid generation is estimated to be 3.4 million gal/yr, exclusive of dilute acid rinse waters. The bulk of these acids are treated on site. Chrome present in the acids is reduced to the trivalent state through addition of sodium bisulfite. A portion of the nonchrome acids are used to adjust the pH of chrome-bearing acid wastes during the chrome reduction step. The remainder of the nonchrome acids are piped to a waste pit together with reduced chrome wastes. The pH of the materials in the waste pit is adjusted by metering waste acids and spent caustic. An aqueous waste stream is decanted from the waste pit and discharged to the city sewer system.

In 1984, approximately 59,200 gallons of mixed acids were not treated in the AFP 4 treatment system due to operational problems. These mixed acids were removed in bulk by Gibralter Wastewaters for underground injection at a cost of $63/ton. Total 1984 off-site disposal costs for mixed acids were $17,170.

3.17.2 Waste Minimization Opportunities

General Dynamics has recently implemented changes to reduce off-site disposal of mixed acids. Spent caustic wastes (described in Section 3.16) are now used to neutralize waste acids in the waste pit. Although effective at reducing off-site waste disposal requirements, this system is cumbersome and labor intensive, as the acid/caustic proportioning must be controlled manually. In addition, this reliance on manual control and the lack of adequate treatment facilities (piping, tankage and controls) results in inefficient operations, excessive sludge production and occasional discharges which are in violation of sewer discharge limitations. These ineffeciencies were identified by Lockwood Greene Engineers in a study of AFP 4 waste management operations.

Based on the recommendations provided by Lockwood Greene, General Dynamics has requested funding to renovate the AFP 4 waste treatment system. This renovation, which consists primarily of improvements in piping, tankage and control capabilities, would allow better control over chrome reduction and pH as well as providing for removal of other heavy metals of regulatory concern. These improvements would assure the availability of an effective, on-site treatment system for mixed acid wastes.

3.17.3 Recommendations

It is recommended that General Dynamics continue the planned waste treatment system renovation. The planned modifications will further assure elimination of the need for off-site land disposal of acids, thereby reducing liability exposure significantly.

3.18 HEAVY METAL SLUDGE

3.18.1 Waste Description and Management Practices

Heavy metal sludge is generated at AFP 4 as the result of on-site treatment of acidic and caustic wastes. The current waste treatment system provides for chrome reduction and neutralization, as appropriate. Sludge generated during chrome reduction of acids is piped directly to a filter press for dewatering. Other treated wastes are stored in two 85,000-gallon waste pits, the decant from which is discharged to city sewers. Sludge is removed from the waste pits to a tank where final settling of suspended solids is achieved. The settled sludge is fed to a filter press where dewatering to approximately 25 percent solids is accomplished. The dewatered sludge drops into a dump truck and is transferred to a concrete pad for further air drying. Figure 3-5 presents a schematic representation of the AFP 4 waste treatment system.

Dried sludge is periodically removed in bulk for hazardous waste landfilling by Chemical Waste Management. Approximately 890 tons/yr of sludge are disposed in this manner at a cost of $63/ton. Total sludge disposal costs in 1984 were $56,000.

3.18.2 Waste Minimization Opportunties

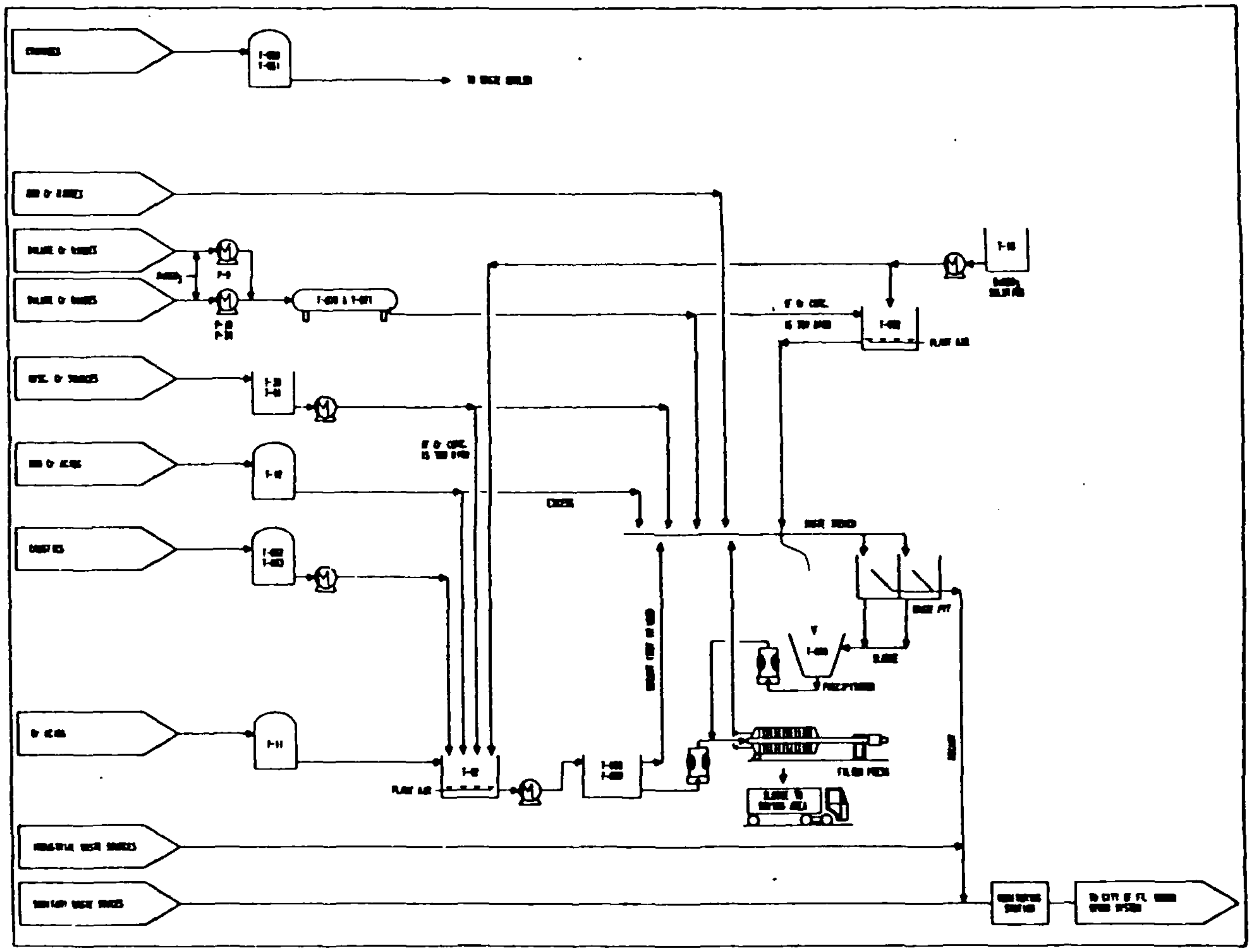
General Dynamics has requested funding for renovation of the AFP 4 waste treatment system. Preliminary engineering studies performed by Lockwood Greene Engineers indicate sludge production will increase by 740 percent to 6,600 tons/yr with the implementation of the recommended treatment system improvements. It appears, however, that substantial reductions in this projected rate can be achieved through alternative treatment approaches. The sludge production rate calculated by Lockwood Greene was based on treatability tests performed on a composite sample of AFP 4 wastewater. The treatment procedure utilized consisted of the following steps:

- Reduction of sample pH from 11.6 to 2.0 with sulfuric acid;
- Conversion of Cr^{+6} to Cr^{+3} with sodium bisulfite;
- Increase of sample pH from 2.0 to 9.0 with caustic soda; and
- Precipitation of metal hydroxides with polymer addition to enhance sludge settling.

Review of these data indicate that separate treatment of acid and alkaline wastes could achieve significant reductions in projected sludge production rates. If chrome-bearing acids are treated separately instead of first being mixed with waste caustic, no sulfuric acid addition should be required to adjust the pH to 2.0. Rather, this can be accomplished, as is currently done, by the addition of nonchrome acid wastes.

After chrome reduction is accomplished, the acid and caustic waste streams can be combined. As significantly more spent caustic than acid waste is generated at AFP 4, no purchased

FIGURE 3-5
EXISTING AFP 4 WASTE
TREATMENT SYSTEM



Source: Lockwood Greene Engineers

caustic soda should be required to achieve a final pH of 9.0. In fact, it appears that less than 15 percent of the spent caustic waste would be required to raise the waste stream pH to 9.0. The remaining spent caustic waste could potentially be recovered, as described in Section 3.16.

Based on a preliminary analysis of design data prepared by Lockwood Greene, it appears that such an approach would eliminate the need for the addition of over one million gallons per year of purchased sulfuric acid and caustic soda. This change to the preliminary treatment system design, combined with the independent recovery of spent caustic, would significantly reduce sludge generation from the calcuated value of 6,600 tons/yr. General Dynamics' design efforts currently call for pretreatment of chrome wastes in this manner. Assuming the use of a high-performance polymer to aid in settling, and air drying of sludge in the roll-off dumpster in which it is collected, it appears that sludge production can be contained to less than 2,000 tons/yr.

A slight reduction in sludge production is expected to result from the planned installation of a chromic acid recovery system at AFP 4. Etching solutions containing hexavalent chromium ions are used as precleaners prior to anodize, chemical film, bonding, and masking. Chromic acid solutions are also used for anodizing, as deoxidizers following chemical milling, and for pre-penetrant etching. As the solutions are used, hexavalent chromium ions are reduced to their trivalent state, contaminants (primarily copper and aluminum) accumulate in the solution, and the effective acid concentration is reduced. When the solution becomes unsatisfactory for a particular operation, it is treated in the AFP 4 waste treatment system.

A chromic acid regeneration unit capable of converting the complexed acid back to the original "free acid" state, while simultaneously removing dissolved aluminum and copper contaminants, is planned for use at AFP 4. This recovery method is based on technology developed by the U.S. Bureau of Mines.

Approximately $75,000/yr is currently being spent on replenishing chromic acid in the two 8,600-gallon tanks targeted for recovery systems. This yearly expenditure reflects chemical, labor, waste treatment, and subsequent sludge disposal costs. Lockwood Greene estimates that cost savings of $70,000/yr may be realized (following an 18 month payback on a $105,000 unit) after adjustment for electrical operating costs and additions of small amounts of make-up chemicals lost due to dragout. Uncalculated additional savings will also be realized from the elimination of production downtime incurred during routine solution changeouts and replenishments.

Approximately 441,000 gal/yr of chrome acids are currently treated in the AFP 4 waste treatment system. Acid recovery systems for tanks T513 and T519 are expected to reduce these flows by 65,570 gal/yr or 15 percent. Based on Lockwood Greene's calculated sludge production rates, the planned chromate recovery operation will reduce sludge production by approximately 2 tons/yr or about 0.2 percent from 1984 rates.

3.18.3 Recommendations

It is recommended that General Dynamics proceed with the planned treatment plant renovation. These renovations are necessary to achieve compliance with local discharge requirements. It is recommended that the recently-initiated design study focus on treatment methods which will minimize the generation of sludge requiring off-site disposal.

It is also recommended that General Dynamics proceed with implementation of the planned chromic acid recovery system. The planned system will result in significant long-term cost savings and will decrease land disposal requirements by approximately 2 tons/yr.

3.19 CYANIDE WASTE

3.19.1 Waste Description and Management Practices

Cyanide wastes generated at AFP 4 consist mainly of spent cadmium plating solutions and sludges. Silver-rhenium plating solutions and silver stripping wastes account for approximately 20 percent of this stream. Approximately 11,200 gallons of cyanide wastes were collected in drums in 1984 and sent to Gibralter Wastewaters for cyanide destruction. At the current fee of $125/ton, cyanide waste disposal costs are approximately $5,700/yr.

3.19.2 Waste Minimization Opportunities

3.19.2.1 Ion Vapor Deposition

General Dynamics has requested $472,000 in FY 1987 funding to replace existing cadmium plating equipment with an Ion Vapor Deposition (IVD) system in Building 181. The system, which relies on the deposition of ionized aluminum in a vapor form, would virtually eliminate waste generation from the cadmium plating line and would reduce plant-wide cyanide waste generation by 80 percent. Perhaps the most significant advantage of IVD is the reduction in plantwide usage of highly toxic cyanide and cadmium of 80 percent and 100 percent, respectively, that could be achieved. Material consumption would decrease significantly, owing to the high efficiency of IVD, and the need for continuous rinsing would be eliminated, thus reducing wastewater generation. Assuming reduced operating costs of $10,000/yr, total cost savings would be approximately $16,000/yr. IVD system payback would be realized in approximately 30 years.

3.19.2.2 Acid Cadmium Plating

A possible alternative available for cadmium cyanide plating replacement is acid cadmium plating. One such plating solution is manufactured by LeaRonel, Inc. of Freeport, New York under the trade name "Kadizid" plating solution. This proprietary batch solution consists of cadmium oxide, sulfuric acid, and brightener, starter, and stabilizer compounds. Lockheed-Georgia Company at AFP 6 incorporated this acid cadmium plating system in August, 1983. Lockheed has found no reduction in product quality following changeover, but has realized a slight reduction in operating costs and total elimination of cyanide operations. Based upon conversations with vendors and Lockheed, it appears that General Dynamics would experience a small reduction in the treatment cost of cadmium solution which would be offset by increased raw material costs. Acid cadmium plating does not offer the benifit of eliminating the use of toxic cadmium, as does IVD, but does offer similar waste reduction opportunities.

3.19.2.3 On-Site Treatment

As an alternative to switching cadmium plating operations, cynaide wastes could be destroyed on-site using conventional methods, such as treatment with sodium hypochlorite at an elevated pH. Although cost-effective, cyanide destruction processes entail an additional cyanide handling step, thus increasing the potential for serious accidents. Lockwood Greene has performed preliminary system evaluations which indicate that a 2,000-gallon batch treatment system could be utilized to effectively treat all AFP 4 cyanide wastes. The incremental cost of including a cyanide destruction system in the planned waste treatment system renovation is estimated to be $20,000 with O&M costs of $2,000/yr. Based on avoided disposal costs of $6,000/yr, payback would be realized in approximately five years.

3.19.3 Recommendations

It is recommended that General Dynamics conduct further evaluations of the alternatives discussed in this section. As all three approaches appear to be viable alternatives to current practices and offer significant reductions in off-site disposal requirements, the net costs and benefits should be weighed to determine which approach will be most beneficial to the Air Force. Of the three options, IVD is preferred from a technical standpoint as it achieves the greatest possible increse in workplace safety while greatly reducing waste generation. It is noted that on-site treatment is the only technology which would eliminate the need for any off-site cyanide disposal and, hence, may be appropriate for use with cyanide waste generated from siver-rhenium plating operations.

3.20 MERCURY CONTAMINATED WASTE

Approximately 100 lbs/yr of mercury contaminated waste are generated by AFP 4 from the cleanup of small mercury spills. Metallic mercury is recovered for resale from spill residues to the maximum extent economically practical. No additional opportunities for waste minimization have been identified.

3.21 CONTAMINATED GROUNDWATER

Approximately 500,000 gallons of contaminated groundwater were collected by General Dynamics in 1984 from three sources; the french drain, outfall, and south storm basin. These contaminated waters were disposed in bulk by Gibralter Wastewaters at a cost of $57/ton resulting in a total annual disposal cost of $204,200.

General Dynamics temporarily ceased pumping contaminated groundwater from these sources early in 1985 to accomodate data collection concerning operation of on-site groundwater decontamination systems. Contaminated groundwater is again being accumulated for off-site disposal pending completion of remedial actions under the Air Force's Installation Restoration Program (IRP). As the ongoing IRP actions will attempt to minimize off-site land disposal of waste materials while providing a permanent soltuion to contamination problems, no waste minimization measures are presented for this waste stream.

3.22 DIRT, OIL & SOLVENT WASTE

Approximately 112 tons of floor sweepings contaminated with spilled oils and solvents are generated at AFP 4 annually. No opportunities for waste minimization, other than on-site incineration, as described in Section 3.25, have been identified.

3.23 EMPTY DRUMS

3.23.1 Waste Description and Management Practices

Approximately 280 steel, 35-gallon and 55-gallon drums are disposed by AFP 4 each year. These drums are contaminated with hazardous wastes or hazardous materials and are unacceptable for reuse owing to either the nature of the contamination or physical damage to the drum itself. General Dynamics personnel attempt to suction out drum contents, however, many drums contain greater than one inch of hazardous material and must be managed as hazardous watses.

The hazardous empty drums are removed, without size reduction, by Chemical Waste Management for land disposal. Drum disposal costs are approximately $15/drum plus $1,500/load for transportation, resulting in annual dipsosal costs of approximately $9,450.

3.23.2 Waste Minimization Opportunities

Empty drums could potentially be washed and, if damaged, crushed on-site, making their sale for reuse or as scrap economically viable. General Dynamics drum management personnel have indicated interest in adopting this alternative to land disposal.

Equipment requirements for on-site drum salvage include a drum deheader, a drum washer and a drum crusher. Drum washing wastes are estimated to be approximately two gallons per drum, resulting in annual generation of approximately 560 gallons (4,670 pounds) of hazardous waste requiring disposal. Potential annual cost savings of $6,900 have been calculated based on the following assumptions:

1. All drums are recovered for a scrap salvage value of $1.80/drum (current salvage prices paid to General Dynamics);
2. Rinsate disposal costs are $0.53/gal (current off-site land disposal costs paid by General Dynamics); and
3. O&M costs are $10/drum (Earth Technology estimate).

Based on estimated system aquisition costs of $15,000, capital cost recovery is estimated to occur in 2.2 years.

3.23.3 Recommendations

It is recommended that General Dynamics evaluate acquiring drum salvage equipment suitable for reclamation of empty drums now disposed as hazardous wastes. If system economics prove as favorable as initial projections, such a system would achieve a waste stream reduction of approximately 70 percent by weight and 94 percent by volume.

3.24 MASKING SOLVENT

3.24.1 Waste Description and Management Practices

Approximately 256 tons/yr of toluene and xylene isomers are lost as vapor emissions from the AFP 4 chem mill masking operation. The two covered maskant tanks employed at AFP 4 are opened approximately 20 min/hr for part masking throughout two shifts per day of operation. The replacement cost of these solvents, which are currently exhausted directly to the atmosphere, is estimated to be $145,000/yr.

3.24.2 Waste Minimization Opportunities

General Dynamics is currently evaluating viable techniques for reducing vapor losses from AFP 4 masking operations. The most feasible approach appears to be volatile hydrocarbon capture using activated carbon followed by steam regeneration of carbon and reuse of recovered maskant solvents. Both toluene and xylene have low water solubilities (5 percent and 2 percent, respectively), making their separation from the bed regenerant solution by simple physical methods quite feasible.

The principal drawback to adsorptive solvent recovery is the high capital cost of system implementation. It appears that the carbon beds utilized will have to be extremely large to effectively purify the dilute exhaust concentrations expected. System costs are estimated to range from one to two million dollars, resulting in payback periods of 7 to 14 years.

3.24.3 Recommendations

It is recommended that General Dynamics continue its evaluation of solvent recovery systems. Although such systems do have extensive payback periods, cost savings after payback are considerable. Further, the recovery of solvent emissions would represent significant progress towards achieving recently revised state restrictions on volitile organic carbon emissions at AFP 4.

3.25 WASTE INCINERATION

Many of the hazardous wastes generated at AFP 4 contain significant organic fractions, making them potential candidates for high temperature incineration. General Dynamics has requested funding for the design and engineering of a dedicated on-site system for the incineration of waste materials. A preliminary analysis of such a system is presented in this section.

3.25.1 System Description

In September, 1984 General Dynamics completed a feasibility study of incinerating AFP 4 waste materials. Based on the results of that study, General Dynamics has requested approximately $8 million for the construction of a high temperature incineration system at AFP 4. These estimates are based on quotations for the aquisition of a rotary kiln system with the capacity to incinerate approximately 33 tons/day of solid and liquid wastes, including nonhazardous plant trash. Included in the preliminary design are provisions for waste heat recovery to reduce AFP 4's fuel purchases.

Because the September, 1984 design did not factor in many of the waste reduction measures developed in the last 17 months and included provisions for nonhazardous waste incineration and heat recovery, an evaluation was conducted as a part of this study to identify the minimum system requirements for incineration as a part of a plant-wide waste minimization program. Table 3-6 presents a tabulation of the hazardous wastes generated at AFP 4 which are potentially amenable to incineration for volume and mass reduction. This listing has been prepared on the assumption that all other recommendations provided in this report are implemented. Hence, the waste quantities presented in Table 3-6 are the residual or unrecoverable portions of organic waste streams generated at AFP 4.

Degreaser solvents have not been included in Table 3-6 as their incineration does not appear to be advantageous. The degreaser solvents contain approximately 80 percent chlorine by weight and would generate a greater volume of calcium chloride scrubber sludge than the volume of degreaser solvents incinerated. These sludges would probably be hazardous, as hexavalent chrome present in other wastes incinerated would likely be captured by any caustic scrubbing system used, rendering the sludge hazardous. Further, wastes which appear to be amenable to other, less expensive treatment methods, such as contaminated groundwater, acids and caustics, have not been included in Table 3-6. Heavy metal sludge has not been included as it contains minimal amounts of volatile organics. It does not appear that incineration would render the sludge nonhazardous or significantly reduce its volume.

On this basis, the cummulative mass of waste available for incineration is calculated to be 664 tons/yr with a gross heat content of 11,274 mmBtu/yr. Based on 7700 hours/yr of operation (88 percent capacity), average loadings of 1.5 mmBtu/hr and 172 lb/hr are estimated. It should be noted that these minimum system requirements result in a design which has approximately six percent of the capacity of the system costed in the 1984 study.

From these preliminary calculations, it appears that a small rotary kiln incinerator equipped with a secondary combustion chamber and venturi scrubber could serve AFP 4's needs. As the wastes listed in Table 3-6 contain negligible amounts of halogens, it does not appear necessary to include a caustic scrubbing system in the design. A system with these features and an average heat release rating of 5 mmBtu/hr could be acquired for approximately $1 million. Engineering, facilities and installation are estimated to add $1 million to these costs and permitting $200,000. Total implementation costs for this minimum system are estimated to be $2.2 million.

As current land disposal costs are significantly lower than incinerator O&M costs, no direct cost savings would be realized by instituting incineration at AFP 4. Rather, O&M costs could be expected to increase to two to three times current land disposal costs or approximately $300,000/yr. Some reduction in costs is possible if waste heat can be beneficially recovered from the process. Assuming 30 percent of the combusion heat tabulated in Table 3-6 is recoverable, approximately $50,000/yr in fuel cost savings are achievable. General Dynamics has estimated energy savings of approximately $500,000/yr for the larger system described in its 1984 feasibility study.

A significant drawback to on-site incineration is the extensive time required for implementation. Neglecting any time delays associated with obtaining system funding, the time required for design, permit application preparation, regulatory review, public hearings, approval, construction, shakedown and certification testing is estimated to be 2.5 to 3 years.

Balancing these drawbacks is the ability of incineration to reduce waste streams not amenable to other treatment techniques. It is estimated that incineration of the wastes listed in Table 3-6 would produce approximately 140,000 lbs/yr of ash requiring hazardous waste land disposal. This constitutes an 87 percent volume reduction in the hazardous wastes incinerated. Scrubber water could presumably be routed to the AFP 4 waste treatment plant for removal of suspended solids and metals.

3.25.2 Recommendations

It is recommended that General Dynamics evaluate on-site incineration of organic wastes not amenable to reduction through other means. As the preliminary analysis provided here reveals that even the smallest capacity incinerator system that is commercially available would only be utilized at 25 percent capacity to incinerate hazardous wastes, consideration should be given to operating the system as a heat recovery system with nonhazardous plant waste for the remaining 75 percent of its available unused capacity. In the nonhazardous mode, ash should not require management as a hazardous waste and more efficient (i.e., lower temperature) operating conditions should be allowable. This approach should be evaluated as it may reduce system operating costs to the point where operating cost savings can be realized over land disposal practices.

The economics of on-site incineration can be expected to change considerably in the near future owing to increasing land disposal costs. In addition, as illustrated in this analysis, the costs of aquiring and operating an incineration system will vary tremendously with the capabilities aquired. For these reasons, it is recommended that cost/benefit studies of incineration be conducted to identify the most advantageous course of action. It is recommended that these studies cover a variety of approaches and options for on-site waste incineration , including those described in this section.

TABLE 3-6
WASTES AMENABLE TO HIGH-TEMPERATURE INCINERATION

WASTE	QUANTITY AVAILABLE (LBS/YR)		ESTIMATED	AVAILABLE HEAT
	LIQUIDS	OTHER	HEAT (BTU/LB)	(MMBTU/YR)
1. Tramp Oils from coolant recycle	34,400		18,000	619
2. Unrecoverable hydraulic oil	41,500		18,000	747
3. Waste JP-4	84,800		20,000	1,696
4. Paint sludge		161,000	2,000	322
5. Dry paint		108,500	2,000	217
6. Paint booth solids		83,600	2,000	167
7. Unrecoverable paints & thinners	288,300		10,000	2,883
8. Unrecoverable naptha	300		17,000	5
9. Isopropyl Alcohol	3,920		9,000	35
10. Unrecoverable mixed solvents	281,500		14,000	3,941
11. Fiberglass resins and acetone	16,200		12,000	194
12. Dirt, Oil and Solvents		223,810	2,000	448
TOTALS	750,920	576,910		11,274

APPENDIX A

APPENDIX A
UNIT WASTE MANAGEMENT COSTS

1. Gibralter Wastewaters, Inc.
   Winona, Texas

   A. Deep Well Injection

      -Organics, $0.53/gal
      -Spend Caustics, Acids and Contaminated Groundwater, $57/ton

   B. Cyanide Destruction, $125/ton

2. Chemical Waste Management
   Carlyss, Texas

   A. Organic Solids and Sludges, $125/ton

   B. Heavy metal aludge, $63/ton

   C. Empty drums, $15/drum plus $1500/load trans.

3. Cooks Oil
   Forth Worth, Texas

   A. Hydraulic Oil, $0.35/gal revenue

APPENDIX B

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: WATER-SOLUBLE CUTTING OIL

CHARACTERISTICS: 96% H_2O, 4% CUTTING OIL (TRIMSOL & HYDE PRODUCTS) METAL CHIPS, SOME VARSOL, SOME HYDRAULIC OILS, TRACE OIL-SORB
(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: TWO SOURCES: ① ABOUT 500 MACHINES WITH SEPARATE SUMPS - COLLECTED BY VACUUM TRUCK - DRUMMED (55-GAL) AND SENT TO DEEP WELL INJECTION ② SIX LARGE MACHINES IN "CNC" AREA PUMPED TO CHIP REMOVAL + WESTFALIA CENTRIFUGE - TO 12,000-GAL HOLDING TANK - BIOCIDE ADDED AS NEEDED AND PUMPED BACK TO MACHINES - DUMPED TWICE/YEAR - REMOVED IN BULK FOR DWI

GENERATION
1. RATE: 1.907×10^6 LBS (1985 PROJ)
2. FREQUENCY: ① DAILY ② TWICE/YR
3. COST: $0.53/GAL FOR DWI

PROPOSED CHANGES: LOOKING AT INDEPENDANT CONTRACTED ON-SITE RECYCLE @ $0.48/GAL (75% RECOVERY)

EVALUATING RADIOACTIVE STERILIZATION.
FUNDING REQUESTED FOR SUMP SUCKER, NEW CENTRIFUGE & ULTRAFILTRATION SYSTEM FOR UNRECOVERABLE COOLANT

RAW MATERIAL DATA
1. CHARACTERISTICS: PURE TRIMSOL OILS
2. QUANTITY: 21,570 GAL (1985 PROJ)
3. COST: $7.69/GAL

NOTES: TRYED DI MAKEUP - CALCIUM SEQUESTERING AGENT CAUSED FOAMING. USING COOLANT AS WAYLUBE IN MACHINES THAT DRAIN TO COOLANT SUMP. USED 20,615 GAL TRIMSOL IN 1984.

PLANT # 4
OPERATOR: GD
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WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: HYRDRAULIC OIL

CHARACTERISTICS: MACHINE HYDRAULIC OIL CONT. WITH DIRT

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM LATHES, MILLS, ETC. DURING ROUTINE MAINTENANCE

46% FROM ~500 MACHINES — COLLECTED IN DRUMS FOR DWI

54% FROM 4 LARGE MACHINES - COLLECTED IN STORAGE TANKS @ #88 FOR RECYCLE BY COOKS OIL

GENERATION
1. RATE: 414,500 LBS (1984 EST)
2. FREQUENCY: DAILY
3. COST: $0.35/GAL - RECYCLE (REVENUE)
$0.53/GAL - DWI

PROPOSED CHANGES: RATES ARE RUNNING 33% HIGER IN 1985 (FIRST 6 MOS)

RAW MATERIAL DATA
1. CHARACTERISTICS: 4 DIFF GRADES HYD. OIL
2. QUANTITY: 57,970 GAL (1984)
3. COST: AVG $2.18/GAL

NOTES: 15,840 GAL WENT TO 1 MACHINE (4 POST STRETCHER) DUE TO LEAKS

PLANT # 4
OPERATOR: GD
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WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: MOTOR OIL

CHARACTERISTICS: USED ENGINE OIL, ANTI-FREEZE, HYDRAULIC FLUID, TRANSMISSION FLUID, GEAR OIL

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM MAINTENANCE OF VEHICLES IN MOTOR POOL.

COLLECTED IN 55-GAL DRUMS FOR DWI

GENERATION
1. RATE: 202,600 LBS (1985 PROJ)
2. FREQUENCY: DAILY
3. COST: $0.53/GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
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WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: JP-4

CHARACTERISTICS: JET FUEL w/ SOME TRACE CONTAMINATION

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM AIRCRAFT FUELING & TANK DRAINING

SOLD TO COOK'S OIL FOR RECYCLING

GENERATION
1. RATE: 84,800 LBS (1984)
2. FREQUENCY: CONTINUOUS
3. COST: $0.35/GAL (REVENUE)

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: ALSO PAY $0.53/GAL FOR DISPOSAL OF $24,151/LBS/YR OF MIXED JP4/JP5/HYDRAULIC OIL.

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: PAINT SLUDGE

CHARACTERISTICS: WATER & PAINT SOLIDS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM PAINT BOOTH WATER CURTAINS
DRUMMED FOR ~~DWI BY GIBRALTER~~ LANDFILL
BY CHEM WASTE MANAGEMENT

GENERATION
1. RATE: 161,000 LBS (1985 PROJ)
2. FREQUENCY: PERIODIC
3. COST: $125/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: DRY PAINT

CHARACTERISTICS: PAINT PIGMENTS & SOLIDS
WITH SOME CHROME.

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM PERIODIC SCRAPE-DOWN
& CLEANOUT OF PAINT BOOTH ARES BY CONTRACTOR.

HAULED IN DRUMS FOR LANDFILL BY CWM

GENERATION
1. RATE: 108,490 LBS (1984)
2. FREQUENCY: 8 TIMES IN 1984
3. COST: $125/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: PAINT WASTE SOLIDS

CHARACTERISTICS: AIR FILTERS W/ PAINT RESIDUES

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM REPLACEMENT OF DRY PAINT BOOTH FILTERING SYSTEMS

HAULED IN DRUMS BY CWM FOR LANDFILL

GENERATION
1. RATE: 83,600 LBS (1984)
2. FREQUENCY: PERIODICALY
3. COST: $125/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: PAINTS & THINNERS

CHARACTERISTICS: PAINTS, MEK, XYLENE, TOLUENE & OTHER THINNERS (MIBK, ACETONE, ALCOHOLS MIL-C CLEANER)
(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM CLEANUP OF PAINTING ING EQUIPMENT

70% URETHANES 30% ACRYLICS

DRUMMED FOR DWI

GENERATION
1. RATE: 576,600 LBS (1985 PROJ)
2. FREQUENCY: PERIODIC — CONTINUOUS
3. COST: ~~$0.56/GAL~~ $0.53/GAL

PROPOSED CHANGES: APPROVAL EXPECTED SOON FOR SWITCHING ALL PRIMERS TO WATER BASE COATING

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: POLY-URETHANE USED FOR TOP COATS
ACRYLIC ~~EPOXY~~ USED FOR PRIMERS
EPOXY ~~ACRYLIC~~ FOR OTHER USES

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: DEGREASING SOLVENTS

CHARACTERISTICS: 70% TCE, 30% TCA PLUS OIL & WATER CONTAMINATION

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM PLANT'S VAPOR DEGREASERS PERIODICALLY DRAINED INTO DRUMS FOR DWI. NO FIXED METHODOLOGY FOR DETERMINING WHEN TO DRAIN DEGREASERS.

GENERATION
1. RATE: 238,700 LBS (1985 PROJ)
2. FREQUENCY: PERIODIC
3. COST: $0.53/GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-24-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: NAPTHA

CHARACTERISTICS: NAPTHA WITH TRACE CONTAMINANTS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: CLEANING AROUND LABS & OTHER AREAS

DRUMMED FOR DWI

GENERATION
1. RATE: 15,700 LBS (1985 PROJ)
2. FREQUENCY: ROUTINE
3. COST: $0.53/GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY: 1456 GAL IN 1984
3. COST: $1.02/GAL

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: ISOPROPYL ALCOHOL

CHARACTERISTICS: IPA WITH TRACE CONTAMINATION

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: USED AS ELECTRICAL CONTACT CLEANER IN ENGINEERING LABS.

ACCUMULATED IN 55-GAL DRUMS FOR DWI

GENERATION
1. RATE: 3,920 LBS (1985 PROJ)
2. FREQUENCY: DAILY
3. COST: $0.53/GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY: 4362 GAL (1984)
3. COST: $2.29/GAL

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: TURCO CLEANER & WATER

CHARACTERISTICS: TURCO 3878 (EMULSION CLEANER CONTAINING SODIUM CHROMATE & POTASSIUM HYDROXIDE) WITH WATER
(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM PART CLEANING PRIOR TO CHEM FILM & ANODIZE PROCESSES.

COLLECTED IN 55-GAL DRUMS FOR DWI

GENERATION
1. RATE: 8,680 LBS (1985 PROJ)
2. FREQUENCY: DAILY
3. COST: $0.53 /GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: MIXED SOLVENTS

CHARACTERISTICS: MEK, TOLUENE, MIL-C CLEANER, METHANOL, ETHANOL, DICHLOROMETHANE,

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM HAND-APPLIED CLEANING OPERATIONS

MINIMAL SEGREGATION - ACCUMULATED IN DRUMS FOR DWI

GENERATION
1. RATE: 563,000 LBS (1985 PROJ)
2. FREQUENCY: DAILY
3. COST: $0.53/GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PAGES 15 - 30

PAINT AND DEGREASING

The division of materials in the computerized emissions data report of 1983 is not entirely clear. In order that your records may be kept consistent, we provide herewith an updated summary of materials used for 1984. This is an update of the inserted page for 1983 and is listed in the same format. Quantity determinations were by material balance.

ALL PRICES AS OF 2/26/85

$/GALLON		FEED QUANTITY (gallons)	AIR EMISSIONS (tons)
3.45	TRICHLOROETHENE	43,682	251.1
4.34	TRICHLOROETHANE	19,204	102.2
1.02	NAPHTHA	1,456	4.6
2.40	METHYL ISOBUTYL KETONE	28	0.1
1.82	SAFETY SOLVENT	11,226	35.7
2.17	METHYL ETHYL KETONE	20,240	64.4
0.86	METHYL ALCOHOL	566	1.8
0.89	ETHYL ALCOHOL	167	0.5
2.29	ISOPROPYL ALCOHOL	4,362	13.5
1.45	ACETONE	3,337	10.5
?	DICHLOROMETHANE	2,370	12.5
3.15	AIR FORCE CLEANER	31,093	101.7
5.18	CELLOSOLVE ACETATE	469	1.8
45.75	URETHANE COATING/EPOXY PRIMER	13,079	31.6
	URETHANE COATING/EPOXY PRIMER	13,079	31.6
5.35	MASKANT	13,216	45.2
2.02	TOLUENE	~~15,180~~	~~51.9~~≈218 –
1.41	XYLENE	14,114	48.3
7.69	TRIMSOL		
1798.00	SEALANT		
0.68	CAUSTIC ETCH SOLUTION		

[illegible]

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: FIBERGLASS RESINS + ACETONE

CHARACTERISTICS:

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM PREPARATION OF FIBERGLASS COMPONENTS + MOLDS

DRUMMED FOR DWI

GENERATION
1. RATE: 16,200 LBS (1985 PROJ)
2. FREQUENCY: ROUTINE
3. COST: $0.53/GAL

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS: ACETONE
2. QUANTITY: 3,337 GAL IN 1984
3. COST: $1.45/GAL

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: WASTE SEALANT

CHARACTERISTICS: TWO-PART POLYSULFIDE & ACCELARATOR IN CONTAINERS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM FUEL TANK/CELL SEALING

STORED IN DRUMS FOR OFF-SITE LANDFILL

GENERATION
1. RATE: 14,250 LBS (1984)
2. FREQUENCY: DAILY
3. COST: $125/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: DISCARDED BECAUSE OF SHORT POT LIFE AFTER BEING THAWED OUT AT BEGINNING OF DAY.

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: SPENT CAUSTIC

CHARACTERISTICS: SODIUM ALUMINATE, SODIUM HYDROXIDE, SODIUM SULFIDE, Cu^+

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM ALUMINUM CHEM MILLING

REMOVED IN BULK FOR DEEP WELL INJECTION BY GIBRATER

SOME CAUSTIC MIXED WITH 3 PARTS ACID TO ACHIEVE NEUTRALIZATION ON-SITE

GENERATION
1. RATE: 3,055,380 LBS (1984)
2. FREQUENCY: PERIODIC
3. COST: $57/TON

PROPOSED CHANGES: 1985 OFF-SITE DISPOSAL WILL BE APPROX. 2,874,000 LBS; A 6% REDUCTION IS EXPECTED FROM UTILIZING CAUSTIC TO NEUTRALIZE WASTE ACIDS ON-SITE

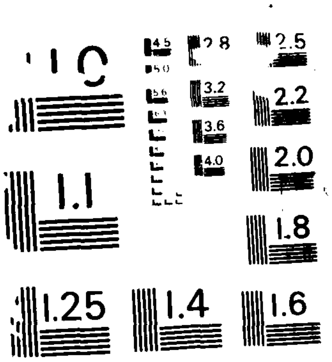
HOWEVER – BASED ON 1ST 6 MONTHS OF 1985 TOTAL FOR YEAR WILL BE 3.5×10^6 LBS

RAW MATERIAL DATA
1. CHARACTERISTICS: 12.2 LB/GAL
2. QUANTITY:
3. COST: $0.68/GAL

NOTES:

AD-A191 835 WASTE MINIMIZATION PROGRAM AIR FORCE PLANT 4(U) REL INC 2/2
BOYNTON BEACH FL 01 FEB 86 ASD/PMDA-04-WMN-001
F09603-84-G-1462-SC01

UNCLASSIFIED F/G 24/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: MIXED ACIDS

CHARACTERISTICS: CrO_3, HNO_3, HF, H_2SO_4

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM ALL CHEMICAL PROCESSES

PUMPED OUT IN BULK FOR OFF-SITE DISPOSAL BY DEEP WELL INJECTON

GENERATION
1. RATE: 545,000 LBS (1984)
2. FREQUENCY: INTERMITTANT
3. COST: ~~$63/TON~~ $57/TON

PROPOSED CHANGES: PLAN TO NEUTRALIZE IN FUTURE WITH WASTE ETCHANT IN CONCENTRATED WASTE TREATMENT SYSTEM - MIX TO pH=2, PRECIPITATE Cr, TAKE TO pH 6.0-9.5 w/ NaOH THEN TO IWWT SYSTEM

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: HEAVY METAL SLUDGE

CHARACTERISTICS: 25% Solids, (metal Hydroxides)
75% H_2O
SOME CHROME IN TRIVALENT STATE
(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: GENERATED FROM PLANT IWWT SYSTEM (PLATE & FRAME FILTER)

BULK LANDFILL BY CWM

GENERATION
1. RATE: 1,779,680 LBS (1984)
2. FREQUENCY: PERIODIC
3. COST: ~~$63/TON~~ $63/TON

PROPOSED CHANGES: CR WOULD BE REDUCED AS RESULT OF PLANNED CR RECOVERY SYSTEM.

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: Cr^{+6} LEVELS IN ATTACHED ANALYSES ARE NOT REPRESENTATIVE AS Cr^{+6} IS NOW REDUCED TO Cr^{+3}

ANALYSIS -10

GENERAL DYNAMICS
Fort Worth Division

INDUSTRIAL HYGIENE SURVEY

File No. 30-65

Date: 17 October 1980

To: E. L. Paschal, Jr. **Dept.** 003-4 **Mail Zone:** 6891

Copies To: Industrial Waste Committee, E. M. Drass, Jr., Walter R. Hill, File

Subject: Centrifuge Sludge Composition

Procedure & Results:

For information, all known analyses of the Waste Treatment Facility centrifuge sludges (Bldg. 203) are listed below. Except as noted, the analyses were performed in the Environmental Health laboratory. A blank indicates no analysis for that metal. It is uncertain how representative the ranges indicated are. This investigation is continuing in an effort to determine if the sludge can be defined as non-hazardous.

	11/21/77[1]	2/25/80[2]	2/28/80[3]	4/16/80[4]	10/9/80[5]	AVG	ANHYD. OXIDE
Al	137,000	28,400	32,000	26,300	315,000	107,740	203,50
Ba	-	-	-	ND*	-		
Cd	20	5.2	10	ND*	16	10	10
Ca	12,000	-	-	-	-		
Cr	415,000	2,000	100	988	21,600	87,937	169,110
Cu	2,900	2,540	690	3,535	5,900	3,105	3,881
Fe	3,600	-	-	2,200	1,762	2,521	3,601
Pb	-	ND*	10	143	130	71	71
Mg	1,100	-	-	-	-	1,100	1,837
Mn	370	-	110	186	113	195	195
Ni	150	-	40	25	40	64	64
Ag	-	-	-	-	9	9	9
Na	1,200	-	-	-	-		
Zn	-	-	540	479	171	1,200	1676
Solids	-	13%	16%	-	14%	397	39
						204,349	~385,00
							157

1 - Southern Spectrographic Laboratory - mg/kg, uncertain wet or dry

2 - mg/kg dry weight

3 - ERC/Lancy - mg/kg, uncertain wet or dry

4 - mg/kg, uncertain wet or dry

5 - mg/kg dry weight

* - not detected

more as (hydrated) sulfates + chlorides nitrates

From: TBSmiley, Jr. **Survey By:** J. T. Howard/T. B. Smiley, Jr.

Dept. 003-4 **Extension:** 3381 **Mail Zone:** 6876

ERC/LANCY

<u>General Dynamics</u>
<u>Fort Worth Division</u>

<u>Fort Worth, Texas</u>

TABLE IV

ERC/LANCY ANALYSIS REPORT

Date of Grab Sampling: 2/28/80
Date Received: 2/29/80
Date of Report: 3/11/80, 3/28/80

ERC/Lancy Project #10,050
Plant Services Contract #3217

	Centrate	Centrifuge Sludge	Chrome Reduction	Pit #184 So. Pit Sludge Bottoms	Recirculated Paint Booth Wash
pH	9.20	8.80	4.40	7.90	7.05
CN^T	1.75	102 mg/Kg	8.41	2.21	
Cr^{+6}	45.5	17.1 mg/Kg	< .01	< .01	32.0
Sol. Cr^{+3}	17.5		183	< .01	6.0
Cr^S	63		183	< .01	38
Cr^T	66.4	0.1 gm/Kg	1080	84	39.2
Cu^S			11.8	0.04	
Cu^T	1.6	.69 gm/Kg	34.4	37.2	< .04
Pb^S				< .01	
Pb^T	< .04	< .01 gm/Kg	< .04	0.56	< .04
Ni^S				< .01	
Ni^T	< .04	.04 gm/Kg	0.48	3.6	< .04
Cd^S				< .01	
Cd^T	< .04	< .01 gm/Kg	0.08	0.24	< .04
Zn^S				0.03	
Zn^T	2.8	.54 gm/Kg	1.88	66.0	3.36
Mn^S				0.13	
Mn^T	0.04	.11 gm/Kg	2.36	5.40	< .04
Al^S				0.6	
Al^T	45.6	32.0 gm/Kg	1.65 g/l	2.10 g/l	
S^-	< 10	< 10	< 10	< 10	
SO_3			< 10		
O & G	5.0	.55 gm/Kg	25.0	25.0	
TDS			42.1 g/l		1.0 g/l
% Dry Solids		16.3%		.86%	
TSS			10.7 g/l		31.0
Sr			1.24		54.8
SO_4	8.25 g/l	2.0 g/Kg	26.0 g/l	2.97 [illegible]	1[illegible]3.5

Analysis Report, continued

Notations and Comments:

1. Centrifuge sludge results are reported in either mg/Kg or gm/Kg units.

2. All other analytical results except pH are reported in mg/l units unless otherwise noted.

3. The recirculated water wash paint spray booth sampled is located in the southwest paint area (north booth) close to column 15N.

4. S and T designate "Soluble" and "Total," respectively.

5. The South Pit Sludge Sample was collected approximately one hour after the Centrate and Centrifuge samples. Therefore, Cr^{+6} levels cannot be directly compared for these three samples.

6. Fairly concentrated chromium waste (Cr^T = 1080 mg/l) from chromic acid storage, T-870, T-871, was being chemically reduced in chrome reduction, T-872, at the time of sampling. The measured influent flow rate was 60 GPM.

7. Two day-shift waste treatment operators were supervising the chrome reduction treatment at the time of sampling. Considerable manual valve adjustments (bisulfite feed and waste feed) were required to ensure an adequate supply of sodium bisulfite to compensate for the higher than normal 60 GPM relatively concentrated chrome waste influent. (The operators were notified in advance by John Bielefeld of Process Control to anticipate these concentrated chrome wastes.)

8. The waste treatment operator's chrome reduction, T-872, pH measurement = pH 3.6 (Markson Model #74 portable pH meter). His second-stage chrome precipitation, T-872, pH measurement = pH 6.5.

9. The waste source for CN^T is assumed to be the production conversion coating treatment for aluminum (Alodine 1200S).

7

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: CYANIDE WASTE

CHARACTERISTICS: CD-CN; Ag-CN; STRIPPER

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM ① Cd PLATING ② SILVER PLATING AND ③ SILVER STRIPPING

DRUMMED FOR OFF-SITE CN DESTRUCTION BY GIBRALTER

GENERATION
1. RATE: 89,100 LBS (1984)
2. FREQUENCY: INTERMITANT
3. COST: $125/TON

PROPOSED CHANGES: PLANNING ON 1988 CONSTRUCTION OF ION VAPOR DEPOSITION (IVD) SYSTEM FOR CD PLATE TO ELIMINATE CN

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: VERY LOW SILVER PLATE/STRIP FREQUENCY ONLY FOR F-111 WING PIVOT PINS

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: CYANIDE CONTAMINATED SOLIDS

CHARACTERISTICS: SLUDGE FROM BATHS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: CLEANOUT OF PLATING TANKS

SLUDGE IS DRUMMED FOR DEEP WELL INJECTION

GENERATION
1. RATE: 1,1930
2. FREQUENCY: INFREQUENT
3. COST: $125/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: MERCURY CONTAMINATED WASTE

CHARACTERISTICS: GLOVES, APRONS, GLASS, SORBENT, WATER, RAGS, ETC. + TRACE MERCURY

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM CLEANUP OF SMALL Hg SPILLS (THERMOMETERS & MANOMETERS)

DRUM DISPOSAL AT LANDFILL BY CHEM WASTE

GENERATION
1. RATE: 10 LBS (1984)
2. FREQUENCY: 4 TIMES /YEAR
3. COST: $125/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: Hg RECOVERED FROM SPILLS & SOLD FOR RECYCLE

4 SPILLS IN 1984 - 2 GAL WASTE /SPILL

PLANT # 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: FRENCH DRAIN

CHARACTERISTICS: GROUND WATER CONTAMINATED W/ORGANICS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: PUMPING FRENCH DRAIN FROM WEST PARKING LOT TO REMOVE SUBSURFACE CONTAMINATION.

HAULED OFF IN BULK TANKER BY GIBRATER FOR DWI

GENERATION
1. RATE: 2,805,990 LBS (1984)
2. FREQUENCY: DAILY
3. COST: [illegible] $57/TON

PROPOSED CHANGES: MUCH LOWER IN 1985 — NOW AIR STRIPPING CONTAMINANTS & DIRECT DISCHARGING WATER

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT #: 4
OPERATOR: GD
DATE: 7-23-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: DIRT, OIL & SOLVENTS

CHARACTERISTICS: SORBENT MAT'L CONTAMINATED WITH OIL & SOLVENTS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: FROM FLOOR SWEEPING OF PRODUCTION AREAS

STORED IN 55-GAL DRUMS FOR LANDFILL BY CWM

GENERATION
1. RATE: 223,810 LBS/YR (1984)
2. FREQUENCY: DAILY
3. COST: $148/TON

PROPOSED CHANGES:

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES:

PLANT # 4
OPERATOR: GD
DATE: 7-22-85

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: EMPTY DRUMS

CHARACTERISTICS: STEEL 55-GAL DRUMS AND
35-GAL DRUMS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: DAMAGED DRUMS AND DRUMS WITH
>1-INCH MATERIAL FROM NEW PRODUCT PURCHASES
AND WASTE MANAGEMENT. – SENT TO LANDFILL (HW)

(GD TRIES TO SUCTION OUT LIQUIDS & ADDS OIL SORB)

GENERATION
1. RATE: 16,790 LBS (1984) = 280 DRUMS
2. FREQUENCY: CONSISTANT
3. COST: $15/DRUM = $0.25/LB + $1500 TRANSPORT

PROPOSED CHANGES: FUNDING REQUESTED FOR DRUM
WASHER & CRUSHER (PROPOSAL TO FACILITIES ENGR) – ALSO
NEED DEHEADER TO OPEN LINED DRUMS (MARKET GONE)
AND DRUMS W/ CORRODED BUNGS

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST:

NOTES: RECEIVE $2.50/DRUM FIR CLOSED HEAD IN GOOD
CONDITION – RECEIVE $.03/LB FOR RECYLABLE STEEL

DRUMS WEIGH ~ 60 LB EACH

PLANT # 4
OPERATOR: GD
DATE: 7-23-84

WASTE MINIMIZATION PROGRAM
DATA SHEET

WASTE STREAM: MASKING SOLVENT

CHARACTERISTICS: 50% TOLUENE, 50% XYLENE
SMALL AMOUNTS OTHER ISOMERS

(ATTACH ANALYSIS IF AVAILABLE)

SOURCE/MANAGEMENT: PART MASKING PRIOR TO
CHEM MILLING.

ALL LOST TO ATMOSPHERE

GENERATION
1. RATE: 256 TON/YEAR
2. FREQUENCY: CONTINOUS
3. COST: N/A

PROPOSED CHANGES: LOOKING AT ENCLOSING PROCESS
AND CARBON STRIPPING LIKE DO @ McD-D IN
HAWTHORNE

MAYBE USE ALT SOLVENT OR WATER BASE.

RAW MATERIAL DATA
1. CHARACTERISTICS:
2. QUANTITY:
3. COST: TOL = $2002/GAL XYL = $1.41/GAL
MASKANT = $5.35/GAL

NOTES: COVERS ARE OPEN 20 MIN/HOUR X 16 HRS/DAY

MASKANT: (12#/GAL) LOST 58 TPY IN VOLITALES
SOLVENT: (7.25#/GAL) LOST 198 TPY IN VAPORS

END
DATE
FILMED
6-1988
DTIC