AD-A055 469 NAVAL AIR DEVELOPMENT CENTER WARMINSTER PA AIRCRAFT --ETC F/G 13/2
A POLLUTION ABATEMENT CONCEPT, RECLAMATION OF NAVAL AIR REWORK --ETC(U)
APR 78 H J LEE, I H CUSTIS, W C HALLOW

UNCLASSIFIED NADC-78028-60 NL

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DATE FILMED
8-78
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REPORT NO. NADC-78028-60

(12)

A POLLUTION ABATEMENT CONCEPT, RECLAMATION OF NAVAL AIR REWORK FACILITIES WASTE SOLVENT, PHASE I

H. J. Lee, I. H. Custis and W. C. Hallow
Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974

5 APRIL 1978

PHASE REPORT
AIRTASK A340/0000/001B/6F57-572-401
Work Unit VQ301

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Prepared for
NAVAL AIR PROPULSION CENTER
Trenton, New Jersey 08628

NADC-78028-60

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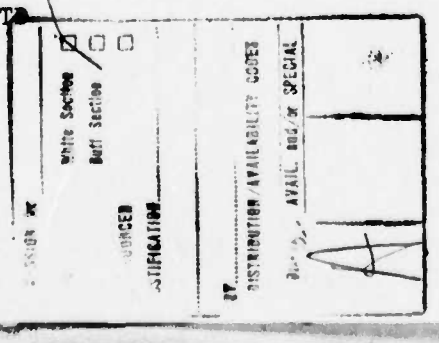

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

(14) 1. REPORT NUMBER: NADC-78028-60

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

(6) 4. TITLE (and Subtitle): A POLLUTION ABATEMENT CONCEPT, RECLAMATION OF NAVAL AIR REWORK FACILITIES WASTE SOLVENT, PHASE I,

5. TYPE OF REPORT & PERIOD COVERED: Phase

6. PERFORMING ORG. REPORT NUMBER

(10) 7. AUTHOR(s): H. J./Lee, I. H./Custis and W. C./Hallow

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Naval Air Development Center
Aircraft & Crew Systems Technology Directorate
Warminster, Pennsylvania 18974

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AIRTASK A340-0000/001B/6F57-572-401, Work Unit VQ301

11. CONTROLLING OFFICE NAME AND ADDRESS:
Naval Air Propulsion Center
Trenton, New Jersey 08628

(11) 12. REPORT DATE: 5 April 1978

13. NUMBER OF PAGES: 21 (26 P.)

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
(16) F57572
(17) WF57572401

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Solvents, Environment, Materials, Chemical, Pollution, Abatement, Chemical Engineering * methylene chloride, trichloroethane, trichloroethylene

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The NARFs were surveyed to determine the type and quantities of solvents used per year, method and/or disposal procedures. Six recoverable solvents, methyl ethyl ketone, Freon TF, and stoddard make up 87% of the solvents used at the NARFs. Reclamation of these solvents by a commercial reclaimer will save the Navy in excess of $1,000,000 per year in disposal and replacement costs.

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S/N 0102-LF-014-6601

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SUMMARY

INTRODUCTION

The investigation reported herein was conducted under AIRTASK A340-0000/001B/6F57-572-401 program element 62765N, Work Unit VQ301. The objective of this program is to eliminate or reduce pollution by preventing the generation of the pollutive wastes through materials and industrial process changes. Reclamation of current waste materials is one of the more cost effective means of accomplishing this objective. The work reported herein is Phase I report on out-of-house reclamation of waste solvents used by Naval Air Rework Facilities (NARFs) in aircraft removal operations.

Traditionally, solvents used in aircraft rework have been considered as one time use items to be disposed of when they become dirty. Some of the present methods of disposal are incineration, evaporation, dumping and to a very limited degree, reclamation. In general, solvents do not break down when used as cleaners to remove grease, oils, dirt, etc.; they merely become contaminated with these materials. Since solvents do not break down they can be reclaimed for reuse by separating the solvent from the contaminants. There are in excess of one million gallons per year of solvents used by the NARFs. Solvent disposal costs are quite high. For example, at NARF, Alameda where such costs have been documented, it costs approximately one hundred fifty thousand ($150,000) dollars per year to dispose of waste solvents.

The approach followed in this investigation was to determine which solvents are present in reclaimable quantities and to determine how to reclaim them. Two general areas for reclamation were considered; in-house reprocessing by Navy personnel and out-of-house reprocessing by a contractor. In the case of the in-house reclamation several factors must be considered, such as, purchasing and installing of the necessary equipment, training of personnel to operate the equipment, the hazardous nature of the materials being reclaimed and the need for a backup system to cover contingencies such as equipment breakdown. The out-of-house method was investigated first and is reported herein. This method was chosen first in order to implement a reclamation program as soon as possible. This method will not require major equipment investment nor training of personnel and would serve as a backup system for the in-house reclamation system.

The approach followed was to utilize state-of-the-art technology to provide the required abatement solution, rather than to engage in a research program which does include a certain amount of risk. It is believed this approach would provide a timely low risk solution to the Navy's pollution problem.

SUMMARY OF RESULTS

The six NARFs were surveyed for information about the types and quantities of solvents used annually. Data was received from five activities. The data indicated that approximately one million gallons of solvents are being used annually for five NARFs. The types of solvents used are ketones, alcohols, hydrocarbons, esters, ethers, amines, halogenated solvents and mixtures of

these. A summary of these solvents is listed in Table 1. Although large quantities of solvents are being used, only a minimal effort is directed toward reclamation of these solvents.

Companies involved in reclaiming solvents were located and visited to discuss the costs and procedures that must be followed to reclaim used solvents. The cost of reclamation depends on the types of solvent being reclaimed, the type and quantity of contaminants, the purity required for the reclaimed solvents and the quantity of non-reclaimables. Cost effective reclamation of solvents requires that solvents be properly identified, the contaminants be identified and that solvents not be intermixed. It is most important that the solvents be kept segregated. This makes it possible to reclaim by simple flash distillation. If the solvents are mixed, reclamation can usually be accomplished but by a more costly method such as fractional distillation. Table 2 is a listing of reclaimers that are located close to the NARFs and who are interested in reclaiming NARF solvents.

Transportation companies were contacted to determine the cost of transporting the solvent, Table 3, to the reclaimer and return. Transportation costs are based on the quantity to be shipped, and the mode of transportation (drums or tanks). The cost would be significantly more if moved in drums, thus, the cheapest method of transporting the solvent is by tank truck. Rail transportation may be available between certain NARFs and processors and should be given consideration.

There are a total of 29 solvents, listed in Table 1, which constitute the 1,103,000 gallons reported. Of this number six solvents; methylene chloride, 1,1,1-trichloroethane, Freon TF, trichloroethylene, methyl ethyl ketone and stoddard, constitute 87% of the total volume used and are available in sufficient quantities for cost efficient reclamation. A summary of the potential cost savings availabie, if these solvents are reclaimed, is presented in Table 4. Other solvents can be reclaimed but they represent only a very small portion of the total and may not be profitable to recover.

A summary of the factors to be considered in a solvent reclamation program is presented in Appendix A. This summary is intended as a reference guide to enable each NARF to identify the steps necessary to establish a solvent reclamation program. This summary is a method to be used in initiating a contract reclamation program.

CONCLUSIONS

There is in excess of 1,103,000 gallons/year of used solvents that are not being reclaimed and this situation is exerting a high cost burden on the NARFs to both dispose of and to replace these solvents. There is a minimal effort being exerted by certain NARFs to reclaim these solvents but the volume reclaimed is small. The Class I disposal sites required for such large quantities of used solvent may not be available in the very near future. An immediate approach to the disposal and site problems would be to initiate an out-of-house reclamation program which would reduce the quantity of materials to be disposed of to approximately 10% of the present volume. It would also eliminate the cost of disposal presently being borne by the NARFs and return valuable solvents

to the NARFs at a cost savings of approximately one million dollars per year. The present methods of disposal which are pollutive, such as evaporation to the atmosphere, incineration and dumping, would be eliminated.

Of the 29 solvents being used by the NARFs, six of them, methylene chloride, 1,1,1-trichloroethane, Freon TF, trichloroethylene, methyl ethyl ketone (MEK), and stoddard are used in large enough quantities to allow for easy reclamation. If reclaimed, the estimated net yearly savings on solvent replacement costs would be; $340,000 for the methylene chloride, $170,000 for the 1,1,1-trichloroethylene, $300,000 for the Freon TF, $70,000 for the trichloroethylene, $66,000 for the MEK and $142,000 for the stoddard. A reclamation program would generate additional savings by eliminating current solvent disposal requirements. Although disposal cost data has not been determined for all NARFs, such costs at NARF, Alameda indicate that these savings, when projected for all of the NARFs, would be in excess of $870,000 per year.

The out-of-house reclamation program can be initiated immediately because commercial facilities and expertise are in place and available for use. Several important steps must be taken by the NARFs to make this approach work efficiently. They are segregation and identification of solvents and identification of the type and quantity of contaminants present in the used solvents.

The in-house approach, which has the potential of realizing a greater cost savings to the Government, should be developed as a follow-on program. Several factors, such as the purchase and installation of equipment, the training of personnel and also establishing safety precautions because of the toxicity and flammable nature of the solvents, make the in-house approach a program requiring significant lead time.

RECOMMENDATIONS

Based on this study, the following recommendations are made:

1. Initiate a demonstration program at one NARF to reclaim the solvents listed in Table 4. This demonstration program would require establishment of an in-house solvent collection phase and an out-of-house contractor reclamation phase. With the in-house phase, all solvents would be kept segregated to reduce reclamation costs and difficulties in contractor processing. The out-of-house contract reclamation phase should be under a total service contract in which the contractor performs the total job from pick-up of the used solvents to return of the reclaimed solvents without involving naval personnel.

2. Each NARF should initiate a six month trial collection program of the low volume solvents to determine if enough of these solvents can be collected for effective reclamation.

3. Should recommendation 2 prove to be not feasible, a demonstration project should be established to determine if small quantities of non-halogenated solvents could be mixed with boiler fuel for heating purposes.

4. Halogenated solvents should never be burned since they will cause air pollution with the toxic and corrosive by-products of combustion. A program should be initiated to devise a treatment system for halogenated solvents disposal.

5. In general, solvents should not be incinerated as a method of disposal.

6. An investigative program should be initiated to reduce the number or types of solvents being used. Fewer solvents in use would make segregation of types for reclamation much simpler and should eliminate many processing hazards. Volatility, effective use and cost would serve as major criteria for those solvents selected for retention.

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B A C K G R O U N D

A large volume (1,103,000 gallons) of solvents is being used annually by five of the six NARFs in all phases of their operations. A minimal reclamation effort is being carried out by a few NARFs but the quantity reclaimed is very small when compared to the total volume, which still leaves a large volume of solvents for disposal. Solvent disposal must be in Environmental Protection Agency (EPA) Class 1 sites which may become non-existent in the very near future.

Disposal of these solvents is very costly. NAS, Alameda, for example, is paying $240K per year to remove solvent waste, and 60% of this solvent waste comes directly from the NARF operations. The currently used methods of disposal are: (1) to sell the more valuable solvents outright to a contractor at a minimal return of $.15 to $.25 per gallon, (2) to pay a contractor to remove the less valuable used solvents, (3) to divert solvents to the industrial treatment plant where they escape to the atmosphere from an evaporation pond. In the latter case, the used solvent is simply poured into a concrete basin and allowed to evaporate into the atmosphere. The residue is then transported to a Class 1 site and buried.

Some small solvent reclamation programs have been undertaken in-house at some NARFs. However, factors such as ineffective equipment, poor operator techniques and lack of trained personnel have limited the success of these programs.

A P P R O A C H

The NARFs were surveyed (references (b), (c) and (d)) and requested to forward information on the types and quantities of solvents used per year and methods of disposal or reclamation. The types of solvents used are ketones, alcohols, hydrocarbons, esters, ethers, amines, halogenated solvents and mixtures of these. The individual solvents and quantities used by each NARF and the totals of each solvent are listed in Table 1. The quantities listed therein also include the components found in the mixed solvents.

The survey also indicated that minimal efforts are being made to reclaim waste solvents and that a number of the disposal options which are available are being practiced by the NARFs.

These options with their adverse effects on the environment and other disadvantages are as follows:

1. Evaporation pits - The waste solvents which are permitted to evaporate from these pits contribute to air pollution and may even constitute a fire hazard.

2. Land fill dumping - Dumping pollutes the environment through soil and water contaminants and through evaporation to the atmosphere and presents to some degree a fire hazard. The scarcity of Class 1 land fill sites is an additional disadvantage. Class 1 land fills must be used for solvents and only one such land fill is available to each West coast NARF.

3. Incineration - Incinerating is costly and may be a secondary form of pollution. Current NARF attempts at incineration have been unsuccessful.

4. Blending with fuels for heating value may or may not prove economical for some solvents, but it does abate pollution where combustion products are clean. However, halogenated solvents cannot be burned since they would generate air pollutants.

5. The out-of-house options are to pay a contractor for disposal or to sell the solvents outright to a contractor.

The disposal option constitutes a cost burden whereas selling the solvents to a contractor realizes some dollar return. In either case, only prime solvents will be accepted by these contractors and at high profit to the contractor.

Another option is reclamation. Although not widely applied, reclamation appears to be the option with the most advantages in that pollution abatement is achieved along with substantial economic return. For reclamation, however, the waste solvents must not be mixed together after use nor drained into a common receptacle, as is the current practice. Segregation of different types of waste solvents prior to reclamation is a primary requirement to render the option viable in terms of processing and economics.

D I S C U S S I O N

METHODS OF RECLAMATION

There are two areas of reclamation available; in-house and out-of-house.

1. <u>In-House</u>

Advantages of in-house reclamation are:

a. Eliminates handling, transportation and commercial reclaiming charges.

b. Allows a positive control on the scheduling and quality of processing.

c. Eliminates minimum reclamation quantities such as the 40,000 lb. transportation load.

A disadvantage of in-house reclamation is the hazardous nature of material to be reclaimed (toxicity and flammability). Materials toxicity is an important consideration since current status is fluid as regulating agencies update worker exposure regulations and new regulations are enacted.

2. <u>Out-of-House</u>

The outstanding advantages of the out-of-house method is that institution of a reclamation program can be almost immediate. No training of government personnel is required and this mode of reclamation serves later as a backup for any in-house method that is adopted.

Potential reclaimers were contacted and parameters were determined for reclaiming waste solvents. A number of reclaimers that are potentially interested in reclaiming NARF solvents are listed in Table 2. There are those that would process waste solvent and return the reclaimed material to the Government. A small group of reclaimers would in addition to reclaiming, add virgin solvent to bring the volume of reclaimed solvents to the initial volume received for processing, but this offers little advantage to the Navy. In addition to these, some reclaimers were interested in buying the waste materials outright at a very minimal dollar return, while other reclaimers would charge a fee for the solvents taken which is relatively costly for hauling away the waste material.

PROCESSING

There are two major methods used in reclaiming solvents; simple or flash distillation and fractional distillation. The particular method used depends on the type of solvent, type and quantity of contaminant in the used solvent and the purity requirement of the reclaimed solvent. Each case will be handled on an individual basis. As previously stated, segregation of the different types of solvents is a prime requirement for reclamation. In general, separation of the solvent from the contaminants can usually be accomplished by simple distillation. However, if segregation is not practical or not possible, fractional distillation, which is much more costly can be used. To generate cost data on reclamation, the Swope Chemical Company (SWOPE), Pennsauken, New Jersey and Solvent Recovery Service (SRS), Linden, New Jersey were consulted. A range of charges for reclamation was obtained from each; however, to establish the exact cost of reclamation for each solvent, samples of waste solvents for study were necessary. Two samples of each waste solvent, trichloroethylene and lacquer thinner were requested from NAS, Jacksonville, (reference (e)) and two samples each of Varsol, 1,1,1 trichloroethane, methylene chloride and Freon TF were requested from NAS, Norfolk (reference (f)). Samples of trichloroethylene and lacquer thinner were sent to SWOPE and SRS, respectively, for reclamation studies to establish cost and percent recovery. Data received from SWOPE indicate a reclaimers charge of $.40/gallon for trichloroethylene if received in tank truck and $0.45/gallon if received in drums. Note that an extra charge for handling is imposed on drum lots. For lacquer thinner reclamation, the charge is $0.28/gallon if received in tank truck and $0.33/gallon if received in drums. In each case, a fee of $0.10/gallon is charged for disposal of the sludge remaining after distillation. No recovery cost estimates have been received from SRS. A cost estimate for recovery of FREON TF has been calculated by SWOPE at $0.70/gallon if shipped by tank truck and $0.80/gallon if shipped by drums. There is no recovery data by volume or weight for FREON TF.

TRANSPORTATION

Trucking companies were solicited to quote prices for handling and transporting waste solvents from the NARFs to the reclaimer and to return the reclaimed solvents to the NARF. The model selected for determining the price was from NAS Norfolk to SWOPE and return, a distance of 640 miles round trip. There are a number of potential reclaimers within a 300 mile radius of each NARF.

These potential reclaimers are listed in Table 2.

The prices quoted varied from $.80 to $1.48 per 100 pound with a minimum load requirement of 40K pounds. The modes of transportation could be either by drum lot or tank truck. If a tank truck is used, there is a fee of $50.00 for cleaning the tank at the end of each round trip. When drums are used for transportation, there is a charge of $6.00 for cleaning and refurbishing each drum for each trip. This service is not provided by the trucking companies but must be provided by the reclaimer. The trucking companies consulted for pricing information are listed in Table 3.

Shipping by tank truck shows a definite economic and handling advantage over shipping by drum lots. The 40K pound load in the tank truck would be all solvent; whereas with drums, part of the 40K pounds include the weight of the drums. For example, to ship trichloroethylene requires 92 drums of 55 gallons of solvent each to make up a 40K pound load. Each empty 55 gallon drum weighs approximately 50 pounds or 4600 pounds of the 40K pound load is dead weight that must be paid for, and will increase the net cost of reclamation. There is also a savings on cleaning and refurbishing of approximately $500 if shipped by tank truck. The cost of cleaning and refurbishing ninety-two 55 gallon drums is approximately $550. Add to these figures the $0.05 per gallon the reclaimer has included into his cost for handling solvents shipped in drums, further increases the advantage of shipping by tank truck.

SUMMARY OF COST INCENTIVES

Using the cost data obtained from SWOPE on reclaiming waste trichloroethylene and lacquer thinner, the transportation cost from trucking and the cost of the virgin material, a cost savings per gallon for reclaiming these two waste solvents were calculated. The savings were calculated for shipping by tank truck and by drums. These calculations are listed in Appendix B. Further calculations were made on the six most used solvents listed in Table 1 to determine the cost savings to the individual NARFs as well as the total cost savings to the Navy. The factors considered in the calculations are gallons used per year, percent loss through use, amount of solvent reclaimable, amount reclaimed, cost of reclaiming, disposal of sludge and cost of transportation. The results revealed a cost savings of from $0.35 per gallon for stoddard to $8.40 per gallon for FREON TF. The potential savings to each NARF varied from $127K to $298K per year, with a total savings of $1,087K per year for the Navy. The table and particulars for each NARF are exhibited in Table 4.

PROPOSED RECLAMATION PROGRAM

To initiate a viable out-of-house reclamation program that will alleviate the pollution problems and at the same time be cost effective, several factors listed in Appendix A must be considered. These factors are divided into three major categories, (1) general considerations, (2) transportation and (3) types of contracts. In the first category, the type and quantity of solvent available for reclamation must first be determined. The quantity will be referred to later, since this is utilized under category (2) transportation. The next step is to identify the contaminants in solvents. This can be done by identifying the shop generating the waste solvent. If one type of solvent

originates from different shops, a list of the different contaminants that batch of solvent contains shall be required. Segregation of solvent is very important to simplify the reclamation process and produce a cost savings to the Navy. Most reclaimers are equipped to process single solvent batches that can be recovered by simple flash distillation which is less costly. This does not mean that mixed solvents can not be recovered, but it would cost significantly more because fractional distillation will be required. It is recommended that in all cases the solvents be segregated to take advantage of the less costly flash distillation method. The last factor in determining the cost of reclaiming a solvent is the cost of sludge disposal.

The second reclamation cost category is transportation. This involves picking up the waste solvent, transporting it to the reclaimer and return of the reclaimed solvent to the NARF. The cost of transporting the waste solvent will depend on the mode of transportation and the distance to be moved. There are two modes of transporting; by tank truck and by drums. Where quantities are substantial, tank transport should be cheaper. Selection of the mode of transportation will depend on the minimum load the carrier will accept and other costs such as cleaning equipment, drum handling charges, refurbishing, etc.

Based on these costs for reclaiming and transportation, the economical feasibility of reclaiming each solvent at each NARF can be determined, using the examples in Appendix B.

There are basically two types of contracts that may be arranged; total service and partial service. In the total service, the contractor will do the total job of picking up the waste solvent, transporting it to the reclaimer, and returning the reclaimed solvent to the NARF. All this is done without involving any Naval personnel. A partial service contract would involve Navy personnel in some of the specific operations.

REFERENCES

(a) NAVAIRDEVCEN Work Unit VQ301 - Pollution Control in Aircraft Materials, Packaging Materials for Aircraft and Sonobuoys, and Environmental Protection, for Naval Aircraft Weapons Systems

(b) NAVAIRDEVCEN ltr 3021, 6188 of 2 Aug 1976

(c) Visit of NAVAIRDEVCEN, W. Hallow and H. Lee (6061) to NARF, Jacksonville on 13 and 14 Apr 1977

(d) Visit of NAVAIRDEVCEN, W. Hallow and I. Custis (6061) to NARF, Alameda and NARF, North Island on 1-4 Aug 1977

(e) NAVAIRDEVCEN ltr 3021, 251 of 12 Jan 1977

(f) NAVAIRDEVCEN ltr 3021, 252 of 12 Jan 1977

TABLE 1. SOLVENTS USED BY NARFS
(THOUSANDS OF GALLONS PER YEAR)

	Alameda	Norfolk	North Island	Pensacola	Jax	Total
Halogenated Solvents						
Dichloromethane (Methylene Chloride)	30.7	19.6	22.6	81.0	24.5	178.4*
Tetrachloroethylene	-	-	-	-	0.1	0.1
1,1,1-Trichloroethane	24.2	5.6	48.0	31.0	7.4	116.2*
Freon TF	9.9	26.3	9.7	10.6	-	56.5*
Trichloroethylene	-	-	-	7.3	60.0	67.3*
Chlorinated Hydrocarbon	-	1.1	9.9	-	-	11.0
Ketones						
Acetone	7.8	0.1	-	-	-	7.9
Methyl Ethyl Ketone	21.2	2.6	40.5	22.8	6.8	93.9*
Methyl Isobutyl Ketone	4.9	2.9	-	1.6	-	9.4
Alcohols						
Methenol	2.1	0.7	0.8	5.3	1.4	10.3
Ethanol	-	-	-	0.7	-	0.7
Isopropanol	1.2	0.1	-	-	-	1.3
Cyclohexanol	-	-	0.6	-	-	0.6
Diacetone Alcohol	-	-	-	0.1	1.5	1.6
Methyl Isobutyl Carbinol	0.9	-	-	-	-	0.9
Pine Oil (Terpene Alcohols)	-	-	-	2.3	-	2.3
Petroleum Solvents						
Kerosene C	-	1.9	8.3	-	-	10.2
Aliphatic Naphtha	2.8	-	-	1.1	-	3.9
Stoddard	90.0	24.0	272.0	57.2	7.7	450.9 *
Toluene (Toluol)	7.6	7.4	-	8.3	-	23.3
Xylene	0.8	0.1	-	1.1	-	2.0
Esters						
Cellosolve Acetate	2.4	0.4	-	0.5	-	3.3
n-Butyl Acetate	0.6	0.1	-	6.8	6.3	13.8
Ethyl Acetate	20.0	5.3	-	0.6	2.3	28.2
Ethers						
Ethylene Glycol Mono Butyl Ether	0.1	0.3	1.0	0.1	-	1.5
Amines						
Monoethylamine	-	-	-	2.0	-	2.0
Monoethanolamine	-	-	0.1	-	-	0.1
Triethanolamine	1.0	0.3	0.4	2.2	0.7	4.6
Monoisopropanolamine	-	-	-	0.9	-	0.9
TOTALS	228.2	98.8	413.9	243.5	118.7	1103.1
Major Volume Solvents TOTALS	176.0	78.1	392.8	209.9	106.4	963.2
Major Volume Solvents % of all Solvents	77%	79%	95%	83%	89%	87%

*Major Volume Solvents

TABLE 2. RECLAIMERS SURVEYED FOR RECLAMATION OF NARF SOLVENTS

Arizona	Fluid Conditioning Co., Phoenix, Arizona (602) 243-3914 Southwest Solvents, Phoenix, Arizona (602) 963-5761
California	Bateman Chemicals, San Diego, California (714) 295-0041 Davis Chemical Co., Los Angeles, California (213) 269-6961 Oil and Solvents Process, Azusa, California (213) 334-5117 RHO-CHEM, Inglewood, California (213) 776-6233 Romie Chemical Corp., Palo Alto, California (415) 324-1638 Solvent Distilling Service, San Jose, California (408) 286-6446
Florida	Gold Coast Oil Corp., Miami, Florida (305) 264-2761 City Chemicals, Orlando, Florida (305) 671-1000
Georgia	Arizec Chemical Co., Douglasville, Georgia (404) 942-4332 M & J Solvents Co., Atlanta, Georgia (404) 355-8240
New Jersey	Ashland Chemical, Newark, New Jersey (201) 344-7434 Gold Shield (Division of Detrex), Riverton, New Jersey (609) 786-8686 Marisol, Inc., Middlesex, New Jersey (201) 469-5100 Perk Chemical Co., Elizabeth, New Jersey (201) 355-5800 Solvents Recovery Service, Linden, New Jersey (201) 925-8600 Swope Oil & Chemical Co., Pennsauken, New Jersey (215) 627-1345
North Carolina	Gold Shield Solvents, Charlotte, North Carolina (704) 372-9280
Pennsylvania	Tri State Chemicals, Inc., Philadelphia, Pennsylvania (609) 853-0355
South Carolina	Industrial Chemical Co., Rockhill, South Carolina (803) 327-5276

TABLE 3. COMPANIES SURVEYED FOR TRANSPORTATION OF SOLVENTS FROM NARF, NORFOLK TO PENNSAUKEN, NEW JERSEY

	Bulk Method	Min. Load	Cost Per 100 lbs.
Turners Express Inc. 4200 Almond Street Philadelphia, Pennsylvania	Drums	40,000 lb.	$0.80
Smith & Solomon 3005 W. Marshall Street Richmond, Virginia Also Pennsauken, New Jersey	Drums	40,000 lb.	$1.48
Maislin Transport Corporation 530 Haunted Lane Cornwell Heights, Pennsylvania	Drums	40,000 lb.	$0.98
Matlack Inc. Independent Dr. Cornwell Heights, Pennsylvania	Tank Truck	40,000 lb.	$1.52
Chem Tank Lines Downington, Pennsylvania	Tank Truck	40,000 lb.	$1.32
Smith Transport Corporation Butler and Belgrade Philadelphia, Pennsylvania	Tank Truck	40,000 lb.	$1.69

TABLE 4. SUMMARY OF RECLAMATION ECONOMICS FOR THE SIX MOST USED SOLVENTS AT THE NARFs

Solvent (1)	% Use Loss (2)	% Waste Reclaimable (3)	Alameda Gals. Used	Alameda X1000 Reclaim.	Alameda $ Savings X1000	Norfolk Gals. Used	Norfolk X1000 Reclaim.	Norfolk $ Savings X1000	North Island Gals. Used	North Island X1000 Reclaim.	North Island $ Savings X1000	Pensacola Gals. Used	Pensacola X1000 Reclaim.	Pensacola $ Savings X1000	Jacksonville Gals. Used	Jacksonville X1000 Reclaim.	Jacksonville $ Savings X1000	Total $ Savings X1000 (4)
Methylene Chloride	27	90	30.7	20.2	58.6	19.6	12.9	37.4	22.6	14.8	42.9	81.0	53.2	154.3	24.5	16.1	46.7	339.9
1,1,1-Trichloro-ethane	26	90	24.2	16.1	35.4	5.6	3.7	8.1	48.0	32.0	70.4	31.0	20.6	45.3	7.4	4.9	10.8	170.0
Freon TF (113)	30	90	9.9	6.3	52.9	26.3	16.6	139.4	9.7	6.1	51.2	10.6	6.7	56.3	-	-	-	299.8
Trichloro-ethylene	26	90	-	-	-	-	-	-	-	-	-	7.3	4.9	7.5	60.0	40.0	62.0	69.5
MEK	18	70	21.2	12.2	15.0	2.6	1.5	1.8	40.5	23.2	28.5	22.8	13.1	16.1	6.6	3.9	4.8	66.2
Stoddard	0.8	90	90	80.8	28.3	24.0	21.5	7.5	272.0	244.3	85.5	57.2	51.4	18.0	7.7	6.9	2.4	141.7
TOTALS					$190.2			$194.2			$278.5			$297.5			$126.7	
																	ANNUAL TOTAL	$1087.1

NOTE: (1) Represents 87% by volume of solvents used at the NARFs
(2) Use loss estimated
(3) % recovery estimated
(4) Recovery value based on 640 mile transportation cost by tank truck

APPENDIX A

FACTORS TO BE CONSIDERED IN A SOLVENT RECLAMATION PROGRAM (BY OUT-OF-HOUSE DISTILLATION)

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FACTORS TO BE CONSIDERED IN A SOLVENT RECLAMATION PROGRAM
(BY OUT-OF-HOUSE DISTILLATION)

A. GENERAL CONSIDERATIONS

1. Type of Solvent: Hydrocarbon, Halogenated, Oxygenated, High purity (Freons). Some contractors are only interested in reclaiming high profit margin solvents and some are not equipped to reclaim the high purity solvents.

2. Quantity of Solvent: If only small quantities of a solvent are generated recovery may not be economical. Minimum quantities imposed by transportation companies will usually be the controlling factor.

3. Contaminants in the Solvents: A general knowledge of how the solvent is contaminated is required for economical reclamation. This can usually be done by identifying the originating shop and the solvent uses in that shop.

4. Segregation of Solvents: Solvents should be segregated to original identity for most economical processing.

5. Methods of Recovery: In-house or out-of-house recovery can be considered. In-house processes will be identified in a follow-on report.

6. Cost of Recovery:

   a. Collection of solvent will include storage facilities, and manpower for collection.

   b. Transportation to and from the reclaimer.

   c. Reclaimers will charge for handling, filtering, reclamation, and sludge disposal.

B. TRANSPORTATION

1. Mode of Transportation

   a. Drum quantities may be most convenient for NARFs and allow for mixed shipments to the reclaimer.

   b. Tank truck quantities will be most economical, but will require holding tankage at the NARF and longer collecting periods for single solvent shipments.

2. Cost of Transportation will be controlled by the mode of transportation, quantity of solvent, and distance to the reclaimer.

3. Minimum Load (weight/gallons) minimum charges are maintained by transportation companies.

4. Cleaning and Refurbishing: Charges are imposed for DOT required cleaning and refurbishing of drums after each use. Tank trucks would only require cleaning each time dirty solvent is dumped.

C. TYPE OF CONTRACT

1. Total Service: Contractor assumes total responsibility for the reclamation program. Collection of used solvents, transportation, reclamation, and return of reclaimed solvents are covered by the contract.

2. Partial Service: Navy personnel accomplish some phases of the reclamation program such as; collection, transportation, etc.

APPENDIX B

OUT-OF-HOUSE RECOVERY COST CALCULATIONS

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OUT-OF-HOUSE RECOVERY COST CALCULATIONS

I. Lacquer Thinner Reclamation by Drum Lots

Drum Lot transportation Norfolk, Va. - Pennsauken, N.J. = 320 miles $.98/100 lb.	35,400 lb. lacquer thinner 4,600 lb. drums 40,000 lb. total	
Initial quantity of spent lacquer thinner	35,400 lb. or 5057 gallons	
SpGr = 7 lb./gal.		
Quantity of recovered thinner (based on 70% yield)	24,780 lb. or 3,540 gallons	
Cost of transporting initial quantity of spent lacquer thinner (Norfolk, Va. - Pennsauken, N. J.)		$392
Cost of recovering 3,540 gallons of lacquer thinner @ $.33/gallon		$1168
Cost of sludge disposal 1,517 gallons @ $.10/gallon		$152
Cost of transporting 3,540 gallons of recovered thinner (Pennsauken, N. J. - Norfolk, Va.) (charge for 40,000 lb. minimum shipment)		$392
Cost of reconditioning drums (92 drums) ($6.00)		$558
	TOTAL	$2662

$2662 / 3540 gallons = $.75/gallon*

*Figure does not include: (1) Initial cost of drums. The initial cost of closed head drums for a total 40,000 lb. load of waste lacquer thinner = (92 drums) ($33.17) = $3052. (2) Cost of disposal of non-reuseable damaged drums and replacement of the damaged drums.

Cost of virgin lacquer thinner conforming to Federal Specification TT-T-266a is $135.20/55 gallons = 2.46/gallon.

A savings of $2.46 - $.75 = $1.71 per gallon by reclamation.

II. Lacquer Thinner Reclamation by Tank Truck Lots

Tank truck transportation Norfolk, Va. - Pennsauken, N. J. = 320 miles approximate	40,000 lb. $1.52/100 lb.	
Initial quantity of spent lacquer thinner	40,000 lb. or 5,714 gallons	

$\frac{\$2475}{2900 \text{ gallons}} = \$.85/\text{gallon}^*$

*Figure does not include: (a) Initial cost of drums. The initial cost of closed head drums for total 40,000 lb. load of waste trichloroethylene = (54 drums) ($33.17) = $1957. (2) Cost of disposal of non-reuseable damaged drums or the replacement of those drums.

Cost of virgin trichloroethylene conforming to Federal Specification OT-634B is $128.40/55 gallons = $2.34/gallon.

A savings of $2.34 - $.85 = $1.49 per gallon by reclamation.

IV. Trichloroethylene Reclamation by Tank Truck Lots

Tank truck transportation	40,000 lb.
Norfolk, Va. - Pennsauken, N. J. - 320 miles	$1.52/100 lb.

Initial quantity of waste trichloroethylene = 40,000 lbs. or 3,478 gallons.

Sp. Gr. = 11.5 lb./gallon

Quantity of recovered trichloroethylene (based on 90% yield)	36,000 lb. or 3130 gallons
Cost of transporting initial quantity of waste trichloroethylene (Norfolk, Va. - Pennsauken, N. J.)	$610
Cost of reclaiming 3130 gallons of trichloroethylene @ $.40/gallon	$1252
Cost of sludge disposal 348 gallons at $.10/gallon	$35
Cost of transporting 3130 gallons of recovered trichloroethylene (Pennsauken, N. J. - Norfolk, Va.)	$610
Cost of cleaning tank truck	$50
	$2557

$\frac{\$2557}{3130 \text{ gallons}} = \$.82/\text{gallon}^*$

*Complete cost figure

Cost of virgin trichloroethylene confirming to Federal Specification OT-634b is $128.40/55 gallons = $2.34/gallon.

A savings of $2.34 - $.82 = $1.52 per gallon by reclamation

Sp. Gr. ≈ 7 lb./gallon

Quantity of recovered thinner (based on 70% yield)	28,000 lb. or 4,000 gallons	
Cost of transporting initial quantity of spent lacquer thinner (Norfolk, Va. - Pennsauken, N. J.)		$610
Cost of recovering 4,000 gallons of lacquer thinner		$1120
Cost of sludge disposal		$172
Cost of transporting 4,000 gallons of recovered thinner (Pennsauken, N. J. - Norfolk, Va.)		$610
Cost of cleaning tank truck		$50
	TOTAL	$2562

$\frac{\$2562}{4,000 \text{ gallons}} = \$.64/\text{gallon}^*$

*Complete cost figure

Cost of virgin lacquer thinner conforming to Federal Specification TT-T-266A is $135.20/55 gallons = 2.46/gallon.

A savings of $2.46 - $.64 = $1.82 per gallon by reclamation.

III. Trichloroethylene Reclamation by Drum Lots

Drum lot transportation Pennsauken, N. J. - Norfolk, Va. = 320 miles $.98/100 lb.	37,050 lb. trichloroethylene 2,950 lb. drums 40,000 lb. TOTAL	
Initial quantity of waste trichloroethylene	37,050 lb. or 3,222 gallons	
Sp. Gr. = 11.5 lb./gallon		
Quantity of recovered trichloroethylene (based on 90% yield)	33,345 lb. or 2,900 gallons	
Cost of transporting initial quantity of waste trichloroethylene (Norfolk, Va. - Pennsauken, N. J.)		$392
Cost of recovery of 2,900 gallons of trichloroethylene at $.45/gallon		$1305
Cost of sludge disposal 322 gallons @ $.10/gallon		$32
Cost of transporting 2900 gallons of recovered trichloroethylene (Pennsauken, N. J. to Norfolk, Va.)		$392
Cost of reconditioning drums (59 drums) ($6.00)		$354
	TOTAL	$2475