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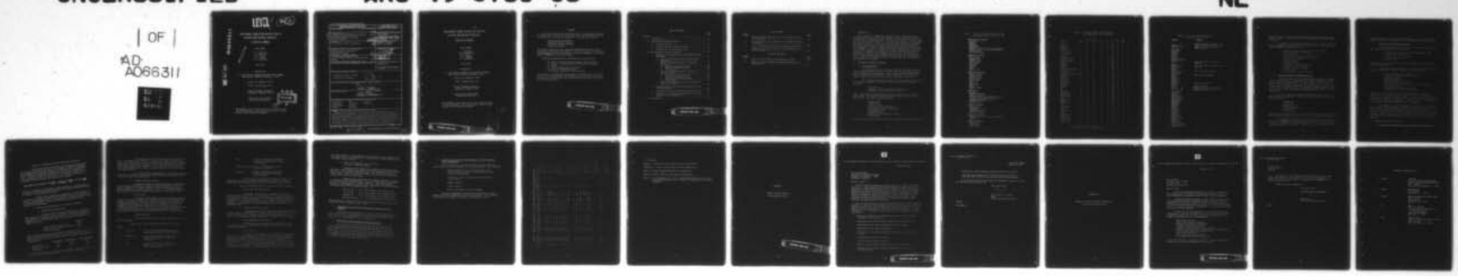

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PRELIMINARY PROBLEM DEFINITION STUDY OF 48 MUNITIONS-RELATED CHEMICALS

EXECUTIVE SUMMARY

FINAL REPORT

J. F. Kitchens
W. E. Harward III
D. M. Lauter
R. S. Wentsel
R. S. Valentine

April 1978

Supported by:

U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21701

Contract No. DAMD17-77-C-7057

COTR: Clarence Wade, Ph.D.

ATLANTIC RESEARCH CORPORATION
Alexandria, Virginia 22314

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propellants	production	toxicology
pyrotechnics	tracers	
primers	pollution	

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

Results are presented of a preliminary problem definition study on 48 munitions related chemicals. The purpose of this study was to determine the Army's responsibility for conducting further research on these chemicals to determine toxicological and environmental hazards, so that effluent standards can be recommended. Both civilian and military uses of the chemical were evaluated. This report outlines the methodology used in obtaining data on the 48 chemicals and the means of estimating losses to the environment.

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FOREWORD

This report documents the methodology used in the preliminary problem definition study of 48 chemicals associated with Army munitions production. The results of this study are presented in four additional volumes:

- Explosives Related Chemicals
- Propellant Related Chemicals
- Pyrotechnic Related Chemicals
- Primers and Tracers

This problem definition study program was performed by Atlantic Research Corporation under Contract No. DAMD17-77-C-7057 from the U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL). Dr. Clarence Wade of USAMBRDL was the project monitor.

The Atlantic Research staff contributing to this report were

- Dr. Ralph S. Valentine-Program Manager; Chemical Engineer
- Dr. Judith F. Kitchens-Principal Investigator; Inorganic Chemist
- Dr. Randall Wentsel-Aquatic Biologist
- Mr. David Lauter-Organic Chemist
- Mr. William E. Harward III-Plant Biologist

The technical staff gratefully acknowledges the contributions of Miss Carol Love and Miss Catherine Boyne who organized and maintained the literature files and of our secretaries - Mrs. Deborah Hinton, Mrs. Mary Alice Nichols and Mrs. Barbara Foutch.

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I. INTRODUCTION

Under contract No. DAMD17-77-C-7057 with the U.S. Army Medical Bioengineering Research and Development Command, Atlantic Research Corporation has performed a preliminary problem definition study on 48 chemicals associated with Army munitions production. The chemicals evaluated during this study are listed in Table 1. The goal of this seven month effort was to determine the Army's responsibility for further investigation into the toxicological and environmental hazards of these chemicals so that effluent standards can be recommended. In order to determine the Army's responsibility for further work on these chemicals, the military and civilian usage and discharges were evaluated. In addition, a preliminary overview of the toxicological and environmental hazards of these compounds was conducted. The methodologies used to obtain the necessary information for this study and the procedures used to evaluate the information, draw conclusions and make recommendations are detailed in this report.

II. INFORMATION GATHERING PROCEDURES

A. Literature Search

The literature search for information on the 48 chemicals concentrated on information which could be readily obtained from computerized data bases, reference books and reviews. Table 2 lists the data bases searched and the availability of information on these compounds in each data base. Table 3 lists the secondary and tertiary key words used in the search.

The citations and abstracts received were then scanned for relevancy. Each citation or abstract was labeled according to one of the following categories:

- not relevant
- relevant: do not obtain the original article
- relevant: obtain the original article

Those citations and abstracts deemed relevant were placed on 3 x 5 index cards. These cards were filed according to the chemical and the subject of the article. Nine subject headings were used

- physical data
- chemical data
- analytical data
- military uses and discharges
- civilian production and discharges
- environmental fate
- mammalian toxicity
- aquatic and microorganisms toxicity
- phytotoxicity

Once the citations and abstracts were filed, the original literature was re-

Table 1. List of Chemicals Evaluated in this Preliminary Problem Definition Study

EXPLOSIVES-Related Compounds

Cyclohexanone
Hexamine
Methylamine
Dimethylamine
Trimethylamine
Hexahydro-1,3-dinitro-5-acetyl-s-triamine (TAX)
Octahydro-1-acetyl-3,5,7-trinitro-s-tetramine (SEX)
1,3-dinitrobenzene
1,3,5-trinitrobenzene

PRIMER-Related Compounds

Barium nitrate
Antimony sulfide
Potassium chlorate
Lead thiocyanate
Calcium silicide
Lead dioxide
Zirconium
Lead azide
TACOT
Acetylene black

TRACER-Related Compounds

Magnesium (powdered)
Strontium nitrate
Polyvinyl chloride
Strontium peroxide
Calcium resinate
Sodium nitrate
Parlon
Lead Dioxide
Barium peroxide
Oxamide
Magnesium carbonate

PYROTECHNICS

Red phosphorus
Benzanthrone (yellow dye)
Auramine (Yellow dye)
1,4-di-p-toluidinoanthraquinone (green dye)
1,4-diamino-2,3-dihydroanthraquinone (violet dye)
1-methylaminoanthraquinone (red dye)
Vat yellow 4 (yellow dye)
Hexachloroethane

PROPELLANT STABILIZERS

Ethyl centralite
Diphenylamine
Diethyleneglycoldinitrate
2-nitrodiphenylamine
N-nitrosodiphenylamine

PROPELLANT PLASTICIZERS

Phthalate esters (ethyl, butyl, octyl, ethylhexyl)
Triacetin

PROPELLANT MODIFIERS

Lead salicylate
Lead stearate
Lead resorcylate

Table 2. Data Bases Search and Availability of Information on the 48 Chemicals.

FILES SEARCHED

Compounds	Medline	Toxline	Cancerline	Enviroline	APTIC	CA 2	CA 3	CA 4	Poll.	AQ SC&FSH	CA
Cyclohexanone	X	X	X	X	X	X	X	X	X	X	X
Hexamine		X	X	X	X	X	X	X	X	X	X
Methylamine	X	X	X	X	X	X	X	X	X	X	X
Dimethylamine	X	X	X	X	X	X	X	X	X	X	X
Trimethylamine	X	X	X	X	X	X	X	X	X	X	X
1,3-dinitrobenzene	X	X	X	X	X	X	X	X	X	X	X
1,3,5-trinitrobenzene	X	X	X	X	X	X	X	X	X	X	X
Ethyl centralite	X	X		X	X	X	X	X	X	X	X
Diphenylamine	X	X	X	X	X	X	X	X	X	X	X
Diethyleneglycoldinitrate	X	X	X	X	X	X	X	X	X	X	X
2-nitrodiphenylamine	X	X	X	X	X	X	X	X	X	X	X
N-nitrosodiphenylamine	X	X	X	X	X	X	X	X	X	X	X
Triacetin	X	X	X	X	X	X	X	X	X	X	X
Red phosphorus	0	0	0	X	X	X	X	X	0	0	X
Benzanthrone	0	X	0	0	X	X	X	X	X	0	0
Auramine	0	X	X	X	X	X	X	X	0	0	X
1,4-di-p-toluidineanthraquinone	X	X	0	0	0	0	X	X	0	0	0
1-methylaminoanthraquinone	X	X	0	0	0	0	X	X	0	0	0
Vat yellow 4	X	X	0	0	X	0	X	X	0	0	0
1,4-diamino-2,3-dihydroanthraquinone	X	0	0	0	0	0	X	X	0	0	0
Hexachloroethane	0	X	0	0	X	X	X	X	0	0	X
Lead azide	0	0	0	0	0	X	X	X	0	0	0
Lead resorcylate	0	0	0	0	0	X	X	X	0	0	0
Lead salicylate	0	X	0	0	0	X	X	X	0	0	0
Lead stearate	0	X	0	0	X	X	X	X	0	0	0
Lead thiocyanate	0	0	0	0	X	X	X	X	0	0	0
Lead dioxide	0	X	0	0	X	X	X	X	X	0	X
Zirconium	X	X	X	X	X	X	X	X	X	X	X
SEX	0	0	0	0	0	0	0	0	0	0	0
TAX	0	0	0	0	0	0	0	0	0	0	0
Barium nitrate	0	X	0	0	X	X	X	X	0	0	X
Antimony sulfide	X	X	0	0	X	X	X	X	0	0	0
Potassium chlorate	0	X	0	0	X	X	X	X	0	0	X
Calcium silicide	0	0	0	0	0	X	X	X	0	0	0
TACOT	0	0	0	0	0	0	X	0	0	0	0
Acetylene black	X	X	X	X	X	X	X	0	X	0	X
Magnesium	0	X	X	X	X	X	X	X	X	X	X
Strontium nitrate	X	X	X	X	X	X	0	0	X	0	X
PVC	0	X	X	X	X	X	X	X	X	0	X
Calcium resinate	0	0	0	0	0	0	0	0	0	0	0
Sodium nitrate	X	X	X	X	X	X	X	X	X	0	X
Parlon		0	0	0	0	0	X	0	0	0	0
Barium peroxide	0	0	0	0	X	X	X	X	0	0	X
Oxamide	0	X	0	0	0	X	X	X	0	0	X
Magnesium carbonate	X	X	0	X	X	X	X	X	X	0	X
Diethylphthalate	0	X	X	X	X		X	X	0	0	X
Dibutylphthalate	0	X	X	X	X		X	X	X	X	X
Dioctylphthalate	0	X	X	X	X		X	X	X	0	X
Ethylhexylphthalate	0	X	X	X	X		X	X	X	X	X
Strontium peroxide	0	0	0	0	0	X	X	0	0	0	0

X = citations found in data base
0 = no citations found in data base

Table 3. List of Secondary and Tertiary Key Words Used in Search.

Secondary	Tertiary
decomposition	chemical, photochemical, thermal, in soil, in water, in vegetation, in plants, in leaves, microbial, microbiological, bacterial, biological
degradation	
photochemistry	
hydrological	
hydrology	
ecokinetics	
ecosystem	
ecology	
ecological	
environmental fate	
environmental effects	
extraction	soils, water, tissue, leaves, plants, vegetation
analysis	
detection	soils, water, vegetation, leaves, tissue, urine, blood
determination	
monitoring	
sampling	
absorption	soil, roots, plants, vegetation
biological effects	
health effects	
absorption	eyes, skin, mucous membranes
uptake	
inhalation	
ingestion	
distribution	
metabolism	
metabolites	distribution, excretion
excretion	
effects	growth, reproduction
toxicity	humans, mammals, fish, insects, aquatic organisms, microorganisms, plants, bactericidal, pesticidal
toxicology	
toxicological	
phytotoxicity	
poisoning	
intoxication	
biomagnification	
bioconcentration	
carcinogenesis	
carcinogenic	
carcinogenicity	
mutagenesis	
mutagenicity	
mutagenic	
mutations	
teratogenesis	
teratogenic	
teratogenicity	
synergistic	
synergism	
sensitization	
dermatitis	
pharmacodynamics	
pharmacology	
epidemiology	
epidemiological	
industrial hygiene	
occupational exposure	
occupational health	

trieved. Copies of the original articles were obtained from Atlantic Research's library, the National Agricultural Library and the National Library of Medicine.

In addition to the original reference articles, review articles and several comprehensive publications were extensively used. Included among these comprehensive publications were

- *Registry of Toxic Effects of Chemical Substances*
- *The Condensed Chemical Dictionary*
- *The Merck Index*
- *TSCA Candidate List of Chemical Substances*
- *Handbook of Chemistry and Physics*
- *Documentation of TLV's*
- *Federal Register*
- *Predicasts Basebook*
- *Directory of Chemical Producers*
- *Chemical Origins and Markets*
- *Synthetic Organic Chemicals*
- *Colour Index*
- *Comprehensive Inorganic Chemistry*

B. Contacts with the Army Ammunition Plants

In order to identify the Army Ammunition Plants using or producing each of the 48 chemicals, a visit was made to ARRCOM Headquarters in Rock Island, Illinois in December 1978. The main contacts at Rock Island were Mr. Tom Wash and Mr. Joe Sekerke of the Environmental Control Branch. Dr. Clarence Wade of USAMBRDL accompanied the Atlantic Research representatives on this visit. During the meetings at ARRCOM, the plants using each chemical were identified, their operational status determined and points of contact established.

The next step in this information gathering process was visits to the individual Army Ammunition Plants. The following plants were visited during this study

- Radford AAP
- Holston AAP
- Lake City AAP
- Pine Bluff Arsenal
- Lone Star AAP
- Longhorn AAP

The choice of AAP plants visited was based on their current operational status and the number of subject chemicals which they use, produce, or discharge.

The government representative at each AAP plant was contacted by Dr. Wade of USAMBRDL and by Atlantic Research prior to any visits. This previsit contact allowed for the AAP plant staff to gather the information requested and prepare for the visit. A sample copy of the letters sent to the

AAP plant representatives is attached as Appendix A. Dr. Clarence Wade of USAMBRDL accompanied the Atlantic Research representatives on these visits.

C. Contacts with Civilian Manufacturers

Civilian manufacturers of the chemicals of interest to this study were identified through the following sources

- purchase lists supplied by the Army Ammunition Plants
- *Synthetic Organic Chemicals*
- *Directory of Chemical Producer*
- *Chemical Marketing Reporter*
- *Chemical Week*

Plant capacities, U.S. production statistics and uses were also extracted from these publications.

The individual manufacturers were then contacted in order to obtain additional information. Specific information requested included

- current production of the chemical
- specific process used to make the product
- production capacity
- process flow diagram
- material balance, if available
- known losses from the process
- air and water discharges per lb of material produced
- end use of chemical
- availability of product data sheets
- availability of product toxicity sheets

A sample copy of the letters sent to the manufacturers is attached as Appendix B. In most cases, the manufacturers were very cooperative and supplied much of the information requested. However in cases where there are less than three producers, production capacities and production statistics are generally considered as proprietary. Therefore for many of the chemicals of interest to this study, these data were not available.

The contacts with the manufacturers proved to be a time consuming task. However, the large amount of information gathered over that available in the general literature made this expenditure of time worthwhile. Of particular interest was the departure of several firms from the manufacturing of many of these chemicals. Up to date information on the current U.S. manufacturers of many of these chemicals considerably changed the conclusions of this study over what they would have been if only literature sources were evaluated.

III. INFORMATION EVALUATION PROCEDURES

A. Estimation of Discharges from Army Ammunition Plant Operations

1. Basis for Estimating Losses from Explosives Manufacture

Sufficient sampling and analysis data together with production rates and process effluent flow rates were available to make approximations of the amount of each chemical entering the environment from the manufacturing and blending of explosives at Holston AAP and LAP (load, assembly and pack). From the concentration of material in the effluent and the flow rate of the discharge streams, the number of lb of each chemical entering the environment from each operation was calculated as follows:

$$\text{lb/day entering the environment} = \text{conc.}\left(\frac{mg}{l}\right) \times \frac{1\ lb}{454 \times 10^3 mg} \times \frac{3.785\ l}{gal} \times \text{flow rate}\left(\frac{gal}{day}\right)$$

In order to determine the discharges of these chemicals at full mobilication, the number of lb/day entering the environment was divided by mobilization rate at the time of the sampling and analysis.

In some cases, photochemical degradation of other compounds in the effluent resulted in an additional environmental load of the compound of interest. The estimated amount of photochemically produced material was added to the amount discharged to obtain the resulting concentration of this chemical in the environment.

2. Basis for Estimating Losses of Propellant Additives

a. Propellant Processing Losses

The loss rates of propellant additives is a function of the production rate compared to full capacity and the type of propellants being produced. Based upon operations in 1973-74 at Radford AAP (Smith and Dickenson, 1974), the following losses were estimated from propellant processing operations:

	losses
Solvent Process, single base	1.3%
Solvent Process, double & multi base	6.6%
Solventless Process	5.3%

These estimates were based upon operations at 40-50% of capacity for solvent process propellants and near full capacity for solventless propellants. Based upon these figures the following estimates were made of propellant processing losses:

	10% capacity	50% capacity	full mobilization
single base	1.5%	1.3%	1.2%
double & multi base	8.8%	6.6%	5.8%
solventless	8%	6%	5.3%

For loss calculations, it was assumed that propellant additives appear in t lost material in the same percentage as in the basic formulation.

The production mix is an important factor in specific loss rate. For example, ethyl centralite is used in all types of propellant produced. Thus, the portion of ethyl centralite used in double base or solventless propellants may result in losses of 5-8% of the amount used, whereas the amount used in single base propellant may only result in 1.2-1.5% losses. Since the production ratios change, a varying percentage of the ethyl centralite used may be lost.

On the other hand, diphenylamine is used only in single base propellants. Therefore, propellant processing losses will always be in the order of 1.3±0.2% of the amount used.

b. Chemical Preparation Losses

Weighing, grinding and sieving operations are believed to be the largest single source of losses of propellant additives. The loss rate is a function of the amount handled. High volume additives, such as dibutyl phthalate, may suffer a loss of only 1-2%. For low volume chemicals, such as barium nitrate, the preparation loss may be on the order of 3-5%.

c. Total Losses

Production and preparation losses at Radford AAP represent the amount of material actually lost. However, not all of the material lost becomes a constituent of effluents. Some of the material lost, particularly in preparation operations, is collected dry as sweepings or in wet or dry scrubber filters. Production losses are collected in part as solids on effluent stream filters. Thus, only 1/3 to 1/2 of the total losses may appear in effluent to the New River. For relatively soluble additives however, nearly all the lost material may ultimately become part of effluent streams.

Loss Calculations

The losses per unit time for a given chemical were determined as follows:

[(prep loss) + (prod loss)]solubility factor = net loss

where:

prep loss	=	1 to 5% of amount handled depending upon volume used and physical form of additive
prod loss	=	1.2 to 1.5% of amount in single base formulations depending upon degree of mobilization
plus		5.8 to 8.8% of amount in double and multibase formulations depending upon degree of mobilization

plus 5.3 to 8% of amount in solventless formulations depending upon degree of mobilization

solubility factor = 0.33 to 1.0 depending upon water solubility of additive

net loss = amount of additive per unit time actually appearing in discharges to the New River

Because of wide variations in production schedules and uncertainty in each loss category, the estimates of losses are given as ranges which take the upper and lower limit of these factors into account.

3. Basis for Estimating Losses of Pyrotechnic Related Chemicals

a. Pyrotechnic Processing Losses

Pyrotechnic formulations are generally made in small batches, ranging from 1.5 lb to 50 lb per batch. Thus, processing losses are not a function of production rate to the same extent as munitions produced continuously or in very large batches. It is estimated that processing losses of about 1% of the material are typical (Aikman, 1978). This value is low compared to loss estimates for propellant manufacturing, in which up to 10% is sometimes lost.

b. Chemical Preparation Losses

The manufacturing process for pyrotechnics involves drying, seiving, weighing and bagging the constituent chemicals. These steps often result in losses of 3-5%. However, Pine Bluff Arsenal estimates that less than 1% is lost during pyrotechnic manufacture as a result of these operations.

c. Load, Assembly and Pack Losses

Loading losses are generally small, consisting of dust and occassional spills. These losses are probably on the order of 0.1-0.2% of the amount handled.

d. Total Losses

No means of estimating losses from specific preparations was available at Pine Bluff Arsenal. Thus, total losses must be estimated based upon the general guidelines given above. For pyrotechnics manufacture and loading, a typical overall loss estimate is 1-2% of the quantity of material handled. This range appears to be conservative and may be low by a factor of 2 or 3. No means is available for obtaining an accurate material balance on the constituents of pyrotechnic formulations, so the losses cannot be determined independently of operator estimates. Because of the conservative loss estimates, it was assumed that all material lost is discharged into the Arkansas River, even though most of the pyrotechnic related materials are not highly soluble in water.

4. Basis for Estimating Losses From Primer and Tracer Mixing and Loading

Primer and tracer chemicals are purchased from civilian manufacturers. These compounds are weighed, blended and formulated into the mixes and loaded at various Army Ammunition Plants. The primary Army Ammunition Plants using the chemicals specified in this study are Lake City, Lone Star, Longhorn AAP's and Pine Bluff Arsenal.

Chemical losses occur during the weighing operations, cleaning of mixing bowls and building washdown. The waste streams from these operations are not characterized for specific chemicals. Therefore the exact quantity of each chemical lost is not known. According to the plant operators, the average losses from the overall processes are

Lake City AAP - 1-2% of the quantity used (Melton, 1978)

Lone Star AAP - 1-2% of the quantity used (Alexander, 1978)

Longhorn AAP - 1/2-1% of the quantity used (Maley, 1978)

Pine Bluff Arsenal - 1-2% of the quantity used (Aikman, 1978)

These figures were combined with the current and full mobilization use of each chemical in order to estimate overall losses.

B. Estimated Losses from Civilian Manufacture and Uses of These Chemicals

Information on the percentage of the losses from civilian manufacture and use of the 48 chemicals were obtained from EPA documents and contacts with the various manufacturers. Where discharge information was not available, it was estimated at 1% of the production.

C. Toxicological and Environmental Hazards Evaluation

For all chemicals except the pyrotechnic related compounds, the recent toxicological and environmental literature was reviewed. The goal of this review was to gather the available information and to present it in this report. No attempt was made to evaluate the experimental procedures used to obtain this data or the validity of the data. Since Walden Research was evaluating the toxicological and environmental properties of the dyes in a concurrent contract, only data found in the *Registry of Toxic Effects of Chemical Substances* was included in this report.

D. Evaluation of the Army's Responsibility for Further Research on the 48 Chemicals

In the evaluation of the Army's responsibility for conducting further research on these chemicals, the following parameters were considered

- the percentage of the civilian production of the chemical used by the Army at current production rate and at full mobilization

- comparison of the civilian and military discharges of the chemical

- mammalian toxicity

- aquatic toxicity

- fate of the chemical in the environment

Using these parameters, scenarios were established in order to determine the Army's responsibility for further research. These scenarios and the chemicals falling in each group are presented in Table 4.

Table 4. Matrix for Evaluation of the Army's Responsibility for Further Research.

Scenario No.	Current Army Use or	Current Army Discharge	Army Use at Full Mobilization or	Army Discharge at Full Mobilization	Mammalian Toxicity	Aquatic Toxicity	Phase II Recommendations: Toxicological Study	Phase II Recommendations: Environmental Study	Chemicals in this Group
1	>90% of civilian	>90% of civilian	>90% of civilian	>90% of civilian	high or unknown	high or unknown	yes	yes	1,3,5-trinitrobenzene, ethyl centralite, [illegible], [illegible], lead [illegible], hexachloroethane
2	>50% of civilian	>50% of civilian	>90% of civilian	>90% of civilian	low	high	yes	yes	barium peroxide
3	<50% of civilian	>70% of civilian	<50% of civilian	>70% of civilian	high or unknown	high or unknown	yes	yes	lead salicylate
4	<50% of civilian	>70% of civilian	<50% of civilian	>70% of civilian	low	high or unknown	yes	yes	2-nitrodiphenylamine
5	<50% of civilian	>70% of civilian	<50% of civilian	>70% of civilian	high or unknown	low	yes	?	lead azide
6	<50% of civilian	>70% of civilian	<50% of civilian	>70% of civilian	low	low	no	?	dibutylphthalate, hexamine
7	>10% of civilian	>10% of civilian	>30% of civilian	>30% of civilian	low	low	?	?	strontium peroxide
8	<10% of civilian	<10% of civilian	>50% of civilian	>50% of civilian	high	high	yes	yes	lead thiocyanate
9	<10% of civilian	>50% of civilian	<10% of civilian	>50% of civilian	low	low	no	?	triacetin
10	<10% of civilian	>30% of civilian	<30% of civilian	>50% of civilian	high or unknown	high or unknown	yes	yes	benzanthrone, Vat Yellow 4, 1-methylaminoanthraquinone, 1,4-di-p-toluidine-anthraquinone, barium nitrate
11	<10% of civilian	<10% of civilian	<30% of civilian	>50% of civilian	low	low	no	?	sodium nitrate
12	<10% of civilian	<10% of civilian	<10% of civilian	>10% of civilian	high	high	yes	yes	potassium chlorate
13	<10% of civilian	<10% of civilian	<10% of civilian	<10% of civilian	high or unknown	high or unknown	yes	yes	1,3-dinitrobenzene,
14	<10% of civilian	<10% of civilian	<10% of civilian	<10% of civilian	low	high or unknown	no	yes	methylamine, dimethylamine, trimethylamine, diphenylamine
15	<10% of civilian	<10% of civilian	<10% of civilian	<10% of civilian	high or unknown	low	no	no	cyclohexanone, lead dioxide, oxamide
16	<10% of civilian	<10% of civilian	<10% of civilian	<10% of civilian	low	low	no	no	diethylphthalate, 2-nitro[illegible], lead [illegible], [illegible], calcium [illegible], [illegible], strontium [illegible], calcium resinate, carbon black, magnesium carbonate, polyvinyl chloride, magnesium
17	sporadic or no longer used	sporadic or no longer used	sporadic or no longer used	sporadic or no longer used	low or high	low or high	no	no	lead [illegible], [illegible], [illegible], [illegible], 1,4-diamino-2,3-dihydroanthraquinone (?) Tacot, Parlon

IV. References

Aikman, L. (1978), Pine Bluff Arsenal personal communication.

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APPENDIX A

Sample of Letters Sent to
Army Ammunition Plants

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ATLANTIC RESEARCH CORPORATION · 5390 CHEROKEE AVENUE · ALEXANDRIA, VIRGINIA · 22314 · 703-354-340(

January 6, 1978

Mr. William Melton
Lake City Army Ammunition Plant
Independence, Missouri 64056
Attention: SARLC-OR

Dear Mr. Melton:

Atlantic Research Corporation is under Contract No. DAMD 17-77-C-7057 with the U. S. Army Medical Research and Development Command to perform a preliminary problem definition study on 49 chemicals associated with munitions manufacturing. During this study we are to evaluate the Army and Civilian usage and pollution of these 49 chemicals in order to determine if the Army should be responsible for further research on each of the chemicals. The 49 chemicals which are being studied are listed in Attachment 1. These chemicals are mainly starting materials, by-products or materials manufactured in small quantities by the Army.

Lake City AAP is one of the Army's main users of many of these chemicals. Therefore, in order to obtain information on the Army's usage, Drs. Valentine and Kitchens would like to visit Lake City January 30-February 1, 1978. The required security information on these Atlantic Research personnel is listed in Attachment 2. The purpose of this visit will be to obtain the following information:

- Historical pictures of the quantities of each of the 49 chemicals produced or used at Lake City
- Quantities which would be used or produced at full mobilization
- Manufacturers from whom starting materials are purchased
- Known impurities in starting materials
- Description of the process in which these chemicals are produced or used
- A material balance on each process
- A tour of the process, if possible
- Identification of known effluent streams from each process
- Analyses of these streams and the production rates at the time of these analyses

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- Treatment of these streams with analysis data after treatment

- Any other data available which would aid in the comparison of the Army versus Civil Sector uses and environmental discharges

If you have any questions concerning the information requested, please call me at 703 354-3400, Ext. 207.

Very truly yours,

(Dr.) Judith F. Kitchens
Head
Pollution Technology Section

JFK/man

Attachments

APPENDIX B

Sample of Letters Requesting Information
from Civilian Manufacturers

ATLANTIC RESEARCH CORPORATION · 5390 CHEROKEE AVENUE · ALEXANDRIA, VIRGINIA · 22314 · 703-354-3400

January 9, 1978

Mr. Jim Lipe
Monsanto Textile Company
P.O. Box 12830
Pensacola, Florida 32575

Dear Mr. Lipe:

During our telephone conversation of January 6 you explained that in order to answer inquiries on Monsanto's production and use of cyclohexanone you required a written request for this information.

Atlantic Research Corporation is under contract with the U.S. Army Medical Research and Development Command to evaluate the Army's responsibility for further toxicity or pollution abatement research on 49 chemicals associated with munitions production. A list of the chemicals to be studied is presented in attachment 1. A copy of our contract with the Army is also attached.

In order to make this evaluation, we are required to compare the production, usage and pollution of these chemicals in the civilian and military communities. We need the following information on your company's production and use of cyclohexanone.

- What process is used?
- What is the production capacity?
- Process flow diagram, if available?
- Material balance, if available?
- What are the known losses from the process?
- Quantity of material lost to air or water per lb. produced.
- Is the product for sales or captive use?
- What is the captive use?
- Are product data sheets available?
- Are product toxicity sheets available?

We are also interested in the same information on any of the other 48 chemicals with which your company might be involved.

Mr. Jim Lipe
January 9, 1978
Page Two

This program is to be completed within the next four months and speedy consideration of this request would be greatly appreciated. If there are any questions concerning the request, please telephone me at (703) 354-3400, ext. 352.

Thank you for your cooperation.

Very truly yours,

ATLANTIC RESEARCH CORPORATION

David Lauter
Pollution Technology Section

la
Encl.

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