A HEALTH AND ENVIRONMENTAL EFFECTS DATA BASE ASSESSMENT
OF U.S. ARMY WASTE MATERIAL

Final Report
PHASE II REPORT

by

J. C. Uhrmacher, Principal Investigator
P.F. Werschulz
D.O. Schultz
D.O. Weber

March 4, 1986

Supported by

U.S. Army Medical Research and Development Command
Fort Detrick, Frederick, Maryland 21701-5012

Contract No. DAMD17-84-C-4133

Carltech Associates, Inc.
Columbia, Maryland 21045

Contracting Officer's Technical Representative:
Mitchell Small
Health Effects Research Division
U.S. Army Medical Bioengineering Research
and Development Laboratory
Fort Detrick, Frederick, Maryland 21701-5010

Approved for public release; distribution unlimited.

The findings in this report are not to be construed
as an official Department of the Army position unless
so designated by other authorized documents.


**Title:** A Health and Environmental Effects Data Base Assessment of U.S. Army Waste Material  

**Authors:** J. Carl Uhrmacher, Principal Investigator  

**Performing Organization:** CARLTECH, Inc.  
Overlook Ctr., 5457 Twin Knolls Road  
Columbia, MD 21045  

**Monitoring Organization:** U.S. Army Medical Res. & Dev. Command  
Fort Detrick  
Frederick, MD 21701-5012  

**Abstract:**  
Substances used by the U.S. Army on a regular basis in accomplishing their missions of training, defense and weapons development have a wide range of uses, storage and disposal methods. Humans and the environment may be exposed to them in varying amounts. Proper research planning requires knowledge of gaps in health and environmental data on those compounds. CARLTECH was contracted to develop a data base on health and...
environmental effects of waste materials generated by the U.S. Army.

The project was divided into two phases:

Phase I which consisted of identification of Army-unique materials for inclusion in the data base.

Phase II which consisted of researching, aggregating and reporting data on physical, chemical, health and environmental properties of the substances. This report covers Phase II efforts.

Sixty-one substances were studied during Phase II of this project. Data on chemical and physical properties, Army and other uses, analytical methods, health effects, environmental effects, standards and regulations, and disposal methods were obtained on each substance researched.

Results of this project with respect to data gaps are presented below. Physical and chemical data; analytical methods; and health effects areas had the better data coverage. Twenty substances had insufficient direct health effects data and were characterized using structural analogues. Additional research is required for these 20 substances.

<table>
<thead>
<tr>
<th>AREA</th>
<th>ESSENTIALLY COMPLETE</th>
<th>SOME GAPS</th>
<th>SEVERE GAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical and Chemical Data</td>
<td>40</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Analytical Methods</td>
<td>43</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Health Effects</td>
<td>35</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>Environmental Effects</td>
<td>18</td>
<td>26</td>
<td>16</td>
</tr>
<tr>
<td>Standards and Regulations</td>
<td>15</td>
<td>33</td>
<td>12</td>
</tr>
<tr>
<td>Disposal Methods</td>
<td>35</td>
<td>23</td>
<td>2</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

The U.S. Army uses a variety of substances on a regular basis in accomplishing the missions of training, defense, and weapons development. These materials include pyrotechnics, fuels, explosives, obscurants, propellants, solvents, lubricants, preservatives, and chemical intermediates. The diversity of the substances brings about a wide range of uses, storage and disposal methods. Humans and the environment are exposed to these substances in varying amounts.

The U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL) was charged with identifying hazards of materials currently being used by the Army. Proper research planning required identification of the compound and, especially, informational gaps in health and environmental data. What is required, therefore, is development of a data base on health and environmental effects of waste materials generated by the U.S. Army.

This project was divided into two phases:

o Phase I consisted of identification of Army-unique materials for inclusion in the data base.

o Phase II consisted of researching, aggregating, and reporting data on physical, chemical, health, and environmental properties of the substances identified in Phase I and identifying data gaps.

This report covers Phase II efforts. Phase I efforts are reported in detail in a separate document prepared under this contract, "Phase I Report, May 1, 1985."

The following types of data were obtained on each substance during this study:

o Chemical and physical data
o Army and other uses
o Analytical methods
o Health effects
o Environmental effects
o Standards and regulations
o Disposal methods.

Both manual and computerized methods of literature search were used. Twenty-four computerized databases were consulted.

The methodology included searching twenty-four computerized databases for physical and chemical properties. Handbooks, such as the Chemical Rubber Company Handbook of Chemistry and Physics, and Army references were used to confirm, and supplement database information. Material Safety Data Sheets and Hazardous Component Safety Data Sheets were used as alternate sources for supplementing database information.
Army Hazardous Component Safety Data Sheets and Army Technical Publications provided Army use data. Interviews with Army personnel also provided information. Civilian use data was obtained from handbooks and from databases. Army technical literature, and vendors were consulted if other sources were inadequate.

Analytical methods were obtained from databases and were evaluated using the following criterion: Trace or forensic analytical methods or those using separation were preferred. If more than one method satisfied the above criteria, both were reported. Environmental, health effects, and health related standards and regulation data were obtained from the literature, from specialized computerized databases, and by estimation. Bioconcentration factors were estimated using the Veith equation whenever possible. Whenever literature reported experimentally-determined values of bioconcentration factor, both estimated and experimental values were reported together.

Data from Section 8(e) of the Toxic Substances Control Act supplemented handbook data. Characterization of toxic effects for substances with little or no toxicity data was completed using information based on structure/activity relationships (SAR).

Environmentally related standards and regulations were obtained from the Federal Register, and from specialized databases.

Three types of disposals were considered during Phase II:

- Current Recommended Army Disposal Practices
- Alternate Disposal Practices under Consideration by the Army
- Other Disposal Practices Employed.

Disposal practices were obtained from Army reports, private communications, manuals, and chemical supply catalogs.

Sixty-one substances were studied during Phase II (Exhibit II-1) of this project. Acetic anhydride was eliminated from further consideration in Phase II because rapid hydrolysis poses a minimal threat on release to the environment.

Potassium dinitrobenzofuroxan was particularly difficult to characterize because data on empirical and structural formulas were significantly different from data reported in Army references. A recent article confirming the structure through infrared and nuclear magnetic resonance spectroscopy was evaluated and incorporated. Lead styphnate had four different formulas, structures, Registry Numbers, molecular weights and index names.

Twenty substances had little or no toxicity data (Exhibit III-1). In the absence of data, toxicity information about structurally related substances or substance classes was reported. Few, if any, substances had complete environmental coverage. Physical and chemical data, analytical methods, and health areas had the better data coverage. Regulations had poor coverage, but new regulations will soon be issued covering many of the substances discussed in this report.

Data gaps in the project are listed below and in more detail in Exhibit III-2.
Based on results presented in Section III, the largest number of data gaps were found in the following areas:

- Environmental Effects
- Health Effects.

In no case did Environmental Effects have total data coverage, even for well-documented compounds. This lack of coverage is believed to be caused by lack of research in some specialized areas. Additional research would be required for total coverage if desired. Twenty substances had insufficient direct health effects data and were characterized by using structural analogues (Exhibit III-1). Additional research is required to conclusively identify health effects of those 20 substances.

In general, waste preservatives, inorganic obscurants and new or experimental ordnances appeared to have less data available than other substances. Almost no data were available for magnesium thorium alloy, which has fairly widespread use and possesses many apparent environmental and occupational hazards. It is recommended that research be conducted on hazards of this waste substance. While data were available on analytical method descriptions, data coverage of lower limits of detection was poor. Further research is needed to clarify this area.
## CONTENTS

### EXECUTIVE SUMMARY

1

### I. INTRODUCTION

7

A. BACKGROUND ........................................... 7
B. PURPOSE .................................................. 7
C. ORGANIZATION ............................................ 7

### II. METHODOLOGY

8

A. DATABASE AGGREGATION AND ORGANIZATION ................. 8
B. CHEMICAL AND PHYSICAL DATA ............................. 8
   1. Structural and Chemical Formulas and Molecular Weight 8
   2. Alternate Names and Registry Numbers ................. 8
   3. Chemical and Physical Properties ...................... 6
C. USES .......................................................... 9
D. ANALYTICAL METHODS ..................................... 9
E. HEALTH EFFECTS ........................................... 10
   1. Literature Retrieval .................................. 10
   2. Structure Activity/Related Data ..................... 11
   3. Data Aggregation ........................................ 11
F. ENVIRONMENTAL EFFECTS .................................. 11
G. STANDARDS AND REGULATION .............................. 12
H. DISPOSAL ...................................................... 12
I. REVIEWS ....................................................... 13

### III. RESULTS

21

A. CHEMICAL AND PHYSICAL DATA ............................ 21
   1. Structure and Chemical Formulas and Molecular Weight 21
   2. Alternate Names and Registry Numbers ................. 21
B. HEALTH EFFECTS ........................................... 22
C. ENVIRONMENTAL EFFECTS .................................. 22
D. DISPOSAL ...................................................... 23
E. DATA GAPS .................................................... 23

### IV. CONCLUSIONS AND RECOMMENDATIONS

32

### V. REFERENCES CITED

33
LIST OF EXHIBITS

EXHIBIT II-1. WASTE SUBSTANCES STUDIED DURING PHASE II, SUBSTANCE NAME VS. CHEMICAL ABSTRACTS SERVICE (CAS) REGISTRY NUMBER............... 14
EXHIBIT II-2. CHEMICAL SUBSTANCE REPORT FORMAT............... 17
EXHIBIT II-3. ABBREVIATIONS USED IN ENVIRONMENTAL AND HEALTH EFFECTS TABLES....................... 20
EXHIBIT III-1. CHEMICALS REQUIRING ANALOGUES TO PROVIDE APPROXIMATE HEALTH EFFECTS............... 24
EXHIBIT III-2 DATA GAPS IDENTIFIED......................... 25
I. INTRODUCTION

A. BACKGROUND

The U.S. Army uses many substances on a regular basis in accomplishing the missions of training, defense, and weapons development. These materials include a wide range of pyrotechnics, fuels, explosives, obscurants, propellants, solvents, lubricants, preservatives, chemical intermediates, and chemical-bacteriological warfare agents.

These Army materials have a broad range of uses, storage, and disposal practices. At any time, humans may be exposed to these materials in varying amounts. The U.S. Army felt that a complete assessment of the effects of these substances on the environment and on human beings was necessary so that consistent and valid handling and disposal standards could be developed.

The U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL) was charged with the responsibility for developing a data base on environmental effects of waste materials generated by the U.S. Army. This data base was to include state-of-the-art knowledge about both health and environmental effects of release of these substances, chemical and physical properties, current uses (both military and civilian), methods of analysis, and current, proposed, or alternate disposal methods. This data base will be used by the Army to develop internal environmental standards for safe and effective handling of these substances.

This project was divided into two phases according to the contract. Phase I consisted of identification of Army-unique materials so that USAMBRDL could select materials to be included in the data base. Phase II consisted of researching, aggregating, and reporting data on physical, chemical, health, and environmental properties of the substances identified in Phase I and locating data gaps to be completed by additional research. This report covers Phase II. Phase I efforts are reported in detail in a separate document prepared under this contract, "Phase I Report, May 1, 1985."

B. PURPOSE

In accordance with the goals discussed above, the U.S. Army has contracted with CARTECH ASSOCIATES, INC. to prepare a list of Army-unique compounds and to assemble a data base on these substances. This report presents both the data base and the results of efforts identified 61 chemicals in Phase I and analyzed them in Phase II.

C. ORGANIZATION

Section II of this report covers methodologies used to obtain the physical, chemical, environmental, and health data required for Phase II. Section III presents results of this research. Section IV covers conclusions and recommendations. Appendix A contains explanatory material and Appendix B contains the data base of 60 substances. Each waste substance is described in a self-contained chemical report which presents data and also includes references and other information used.
II. METHODOLOGY

A. DATA BASE AGGREGATION AND ORGANIZATION

Sixty-one waste substances were identified in Phase I (Exhibit II-1). Twenty-one waste substances were discussed in an earlier series of chemical reports prepared by the Atlantic Research Corporation (ARC) (1). Only data more recent than ARC were reported. A data form was developed to record aggregated data on each individual waste substance (Exhibit II-2).

B. CHEMICAL AND PHYSICAL DATA

1. Structure and Chemical Formulas and Molecular Weight

Structures and chemical formulas were obtained from several sources and were cross-checked whenever possible. Both the Chemical Abstract Registry File (CAS Online) and the Structure and Nomenclature Search System (SANSS), available through Information Consultants, Incorporated—Chemical Information System (ICIS) were used to supply structure and chemical formula data for all compounds. Use of these online databases is discussed in more detail in the following section. Handbooks and other references were consulted to confirm or supplement database information.

Molecular weight could not be found for a few compounds, so molecular weight was calculated, using the CAS or SANSS empirical formulas and the current International Union of Pure and Applied Chemistry (IUPAC) atomic weights for the constituent elements.

2. Alternate Names and Registry Numbers

This segment of the project identified the common or trivial name of a compound, the correct Chemical Abstracts Collective Index name(s), synonyms, CAS Registry Number, and RTECS Registry Numbers, where possible. Determination of the correct CAS registry number was the first step in preparation of a data base substance file. Obtaining subsequent data such as physical and chemical properties and health effects depended on successful completion of this step.

3. Chemical and Physical Properties

Information on sources included the following:

- ICIS database system was searched for physical and chemical properties using CAS Registry Numbers and synonyms.
- Oil and Hazardous Material Technical Assistance Data System (OHMHTADS) was searched for reactivity, corrosivity, synergistic materials, antagonistic materials, field and laboratory detection, flammability, flash point, autoignition point, explosiveness, melting and boiling points, solubility, specific gravity, vapor pressure and vapor density.
ENViroFATE, an ICIS database, supplied solubility and vapor pressure data and a few octanol/water partition coefficients.

Information Consultants, Inc.-Chemical Information System, Information for Hazardous Organics in Water (ICIS ISHOW), supplied octanol/water/partition coefficients. Some partition coefficients were estimated by Drs. Leo and Hantsch (7).

Handbooks included Chemical Rubber Company Handbook of Chemistry and Physics (2), the Merck Index (3), the Encyclopedia of Explosives and Related Items (4), the Army Engineering Design Handbook Properties of Explosives of Military Interest and the Urbanski four volume monograph on chemistry of explosives (5) (6).

Alternate sources were Material Safety Data Sheets and Hazardous Component Safety Data Sheets.

C. USES

Army use data were obtained from interviews with Army personnel, Army Hazardous Component Safety Data Sheets, Army Technical Publications, and literature published or sponsored by the Army in the civilian sector.

Civilian use information was obtained from the same sources listed in the chemical and physical properties section. If the compound was listed in the 1985 Chemical Buyers' Directory, the manufacturer or vendor was contacted if no other source of information was available.

D. ANALYTICAL METHODS

Analytical methods were obtained from citations retrieved by an online database search of STN International's Chemical Abstracts File, which is the computerized searchable form of the printed Chemical Abstracts. Using advanced search strategy, a query "hedge" was formulated to retrieve relevant citations from Chemical Abstracts.

Highly posted compounds such as ethylene glycol were searched by limiting the range to a particular time period which would provide the most recent information. The search on these particular compounds was limited to January, 1984 to present.

Substances not considered analytical reagents or solvents were searched using the Boolean "AND." Substance reports which were ARC updates were limited by range to January, 1984 to present since only updating was required.

Hard copies of citations were retrieved from libraries. Because many articles were inaccessible through usual retrieval methods, an extended abstract, including all bibliographic and indexing information, was retrieved from the CA file and used in this project. Search methods are discussed in more detail in Appendix A.
Analytical methods for each compound were evaluated using the following criteria:

- Methods for trace or forensic analysis, when available, were chosen over quality control methods. Trace methods were more applicable for the evaluation of health or environmental effects. If no trace methods were published, then quality control methods were included to indicate a direction for analytical chemists to follow.

- Preferred methods included separation or the compound-specific method. These methods are more applicable for the evaluation of health or environmental effects because the compound is usually found in complex analytical matrices such as soil, water, urine, or blood.

- If more than one method satisfied the above criteria, both were reported because the best available method for a laboratory is one capable of using available equipment to reach the required sensitivity. However, the most sensitive method published on a given technique was chosen for discussion.

- For inorganic salts, if no methods were available for the compound as a whole species, methods were discussed for each component part. For each method chosen, the application, the technique, the equipment required, sample type, and limit of detection were reported.

E. HEALTH EFFECTS

Collection of health effects data involved retrieval and extraction of information dealing with the toxicity of the chemicals examined.

1. Literature Retrieval

Data were obtained from computerized databases and literature listed below.

- Chemical Hazard Information Profiles (CHIP’s), Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency

- IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans (Volumes 1-29 on Chemicals, Industrial Processes, and Industries Associated with Cancer in Humans)

- National Cancer Institute, National Toxicology Program Technical Reports on the Toxicology and Carcinogenesis Studies of Various Chemicals

- NIOSH Criteria Documents

- Several health-effects handbooks were also searched on a routine basis for health data (2,3,8,9,10,11,12,13,14,15,16,17,18,19,20, 21,22,23)
Material safety data sheets

Section 8(e) of the Toxic Substances Control Act, Environmental Protection Agency

MEDLARS, National Library of Medicine (used for data retrieval).

The NIOSH Registry of Toxic Effects of Chemical Substances (RTECS) (22) data record was examined to determine the existence of positive data on specific chemicals. If RTECS and other handbooks contained necessary toxicity data, no further searches were conducted. TOXLINE and its two backfiles were searched for back-up data. Chemicals in the 1978 AMC updates and in the TOXBACK 1965 file (1965 to 1974) were not searched. The workscope of this project limited the number of articles or reports to six. Thus, original research reports were selected for chemicals with limited data base and manual citations. Recent review articles, when available, were selected for chemicals with more than 30 citations in the bibliographic databases.

Foreign language articles generally were not used, but English abstracts of foreign language articles were used for some chemicals with limited data. Articles and reports were obtained from Washington D.C. area libraries; Defense Technical Information Center (DTIC), Alexandria, Va; and National Technical Information Service (NTIS), Springfield, Va.

2. Structure Activity/Relationship Data

Considerable project effort was devoted to toxic effects characterization of substances with little or no toxicity data. Information based on structure/activity relationships (SAR) was obtained for these chemicals. Preliminary research was necessary to determine a feasible application of SAR data for incorporation in this report. Several SAR methods were researched (See Section III-B).

3. Data Aggregation

Data from reference books and the RTECS data base were not evaluated. Data from primary sources, i.e., original research reports, were evaluated for test results and methodology, author's conclusions, proper laboratory practices, statistical analyses, completeness of data, and applicability to the toxic effects characterization. Study inadequacies such as the lack of a test group or failure to specify the physical state of the test chemical were reported. Data were extracted and organized into a tabular format and included in the substance reports.

Abbreviations used in both environmental and health effects tables are found in Exhibit II-3.

4. ENVIRONMENTAL EFFECTS

Environmental data were obtained from the literature and by estimation. Potential literature citations were located using environmentally oriented computerized databases which included the following:
Citation titles from the databases were examined; for titles appearing promising, journals were ordered. For titles considered doubtful, abstracts were requested and reviewed. Handbooks were also used (24). Occasionally, databases such as RTECS, ENVIROFATE and OHMTADS contained directly related data. If the data appeared consistent with that found on the literature, then the information was included in the report.

Bioconcentration factors were estimated using the Veith equation whenever partition coefficient data were available:

\[ \log BCF = 0.76 \log P + 0.23 \] (25), where \( P \) is the Octanol-Water Partition coefficient.

Wherever literature had experimentally-determined values of bioconcentration factor; both estimated and experimental values were reported together.

G. STANDARDS AND REGULATIONS

Health-related standards and regulations were obtained principally from the Fire Protection Manual (26) and the OHMTADS, RTECS, and Occupational Safety and Health Databases.

Environmental related standards and regulations were obtained from the Federal Register, and from the ENVIROFATE, OHMTADS, and TSCA INITIAL INVENTORY computerized databases.

H. DISPOSAL

Three types of disposal were considered during Phase II:

- Current Recommended Army Disposal Practices
- Alternate Disposal Practices under Consideration by the Army
- Other Disposal Practices Employed.

Current Army disposal practices are those now used by U.S. Army installations to remove waste streams containing one or more of the 61 substances identified in Phase I of this project. These were identified from Army reports (27) and from private communications with U.S. Army personnel.
(28). Data on alternative disposal practices, i.e., those under consideration by the military, were obtained from USATHAMA personnel, from the U.S. Navy CHIL Manual (11), and from Army reports. Data on civilian and other disposal practices were obtained from the same sources discussed above and also from chemical supply catalogs (29). Disposal information was evaluated and prioritized in the chemical report for a substance whenever one of two conditions was achieved:

- The substance was identified specifically by name in the reference cited; or
- The waste substance belonged to a class of materials discussed in the reference cited. Examples of such classes included explosives, pyrotechnics and obscurants.

I. REVIEWS

Each chemical report received three sets of reviews prior to issuance of this report. The aggregated reports were reviewed by colleagues. After incorporating comments, an “outside review,” was performed by scientists and engineers who had not contributed to the earlier phases of the project. After incorporating comments, the 60 chemical reports were given final review by the technical editor and the project manager.
# Exhibit II-1

## Waste Substances Studied During Phase II

<table>
<thead>
<tr>
<th>CAS Number</th>
<th>Substance Name</th>
<th>Project File Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>7446-70-0</td>
<td>aluminium chloride</td>
<td>02</td>
</tr>
<tr>
<td>2582-30-1</td>
<td>aminoguanidine bicarbonate</td>
<td>03</td>
</tr>
<tr>
<td>125-51-3</td>
<td>iso-amyl alcohol</td>
<td>04</td>
</tr>
<tr>
<td>110-46-3</td>
<td>iso-amyl nitrite</td>
<td>05</td>
</tr>
<tr>
<td>1345-04-6</td>
<td>antimony trisulfide</td>
<td>06</td>
</tr>
<tr>
<td>1304-29-6</td>
<td>barium peroxide</td>
<td>07</td>
</tr>
<tr>
<td>59744-77-3</td>
<td>battery lithium</td>
<td>08</td>
</tr>
<tr>
<td>94-36-0</td>
<td>benzoyl peroxide</td>
<td>09</td>
</tr>
<tr>
<td>9007-13-0</td>
<td>calcium resinate</td>
<td>10</td>
</tr>
<tr>
<td>1592-23-0</td>
<td>calcium stearate</td>
<td>11</td>
</tr>
<tr>
<td>16774-21-3</td>
<td>ceric ammonium nitrate</td>
<td>12</td>
</tr>
<tr>
<td>127-65-1</td>
<td>chloramine-T</td>
<td>13</td>
</tr>
<tr>
<td>10380-28-6</td>
<td>copper 8-quinolinolate</td>
<td>14</td>
</tr>
<tr>
<td>1338-02-9</td>
<td>copper naphthenate</td>
<td>15</td>
</tr>
<tr>
<td>108-94-1</td>
<td>cyclohexanone</td>
<td>16</td>
</tr>
<tr>
<td>106-19-4</td>
<td>dipropyl adipate</td>
<td>17</td>
</tr>
<tr>
<td>4682-03-5</td>
<td>diazodinitrophenol</td>
<td>18</td>
</tr>
<tr>
<td>87-31-0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>116-52-5</td>
<td>dichlorodimethyl-hydantoin (DANC)</td>
<td>19</td>
</tr>
<tr>
<td>97-23-4</td>
<td>dichlorophene</td>
<td>20</td>
</tr>
<tr>
<td>CAS</td>
<td>Name</td>
<td>Page</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>693-21-0</td>
<td>diethylene glycol dinitrate</td>
<td>21</td>
</tr>
<tr>
<td>111-40-0</td>
<td>diethylene triamine</td>
<td>22</td>
</tr>
<tr>
<td>4096-88-2</td>
<td>dinitrophenyl azide (2,4-)</td>
<td>23</td>
</tr>
<tr>
<td>122-39-4</td>
<td>diphenylamine</td>
<td>24</td>
</tr>
<tr>
<td>85-98-3</td>
<td>ethyl centralite</td>
<td>25</td>
</tr>
<tr>
<td>107-21-1</td>
<td>ethylene glycol</td>
<td>26</td>
</tr>
<tr>
<td>628-96-6</td>
<td>ethylene glycol dinitrate</td>
<td>27</td>
</tr>
<tr>
<td>110-80-5</td>
<td>ethylene glycol monoethyl ether</td>
<td>28</td>
</tr>
<tr>
<td>75-21-8</td>
<td>ethylene oxide</td>
<td>29</td>
</tr>
<tr>
<td>80-13-7</td>
<td>halazone</td>
<td>30</td>
</tr>
<tr>
<td>302-01-2</td>
<td>hydrazine</td>
<td>31</td>
</tr>
<tr>
<td>13465-08-2</td>
<td>hydroxylammonium nitrate</td>
<td>32</td>
</tr>
<tr>
<td>13424-46-9</td>
<td>lead azide</td>
<td>33</td>
</tr>
<tr>
<td>51531-05-6</td>
<td>lead styphnate</td>
<td>34</td>
</tr>
<tr>
<td>15245-44-0</td>
<td>lead thiocyanate</td>
<td>35</td>
</tr>
<tr>
<td>12403-82-6</td>
<td>lead thiocyanate</td>
<td>35</td>
</tr>
<tr>
<td>63918-97-8</td>
<td>lead thiocyanate</td>
<td>35</td>
</tr>
<tr>
<td>592-87-0</td>
<td>lead thiocyanate</td>
<td>35</td>
</tr>
<tr>
<td>12438-53-8</td>
<td>magnesium thorium alloy</td>
<td>36</td>
</tr>
<tr>
<td>2385-85-5</td>
<td>mirex</td>
<td>37</td>
</tr>
<tr>
<td>86-30-6</td>
<td>N-nitrosodiphenylamine</td>
<td>38</td>
</tr>
<tr>
<td>3156-73-8</td>
<td>nitro,2-propanol</td>
<td>39</td>
</tr>
<tr>
<td>119-75-5</td>
<td>o-nitrodiphenylamine</td>
<td>40</td>
</tr>
<tr>
<td>2899-02-7</td>
<td>octachlor carbamidine</td>
<td>41</td>
</tr>
<tr>
<td>100-02-7</td>
<td>p-nitrophenol</td>
<td>42</td>
</tr>
<tr>
<td>CAS</td>
<td>Name</td>
<td>Page</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>78-11-5</td>
<td>pentaerythritol tetranitrate</td>
<td>43</td>
</tr>
<tr>
<td>7719-12-2</td>
<td>phosphorus trichloride</td>
<td>44</td>
</tr>
<tr>
<td>29267-75-2</td>
<td>potassium dinitrobenzofuroxan</td>
<td>45</td>
</tr>
<tr>
<td>7778-74-7</td>
<td>potassium perchlorate</td>
<td>46</td>
</tr>
<tr>
<td>6423-43-4</td>
<td>propylene glycol 1,2-dinitrate</td>
<td>47</td>
</tr>
<tr>
<td>3457-90-7</td>
<td>propylene glycol 1,3-dinitrate</td>
<td>48</td>
</tr>
<tr>
<td>7723-14-0</td>
<td>phosphorus, red</td>
<td>49</td>
</tr>
<tr>
<td>26628-22-8</td>
<td>sodium azide</td>
<td>50</td>
</tr>
<tr>
<td>7601-89-0</td>
<td>sodium perchlorate anhydrous</td>
<td>51</td>
</tr>
<tr>
<td>814-95-9</td>
<td>strontium oxalate</td>
<td>52</td>
</tr>
<tr>
<td>28453-24-9</td>
<td>tetranitrocobazole</td>
<td>53</td>
</tr>
<tr>
<td>479-45-8</td>
<td>tetryl</td>
<td>54</td>
</tr>
<tr>
<td>7550-45-0</td>
<td>titanium tetrachloride</td>
<td>55</td>
</tr>
<tr>
<td>67539-61-1</td>
<td>triaminotrito-</td>
<td>56</td>
</tr>
<tr>
<td>3058-38-6</td>
<td>benzene</td>
<td></td>
</tr>
<tr>
<td>27096-29-3</td>
<td>triethanolammonium nitrate</td>
<td>57</td>
</tr>
<tr>
<td>111-22-8</td>
<td>triethylene glycol dinitrate</td>
<td>58</td>
</tr>
<tr>
<td>128-66-5</td>
<td>vat yellow 4</td>
<td>59</td>
</tr>
<tr>
<td>12185-10-3</td>
<td>white phosphorus AND phosphorus (includes all forms)</td>
<td>60</td>
</tr>
<tr>
<td>7723-14-0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12001-85-3</td>
<td>zinc naphthenate</td>
<td>61</td>
</tr>
</tbody>
</table>
EXHIBIT II-2

CHEMICAL SUBSTANCE REPORT FORMAT

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula:
Molecular Weight:
Structural formula:

B. Alternate Names and Registry Numbers

CAS Registry Number:
Deleted CAS Registry Number:
CA Name (9CI):
CA Name (8CI):
RTECS Number:

C. Chemical and Physical Properties

Physical State:
Color:
Odor:
Melting Point:
Freezing Point:
Boiling Point:
Solubilities:
Water:
Nonaqueous Solvents:
Octanol Water Partition Coefficient:
Hygroscopicity:
Specific Gravity (Liquid):
Vapor Pressure:
Flash Point:
Specific Heat:
Heat of Combustion:
Reactivity:
Refractive Index:
Vapor Density:
Autoignition Temp:
Stability:
Flammability:

II. USES
A. Army Unique Use
B. Other Uses

III. ANALYTICAL METHODS
A. Best Acceptable Method
B. Limit of Detection

IV. HEALTH EFFECTS

V. ENVIRONMENTAL EFFECTS
A. Environmental Fate
   A1. Transport
   A1a. Adsorption:
   A1b. Volatilization:
   A1c. Infiltration:
   A1d. Bioaccumulation:
   A2. Transformation
   A2a. Biodegradation:
A2b. Hydrolysis:
A2c. Photolysis:
A2d. Other chemical reaction:
A2e. Half-life:

B. Effects on animals
B1. Avian species:
B2. Mammalian wildlife species:
B3. Terrestrial invertebrates:
B4. Reptiles:
B5. Amphibians:
B6. Microorganisms, aquatic and soil:
B7. Aquatic species (fish and invertebrates):
   Fish:
   Invertebrate:

C. Effects on plants
C1. Phytotoxicity:
C2. Uptake:
C3. Metabolism:

VI. STANDARDS AND REGULATIONS
A. Health
   TLV: TWA: STEL:

B. Environmental

VII. DISPOSAL
A. Current Recommended Army Disposal Practices
B. Alternate Disposal Practices Under Consideration by the Army
C. Other Disposal Practices

VIII. REFERENCES

DAMD17-84-C-4133 19
### EXHIBIT II-3

**ABBREVIATIONS USED IN ENVIRONMENTAL AND HEALTH EFFECTS SECTIONS**

<table>
<thead>
<tr>
<th>Route</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>inh</td>
<td>$LD_{50}$: lowest dose expected to cause death of 50% of an animal test population</td>
</tr>
<tr>
<td>sc</td>
<td>$LC_{50}$: same as $LD_{50}$ for inhalation studies</td>
</tr>
<tr>
<td>ip</td>
<td>$LD_{lo}$: lowest reported lethal dose</td>
</tr>
<tr>
<td>iv</td>
<td>$LC_{lo}$: same as $LD_{lo}$ for inhalation studies</td>
</tr>
<tr>
<td>im</td>
<td>$TD_{lo}$: lowest reported toxic dose</td>
</tr>
<tr>
<td>occup.</td>
<td>$TC_{lo}$: same as $TD_{lo}$ for inhalation studies</td>
</tr>
<tr>
<td>exp.</td>
<td>NS = not specified</td>
</tr>
</tbody>
</table>

NS = not specified
III. RESULTS

Sixty-one chemicals were studied during Phase II of this project. Acetic anhydride was not included in Phase II because it undergoes rapid hydrolysis in water to form acetic acid, a common chemical readily metabolized by most plant and animal life. Data obtained on acetic anhydride indicated that its half-life at neutral pH and normal ambient temperature (assumed to be 25°C) was less than one hour, thus not posing a significant environmental threat (31).

A. CHEMICAL AND PHYSICAL DATA

1. Structure and Chemical Formulas and Molecular Weight

Several compounds, such as calcium resinate, copper naphthenate and zinc naphthenate, do not have defined structures, formulas or molecular weights because they are salts formed from acid mixtures and are, therefore, not precisely defined.

2. Alternate Names and Registry Numbers

The Chemical Abstracts Registry File, a computerized database, lists six million compounds, each theoretically with a unique Registry Number. However, because of inherent vagueness in indexing chemical literature, compounds occasionally have more than one number. CAS makes every attempt to delete duplicate numbers, but to make a complete and comprehensive search requires identification of deleted Registry Numbers.

Two compounds, triaminotrinitrobenzene (TATB) and tetraniitrocarmazole (TNC), are examples of two active registry numbers for the same compound. TNC is indexed under 9H-Carbazole, 1,3,6,8-tetrinitro- and 9H-Carbazole, tetrinitro--; TATB is indexed under 1,3,5-Benzenetriamine, 2,4,6-trinitro and Benzenetriamine, ar,ar,ar-trinitro-. When authors do not explicitly state the locants for the functional groups, CAS assigns citations to the general rather than the specific chemical name.

Diazodinitrophenol is listed in CAS under two completely different names. The structures appear different, but are resonance structures for the same compound. This cross-over was retrieved through the ICIS SANS database. The Chemical Abstracts system was notified and Registry File experts agreed that this was the same compound.

White and red phosphorus posed a special problem because of identical chemical composition, but different physical properties. In addition, there were two Registry Numbers, one for phosphorus in general and one for tetrahedral phosphorus. White phosphorus is generally considered to be tetrahedral, but a search must also include the Registry Number for phosphorus. Retrieved literature must be checked to assure data are assigned to the proper allotrope.

Initial evaluation of some of the names supplied indicated insufficient information for further investigation. Octachlor carbamalide and dinitrophenyl oxide existed as several geometric isomers. "Battery Lithium" did not identify a specific compound. Sodium perchlorate existed in both anhydrous and hydrated form. Further clarification was obtained from Army sources.

DAND17-84-C-4133 21
Additionally, dinitrophenyl azide had a problem. Searching under the compound name, dinitrophenyl azide, in ICIS and ANSS, two entries were retrieved: Benzene, 1-azido-1,4-dinitro-, RN 4096-88-2; and Hydroxylamine, O-(2-4-dinitrophenyl) RN 17508-17-1. These compounds are not the same, although they are related. Both listed the same RTECS number and synonyms, but the structures were different. In checking the CAS entries there was no cross-over of names or synonyms. The problem was eventually traced to a mechanical failure in the tape sold to ICIS by CAS and CAS was forced to recall the tape. The extent of this problem is unknown, but future searches will require both numbers to be used in databases other than CAS.

Potassium dinitrobenzofuroxan was a particularly difficult compound. The empirical and structural formulas found in CAS were significantly different from the Army references, including the Encyclopedia of Explosives and the Army Engineering Design Handbook. CARLTECH discussed with Chemical Abstracts experts the source of their information in order to explain the differences. CAS's source was an article published in France in 1969. A recent article (30), published jointly by the Naval Weapons Center at China Lake, CA and the Materials Research Laboratories of Australia, confirmed the CAS structure through infrared and nuclear magnetic resonance spectral data. The article states that the correct structure is not widely recognized in the explosives community. However, CAS also was not completely correct and the Eighth Collective Index Name was wrong and was corrected at the behest of CARLTECH.

Lead styphnate posed a different type of problem. Lead styphnate had four different formulas, structures, Registry Numbers, molecular weights, and index names. The ratio of lead to styphnate moiety varies and is sometimes undefined. Hydroxyl groups also varied. All four compounds and their Registry Numbers were included for completeness.

B. HEALTH EFFECTS

When all means of data acquisition had been exhausted, there remained 20 chemicals with little or no toxicity data (Exhibit III-1). Searches of the National Library of Medicine and citations contained in the TOXLINE data base identified work primarily in the area of drug analogues and pharmacologic receptor sites. Information obtained from an American Chemical Society Conference on SAR analysis and other sources indicated that work in the past focused on mathematical and computer modeling techniques. Environmental Protection Agency, Premanufacture Notification (PMN) submissions and other documents were examined for insight regarding the current practical application of SAR analysis. As a result of this research, the decision was made that in the absence of toxicity data on the chemical of interest, toxicity data of structurally related chemicals and chemical classes would be retrieved and presented. The manual resources and automated data bases listed above were used to obtain this information.

C. ENVIRONMENTAL EFFECTS

Few substances had totally complete environmental effects descriptions. Even well-documented substances such as ethylene oxide had environmental data gaps. Clearly, the literature did not explore all environmental issues. This is discussed in more detail in section III-E.
D. DISPOSAL

A single chemical needed to be chosen for Battery Lithium, since sources listed little or no data under this heading. Lithium Dithionite is a chemical present in spent batteries. This chemical was chosen because it is most likely to be present in disposal of batteries and is most likely to be toxic in some form.

E. DATA GAPS

Data gaps identified during this project are presented in Exhibit III-2. Briefly, Exhibit III-2 shows that 40 waste substances had essentially complete information for Physical and Chemical Data. Fifteen substances had gaps in Physical and Chemical Data, and five compounds had severe gaps.

Analytical Methods showed 43 compounds had essentially complete data, eight compounds had a few gaps, and nine compounds had severe gaps. Health Effects data coverage was good, 35 compounds had essentially complete data, 24 compounds had some gaps, and one compound had severe gaps.

Environmental Effects found 18 compounds with essentially complete information and 26 waste substances with some gaps. Sixteen compounds had severe gaps in Environmental Data. Simultaneously, Standards and Regulations had 15 waste substances with essentially complete information. There were 33 substances with some gaps in information and 12 substances with severe gaps.

Disposal Methods showed 35 waste substances had essentially complete information. There were 23 compounds with some gaps in the information and two substances had severe gaps in Disposal Method data.
EXHIBIT III-1

CHEMICALS REQUIRING ANALOGUES TO PROVIDE APPROXIMATE HEALTH EFFECTS

Aminoguanidine bicarbonate
Calcium resinate
Ceric ammonium nitrate
Chloramine T
Copper 8-quinolinolate
Diazodinitrophenol
1,3-Dichloro-5,5-dimethyl hydantoin
Dinitrophenyl azide
Halazone
Hydroxyl ammonium nitrate
Lead azide
Lead styphnate
Lithium dithionite
Magnesium thorium alloy
1-Nitro-2-propanol
Octachlor carbamidide
Potassium dinitrobenzofuroxan
Strontium oxalate
Tetranitrocarbazole
Triethanol ammonium nitrate
EXHIBIT III-2
DATA GAPS IDENTIFIED
PHYSICAL & CHEMICAL DATA

<table>
<thead>
<tr>
<th>ESSENTIALLY COMPLETE</th>
<th>SOME GAPS</th>
<th>SEVERE GAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Chloride</td>
<td>Calcium Stearate</td>
<td>Dinitrophenyl</td>
</tr>
<tr>
<td>Aminoguanidine</td>
<td>Ceric Ammonium Nitrate</td>
<td>Azide</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>Chloramine t</td>
<td>Magnesium Thorium</td>
</tr>
<tr>
<td>Iso-Amyl Alcohol</td>
<td>di-n-Propyl Adipate</td>
<td>Alloy</td>
</tr>
<tr>
<td>Iso-Amyl Nitrite</td>
<td>Dichlorophene</td>
<td>1-Nitro-2-Propanol</td>
</tr>
<tr>
<td>Antimony Trisulfide</td>
<td>Halazone</td>
<td>Octachlor</td>
</tr>
<tr>
<td>Barium Peroxide</td>
<td>Hydrazine</td>
<td>Carbanilide</td>
</tr>
<tr>
<td>Battery Lithium</td>
<td>Hydroxyl Ammonium Nitrate</td>
<td>Triethanol</td>
</tr>
<tr>
<td>Benzoyl Peroxide</td>
<td>n-Nitrosodiphenylamine</td>
<td>Ammonium Nitrate</td>
</tr>
<tr>
<td>Calcium Resinate</td>
<td>Nitrobenzylamine</td>
<td></td>
</tr>
<tr>
<td>Copper 8-Quinolinolate</td>
<td>1,2 Propylene Glycol Dinitrate</td>
<td></td>
</tr>
<tr>
<td>Copper Naphthenate</td>
<td>1,3 Propylene Glycol Dinitrate</td>
<td></td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>Tetranitrocarbazole</td>
<td></td>
</tr>
<tr>
<td>Diazodinitrophenol</td>
<td>Vat Yellow</td>
<td></td>
</tr>
<tr>
<td>Dischlorodimethyl-hydantoin</td>
<td>Zinc Naphthenate</td>
<td></td>
</tr>
<tr>
<td>Diethylene Glycol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diethylene Triamine-Diphenylamine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl Centralite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol Monoethyl Ether</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Azide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Styphnate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Thiocyanate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mirex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p-Nitrophenol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentaerythritol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetranitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus Trichloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinitrobenzoxoxan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Azide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strontium Oxalate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetrayl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Titanium Tetrachloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triaminotrinitrobenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triethylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Phosphorus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 25
### EXHIBIT III-2 CONTINUED

DATA GAP IDENTIFIED

ANALYTICAL METHODS

<table>
<thead>
<tr>
<th><strong>ESSENTIALLY COMPLETE</strong></th>
<th><strong>SOME GAPS</strong></th>
<th><strong>SEVERE GAPS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Chloride</td>
<td>Barium Peroxide</td>
<td>Battery Lithium</td>
</tr>
<tr>
<td>Aminoguanidine</td>
<td>Calcium Resinate</td>
<td>Ceric Ammonium Nitrate</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>Diethylene Triamine</td>
<td>Dichlorodimethyl-hydantoin</td>
</tr>
<tr>
<td>Iso-Amyl Alcohol</td>
<td>Lead Styphnate</td>
<td>Dinitrophenyl Azide</td>
</tr>
<tr>
<td>Iso-Amyl Nitrite</td>
<td>1,3 Propylene Glycol Dinitrate</td>
<td>Magnesium Thorium Alloy</td>
</tr>
<tr>
<td>Antimony Trisulfide</td>
<td>Strontium Oxalate</td>
<td>1-Nitro-2-Propanol</td>
</tr>
<tr>
<td>Benzoyl Peroxide</td>
<td>Triaminotrinitro-benzene</td>
<td>Octachlor Carbanilide</td>
</tr>
<tr>
<td>Calcium Stearate</td>
<td></td>
<td>Potassium</td>
</tr>
<tr>
<td>Chloramine t</td>
<td></td>
<td>Dinitrobenzfuroxan</td>
</tr>
<tr>
<td>Copper 8-Quinolinolrate</td>
<td></td>
<td>Tetranitrocarbazole</td>
</tr>
<tr>
<td>Copper Naphthenate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>di-n-Propyl Adipate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diazodinitrophenol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dichlorophene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diethylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diphenylamine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl Centralite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol Monoethyl Ether</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halazone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrazine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydroxyl Ammonium Nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Azide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Thiocyanate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mirex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-Nitrosodiphenylamine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrodi phenylamine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p-Nitrophenol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentaerythritol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetranitrate (PETN)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus Trichloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2-Propylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Azide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetryl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Titanium Tetrachloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triethanol Ammonium Nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triethylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 26
<table>
<thead>
<tr>
<th>ESSENTIALLY COMPLETE</th>
<th>SOME GAPS</th>
<th>SEVERE GAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Chloride</td>
<td>Aminoguanidine</td>
<td>Magnesium</td>
</tr>
<tr>
<td>Iso-Amyl Alcohol</td>
<td>Bicarbonate</td>
<td>Thorium Alloy</td>
</tr>
<tr>
<td>Iso-Amyl Nitrite</td>
<td>Battery</td>
<td>Lithium</td>
</tr>
<tr>
<td>Antimony Trisulfide</td>
<td>Cerium</td>
<td>Nitrate</td>
</tr>
<tr>
<td>Barium Peroxide</td>
<td>Calcium</td>
<td>Resinate</td>
</tr>
<tr>
<td>Benzoyle Peroxide</td>
<td>Copper 8-quinolinate</td>
<td></td>
</tr>
<tr>
<td>Calcium Stearate</td>
<td>Chloramine-t</td>
<td></td>
</tr>
<tr>
<td>Copper Naphthenate</td>
<td>Copper 8-quinolinate</td>
<td></td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>Diazoninitrophenol</td>
<td></td>
</tr>
<tr>
<td>Dichlorophene</td>
<td>1,3-Dichloro-5,5-dimethylhydantoin</td>
<td></td>
</tr>
<tr>
<td>Diethylene Glycol</td>
<td>Di-n-propyl adipate</td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td>Diethylene Glycol dinitrate</td>
<td></td>
</tr>
<tr>
<td>Diethylene Triamine</td>
<td>Lead azide</td>
<td></td>
</tr>
<tr>
<td>Diphenylamine</td>
<td>Lead thiocyanate</td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Lithium dithionite</td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>1-nitro-2-propanol</td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td>Ethylene Glycol</td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Octachlor carbanilide</td>
<td></td>
</tr>
<tr>
<td>Monoethyl Ether</td>
<td>Potassium dinitrobenzufurxan</td>
<td></td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td>1,3-Propylene glycol dinitrate</td>
<td></td>
</tr>
<tr>
<td>Hydrazine</td>
<td>Strontium oxalate</td>
<td></td>
</tr>
<tr>
<td>Mirex</td>
<td>Tetrinitrocarbazole</td>
<td></td>
</tr>
<tr>
<td>N-Nitrosodiphenylamine</td>
<td>Triaminotrinitrobenzene</td>
<td></td>
</tr>
<tr>
<td>p-Nitrophenol</td>
<td>Triethanol ammonium nitrate</td>
<td></td>
</tr>
<tr>
<td>Penterythritol</td>
<td>Triethylaminepentane</td>
<td></td>
</tr>
<tr>
<td>Tetranitrate (PETN)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus Trichloride</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### EXHIBIT III-2 CONTINUED

**DATA GAPS IDENTIFIED**

**HEALTH EFFECTS CONTINUED**

<table>
<thead>
<tr>
<th>Essentially Complete</th>
<th>Some Gaps</th>
<th>Severe Gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2-Propylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Azide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetryl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Titanium Tetrachloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triethylene Glycol Dinitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vat Yellow 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Phosphorus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DATA GAPS IDENTIFIED
ENVIRONMENTAL EFFECTS

ESSENTIALLY COMPLETE
 Iso-Amyl Nitrite
 Chloramine t
 Cyclohexanone
 Dichlorophene
 Diphenylamine
 Ethylene Glycol
 Ethylene Glycol
  Monoethyl
 Ether
 Ethylene Oxide
 Halazone
 Hydrazine
 Mirex
 p-Nitrophenol
 Pentachlorothiol
 Tetranitrate
 Potassium
 Perchlorate
 Sodium Azide
 Sodium
 Perchlorate
 Tetryl
 White Phosphorus

SOME GAPS
 Aluminum Chloride
 Iso-Amyl Alcohol
 Barium Peroxide
 Battery Lithium
 Calcium Resinate
 Copper
 8-Quinolinolate
 Copper Naphthenate
 di-n-Propyl Adipate
 Diethylene Triamine
 Ethyl Centralite
 Ethylene Glycol
 Dinitrate
 Hydroxyl Ammonium
 Nitrate
 Lead Azide
 Lead Styphnate
 Lead Thiocyanate
 Magnesium Thorium
 Alloy
 n-Nitrosodiphenylamine
 Nitrodiphenylamine
 Phosphorus
 Trichloride
 1,3 Propylene Glycol
 Dinitrate
 Red Phosphorus
 Strontium Oxalate
 Tetranitrocarbazole
 Titanium Tetrachloride
 Triethylene Glycol
 Dinitrate
 Vat Yellow 4

SEVERE GAPS
 Aminoguanidine
 Bicarbonate
 Antimony
 Trisulfide
 Benzoyl Peroxide
 Calcium Stearate
 Ceric Ammonium
 Nitrate
 Diazodinitrophenol
 Dischlorodimethylhydantoin
 Diethylene Glycol
 Dinitrate
 Dinitrophenyl Azide
 1-Nitro-2-Propanol
 Octachlor Carbanilide
 Potassium Dinitrobenzofuroxan
 1,2 Propylene
 Glycol Dinitrate
 Triaminotrinitrobenzene
 Triethanol Ammonium
 Nitrate
 Zinc Naphthenate
EXHIBIT III-2 CONTINUED
DATA GAPS IDENTIFIED
STANDARDS AND REGULATIONS

<table>
<thead>
<tr>
<th>ESSENTIALLY COMPLETE</th>
<th>SOME GAPS</th>
<th>SEVERE GAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Chloride</td>
<td>Aminoguanidine</td>
<td>Iso-Amyl Alcohol</td>
</tr>
<tr>
<td>Antimony Trisulfide</td>
<td>Bicarbonate</td>
<td>Cerium Ammonium Nitrate</td>
</tr>
<tr>
<td>Barium Peroxide</td>
<td>Iso-Amyl Nitrite</td>
<td>Dinitrophenyl Azide</td>
</tr>
<tr>
<td>Calcium Stearate</td>
<td>Battery Lithium</td>
<td>Magnesium Thorium Alloy</td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>Benzoyl Peroxide</td>
<td>1-Nitro-2-Propanol</td>
</tr>
<tr>
<td>Dichlorodimethyl-hydantoin (DANC)</td>
<td>Calcium Resinate</td>
<td>Nitrodiphenylamine</td>
</tr>
<tr>
<td>Diphenylamine</td>
<td>Chloramine t</td>
<td>Potassium</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Copper</td>
<td>Dinitrobenzofuroxan</td>
</tr>
<tr>
<td>Dinitrate</td>
<td>8-Quinolinolate</td>
<td>1,3 Propylene Glycol</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Copper Naphthenate</td>
<td>Dinitrate</td>
</tr>
<tr>
<td>Monoethyl Ether</td>
<td>Di-n-Propyl Adipate</td>
<td>Tetrynitrocyanobenzole</td>
</tr>
<tr>
<td>Hydrazine</td>
<td>Diazodinitrophenol</td>
<td>Titanium</td>
</tr>
<tr>
<td>Lead Azide</td>
<td>Dichlorophene</td>
<td>Tetrachloride</td>
</tr>
<tr>
<td>Lead Styphnate</td>
<td>Diethylene Glycol Dinitrate</td>
<td>Triaminotrinitrone</td>
</tr>
<tr>
<td>Lead Thiocyanate</td>
<td>Diethylene Glycol Dinitrate</td>
<td>Triethanol Ammonium</td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td>Diethylene Triamine</td>
<td></td>
</tr>
<tr>
<td>White Phosphorus</td>
<td>Ethyl Centralite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylene Glycol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylene Oxide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydroxyl Ammonium Nitrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mirex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n-Nitrosodiphenylamine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Octachlor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbamidine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-Nitrophenol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pentanetriol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tetranitrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphorus Trichloride</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potassium Perchlorate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,2 Propylene Glycol Dinitrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium Azide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium Perchlorate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strontium Oxalate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tetrayl</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triethylene Glycol Dinitrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vat Yellow 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc Naphthenate</td>
<td></td>
</tr>
<tr>
<td>ESSENTIALLY COMPLETE</td>
<td>SOME GAPS</td>
<td>SEVERE GAPS</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Aluminum Chloride</td>
<td>Iso-Amyl Alcohol</td>
<td>Antimony Trisulfide</td>
</tr>
<tr>
<td>Aminoguanidine</td>
<td>Iso-Amyl Nitrite</td>
<td>Magnesium Thorium Alloy</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>Ceric Ammonium</td>
<td></td>
</tr>
<tr>
<td>Barium Peroxide</td>
<td>Nitrate</td>
<td></td>
</tr>
<tr>
<td>Battery Lithium</td>
<td>Chloramine t</td>
<td></td>
</tr>
<tr>
<td>Benzoyl Peroxide</td>
<td>di-n-Propyl Adipate</td>
<td></td>
</tr>
<tr>
<td>Calcium Resinate</td>
<td>Diazodinitrophenol</td>
<td></td>
</tr>
<tr>
<td>Calcium Stearate</td>
<td>Diethylene Triamine</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>Dinitrophenyl Azide</td>
<td></td>
</tr>
<tr>
<td>8-Quinolinolate</td>
<td>Ethyl Centralite</td>
<td></td>
</tr>
<tr>
<td>Copper Naphthenate</td>
<td>Ethylene Glycol</td>
<td></td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>Monoethyl Ether</td>
<td></td>
</tr>
<tr>
<td>Dichlorodimethyl-</td>
<td>Lead Thiocyanate</td>
<td></td>
</tr>
<tr>
<td>hydantoin (DANC)</td>
<td>n-Nitrosodiphenylamine</td>
<td></td>
</tr>
<tr>
<td>Dichlorophene</td>
<td>1-Nitro-2-Propanol</td>
<td></td>
</tr>
<tr>
<td>Diethylene Glycol</td>
<td>Octachlor Carbanilide</td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td>Potassium</td>
<td></td>
</tr>
<tr>
<td>Diphenylamine</td>
<td>Dinitrobenzofuroxan</td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>1,2-Propylene Glycol</td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td>Dinitrate</td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>1,3-Propylene Glycol</td>
<td></td>
</tr>
<tr>
<td>Dinitrate</td>
<td>Dinitrate</td>
<td></td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td>Strontium Oxalate</td>
<td></td>
</tr>
<tr>
<td>Halazone</td>
<td>Triaminotrinitrobenzene</td>
<td></td>
</tr>
<tr>
<td>Hydrazine</td>
<td>Triethanol Ammonium</td>
<td></td>
</tr>
<tr>
<td>Hydroxyl Ammonium</td>
<td>Nitrate</td>
<td></td>
</tr>
<tr>
<td>Nitrate</td>
<td>Triethylene Glycol</td>
<td></td>
</tr>
<tr>
<td>Lead Azide</td>
<td>Dinitrate</td>
<td></td>
</tr>
<tr>
<td>Lead Styphnate</td>
<td>Vat Yellow 4</td>
<td></td>
</tr>
<tr>
<td>Mirex</td>
<td>Triethylene Glycol</td>
<td></td>
</tr>
<tr>
<td>Nitrodiphenylamine</td>
<td>Dinitrate</td>
<td></td>
</tr>
<tr>
<td>p-Nitrophenol</td>
<td>Zinc Naphthenate</td>
<td></td>
</tr>
<tr>
<td>Pentaerythritol</td>
<td>Tetranitrate (PETN)</td>
<td></td>
</tr>
<tr>
<td>Tetranitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Azide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Perchlorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetranitrocarbazole (TNC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetryl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Titanium Tetrachloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Phosphorus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IV. CONCLUSIONS AND RECOMMENDATIONS

Based on results presented in Section III, the largest number of data gaps were found in the following areas:

- Environmental Effects
- Disposal Technology.
- In no case did Environmental Effects have total data coverage even for well-documented compounds such as ethylene oxide. The lack of coverage is believed to be caused by a lack of research in specialized areas. Additional research would be required should total coverage be desired.
- Twenty substances had insufficient direct health effects data and were characterized using structural analogues (Exhibit III-1). Additional research is required for these 20 substances to identify health effects.

In general, waste preservatives, inorganic obscurants, and new or experimental ordnance appeared to have less data available than other substances.

Magnesium thorium alloy, while in fairly widespread use and possessing many apparent environmental and occupational hazards, had almost no data available. It is recommended that research be performed on hazards of this waste substance.

While data were available on analytical method descriptions, data coverage of lower limits of detection was poor. Further research is needed to clarify this area.
V. REFERENCES CITED


14. Gosselin, Robert E., Dr., Dr. Roger F. Smith, Dr. Harold C. Hodge, and Jeanette E. Braddock. 1984. Clinical Toxicology of Commercial


APPENDIX A

ANALYTICAL SEARCH METHODOLOGY

Analytical methods were obtained from citations retrieved by an online search of STN International's Chemical Abstracts File, which is the computerized searchable form of the printed Chemical Abstracts.

Using advanced search strategy, a query "hedge" (i.e., a reusable set of search terms which builds a search profile for specific topics) was formulated to retrieve relevant citations from Chemical Abstracts. The query used to search for analytical methods is as follows:

"QUE (ANAL OR ANALY? OR DETERMIN? OR DET# OR ASSAY OR MONITOR? OR DETECT? OR QUANT? OR MICROANAL? OR MICRODET? OR CHROMATOG? OR IDENTIF?)."

The "OR" is a Boolean "OR" instructs the computer to retrieve references indexed with either term. The "?" is the indefinite truncation symbol instructing the computer to retrieve references beginning with the stem. The "?" represents zero, one, or more letters. For example, "ANALY?" instructs the computer to retrieve analysis, analyze, analyti..al, etc. Indefinite truncation symbols are used only at the end of a term. The "?" is the definite internal truncation symbol instructing the computer to retrieve any references with that stem, except for one letter. For example, "SULF#TE" would result in the retrievals of sulfates and sulfites. In the above example, the internal truncation symbol was used at the end to require only one character be present, not zero or more. "DET#" was used to retrieve the various abbreviations used for determination such as detn., detm., or detr.

This query was linked with the CAS Registry Number(s) of a compound by either a Boolean "AND" or, in special cases, the "L" proximity operator. The Boolean "AND" instructs the computer to retrieve all citations where both search terms appear in the same record. This operator can be used to search the entire file or a previously retrieved answer set to include an additional term. The terms do not have to appear in the same indexing term like the title, but anywhere in the same citation record.

The "L" proximity operator was used in cases such as ethylene glycol or cyclohexanone. "L" instructs the computer to retrieve only those references where the Registry Number and a query term appeared in the same indexing term. It cannot be used in searching an answer set, but must be used in the CA file. For example, the "L" operator would retrieve an article on the detection of ethylene glycol in workplace air, but would not retrieve an article on ethylene glycol used as a solvent in the analysis of another compound, which would have been retrieved using "AND".

There are, however, two disadvantages to using this method: (1) STN limits the number of postings in an answer set; and (2) the search is very slow. This creates problems because both the analytical terms and the particular compounds are highly posted; the search exceeds the limit before completion and aborts. There are two ways to solve this problem: (1) use "AND" instead of "L." Search only the answer set created by the analytical
query "hedge" (which gives too many false hits); or (2) limit the range to a particular time period. The time limited query was preferred since this project required updating the database with only the most recent information. The search on these particular compounds was limited to January, 1984 to present, which retrieved and abstracted articles published since 1983.

The Boolean "AND" gave quicker results with compounds which were not analytical reagents or solvents. Also, ARC update compounds were limited by range to January, 1984 to present because the basic information only required updating.

Citations identified from the above searches were retrieved from libraries. Many articles were inaccessible through usual retrieval methods. In that case, the extended abstract, including all bibliographic and indexing information, was retrieved from the CA file.
APPENDIX B. Database

TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Anhydride</td>
<td>1-1</td>
</tr>
<tr>
<td>Aluminum Chloride</td>
<td>2-1</td>
</tr>
<tr>
<td>Aminoguanidine Carbonate</td>
<td>3-1</td>
</tr>
<tr>
<td>Iso-Amyl Alcohol</td>
<td>4-1</td>
</tr>
<tr>
<td>Iso-Amyl Nitrite</td>
<td>5-1</td>
</tr>
<tr>
<td>Antimony Trisulfide</td>
<td>6-1</td>
</tr>
<tr>
<td>Barium Peroxide</td>
<td>7-1</td>
</tr>
<tr>
<td>Battery Lithium</td>
<td>8-1</td>
</tr>
<tr>
<td>Benzoil Peroxide</td>
<td>9-1</td>
</tr>
<tr>
<td>Calcium Resinate</td>
<td>10-1</td>
</tr>
<tr>
<td>Calcium Stearate</td>
<td>11-1</td>
</tr>
<tr>
<td>Ceric Ammonium Nitrate</td>
<td>12-1</td>
</tr>
<tr>
<td>Chloramine-T</td>
<td>13-1</td>
</tr>
<tr>
<td>Copper-8-Quinolinolate</td>
<td>14-1</td>
</tr>
<tr>
<td>Copper Naphthenate</td>
<td>15-1</td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>16-1</td>
</tr>
<tr>
<td>Di-n-Propyl Adipate</td>
<td>17-1</td>
</tr>
<tr>
<td>Dizadinitrophenol</td>
<td>18-1</td>
</tr>
<tr>
<td>Dichlorodimethylhydantoin</td>
<td>19-1</td>
</tr>
<tr>
<td>Dichlorophene</td>
<td>20-1</td>
</tr>
<tr>
<td>Diethylene Glycol Dinitrate (DEGN)</td>
<td>21-1</td>
</tr>
<tr>
<td>Diethylene Triamine</td>
<td>22-1</td>
</tr>
<tr>
<td>Dinitrophenyl Azide</td>
<td>23-1</td>
</tr>
<tr>
<td>Diphenylamine</td>
<td>24-1</td>
</tr>
<tr>
<td>Ethyl Centralite</td>
<td>25-1</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>26-1</td>
</tr>
<tr>
<td>Chemical Name</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Ethylene Glycol Dinitrate</td>
<td>27-1</td>
</tr>
<tr>
<td>Ethylene Glycol Monoethyl Ether</td>
<td>28-1</td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td>29-1</td>
</tr>
<tr>
<td>Halazine</td>
<td>30-1</td>
</tr>
<tr>
<td>Hydrazine</td>
<td>31-1</td>
</tr>
<tr>
<td>Hydroxyl Ammonium Nitrate</td>
<td>32-1</td>
</tr>
<tr>
<td>Lead Azide</td>
<td>33-1</td>
</tr>
<tr>
<td>Lead Stibniteate</td>
<td>34-1</td>
</tr>
<tr>
<td>Lead Thiocyanate</td>
<td>35-1</td>
</tr>
<tr>
<td>Magnesium Thorium Alloy</td>
<td>36-1</td>
</tr>
<tr>
<td>Mirex</td>
<td>37-1</td>
</tr>
<tr>
<td>N-Nitrosodiphenylamine</td>
<td>38-1</td>
</tr>
<tr>
<td>1-Nitro-2-Propanol</td>
<td>39-1</td>
</tr>
<tr>
<td>2-Nitrodiphenylamine</td>
<td>40-1</td>
</tr>
<tr>
<td>Octachlor Carbanilide</td>
<td>41-1</td>
</tr>
<tr>
<td>p-Nitrophenol</td>
<td>42-1</td>
</tr>
<tr>
<td>Pentaerythritol Tetranitrate</td>
<td>43-1</td>
</tr>
<tr>
<td>Phosphorus Trichloride</td>
<td>44-1</td>
</tr>
<tr>
<td>Potassium Dinitrobenzafuroxan</td>
<td>45-1</td>
</tr>
<tr>
<td>Potassium Perchlorate</td>
<td>46-1</td>
</tr>
<tr>
<td>Propylene Glycol 1,2-Dinitrate</td>
<td>47-1</td>
</tr>
<tr>
<td>Propylene Glycol 1,3-Dinitrate</td>
<td>48-1</td>
</tr>
<tr>
<td>Red Phosphorus</td>
<td>49-1</td>
</tr>
<tr>
<td>Sodium Azide</td>
<td>50-1</td>
</tr>
<tr>
<td>Sodium Perchlorate</td>
<td>51-2</td>
</tr>
<tr>
<td>Strontium Oxalate</td>
<td>52-1</td>
</tr>
<tr>
<td>Tetranitrocarbazole</td>
<td>53-1</td>
</tr>
<tr>
<td>Tetryl</td>
<td>54-1</td>
</tr>
</tbody>
</table>
Titanium Tetrachloride ................................. 55-1  
Triaminotrinitrobenzene ................................. 56-1  
Triethanol Ammonium Nitrate ......................... 57-1  
Triethylene Glycol Dinitrate .......................... 58-1  
Vat Yellow 4 ........................................... 59-1  
White Phosphorus ....................................... 60-3
Chemical No. 1, Acetic Anhydride, was eliminated from further consideration after being found a minimal environmental threat. Acetic anhydride was not included in Phase II because it undergoes rapid hydrolysis in water to form acetic acid, a common chemical readily metabolized by most plant and animal life. Data obtained on acetic anhydride indicated that its half-life at neutral pH and normal ambient temperature (assumed to be 25°C) was less than one hour, thus not posing a significant environmental threat (31).
ALUMINUM CHLORIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: AlCl₃
Molecular Weight: 133.34 (1)
Structural Formula: See exhibit 2-1

B. Alternate Names and Registry Numbers

CAS Registry Number: 7446-70-0
Deleted CAS Registry Number: 41630-01-7
CA Name (9CI): Aluminum chloride (AlCl₃)
CA Name (8CI): Aluminum chloride
RTECS Number: BD0525000
Other significant synonyms: Aluminum trichloride

C. Chemical and Physical Properties

Physical State: Hexagonal crystals (2)
Color: White (pure); gray or yellow to greenish (1)
Odor: Odor of hydrogen chloride (1)
Melting Point: 190 °C at 2.5 atmospheres (2)
Boiling Point: 177.8 °C, sublimes (2)

Solubilities:
Water: Combines with water with explosive violence and liberation of much heat (1); 69.9 g per 100 mL cold water at 15 °C (2)
Nonaqueous Solvents: Freely soluble in many organic solvents, such as benzophenone, benzene, nitrobenzene, carbon tetrachloride, and chloroform (1); 100 g/100mL in absolute alcohol at 12.5 °C; 0.072 in chloroform at 25 °C; soluble in ether, chloroform; slightly soluble in benzene (2).

Octanol Water Partition Coefficient: Not applicable
Hygroscopicity: Deliquescent (2)

DAMD17-84-C-4133 2-1
ALUMINUM CHLORIDE (cont.)

EXHIBIT 2-1

Cl - Al - Cl

H₂O

H₂O

H₂O

H₂O

H₂O
ALUMINUM CHLORIDE (cont.)

Density (Crystal): 2.44 g/cc at 25°C (2)
Specific Gravity (Liquid): 1.31 at 200°C (2)

Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Reacts violently with water (1,2)
Stability: Data not available
Flammability: Data not available

II. USES
A. Army Unique Use
Smokes and obscurants

B. Other Uses
Acid catalyst, especially in Friedel-Crafts type reactions; in cracking of petroleum; and in the manufacture of rubbers and lubricants (1).

III. ANALYTICAL METHODS
A. Best Acceptable Method
A thin-layer chromatography method has been reported for aluminum chloride and other components of water gel explosives. This method can separate and determine the various components in these mixtures. This would be the method of choice for analysis of this compound when it is found in an explosive mixture (3).

B. Limit of Detection
Data not available
### IV. HEALTH EFFECTS

**TABLE IV-1: TOXICITY OF ALUMINUM CHLORIDE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>0.5-5 g/kg</td>
<td>Estimated lethal dose</td>
<td>(4)</td>
</tr>
<tr>
<td>Human</td>
<td>contact dust</td>
<td>NS*</td>
<td>Irritating to eyes, nose and throat</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>contact with solid</td>
<td>NS</td>
<td>Will produce skin, eye, and mouth burns</td>
<td>(5)</td>
</tr>
<tr>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>May cause allergic reactions</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>3.7 g/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>NS</td>
<td>Acute</td>
<td>Increased blood glucose; decreased liver glycogen</td>
<td>(7)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>770 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(8)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>425 mg/kg; multigeneration study</td>
<td>Effects on newborn</td>
<td>(8)</td>
</tr>
<tr>
<td>Mouse</td>
<td>ip</td>
<td>100 mmol/L</td>
<td>Chromosomal aberrations</td>
<td>(8)</td>
</tr>
</tbody>
</table>

* Not specified
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Infiltration -- Data not available

A1d. Bioaccumulation -- In Carp (Cyprinus carpio L.) exposed to 8 ppm aluminum chloride for 48 hours, concentration of aluminum in the gills exceeded 60,000 ug/g. In viscera and other parts of the fish, the aluminum concentration was less than 8,000 ug/g (9).

A2. Transformation -- Data not available

A2a. Biodegradation -- Data not available

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Data not available

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- In Carp (Cyprinus carpio L.) exposed to 8 ppm aluminum chloride for 48 hours, concentration of aluminum in the gills exceeded 60,000 ug/g. In viscera and other parts of the fish, the aluminum concentration was less than 8,000 ug/g (9).
C. **Effects on plants**

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. **STANDARDS AND REGULATIONS**

A. **Health**

3. TLV: TWA 2 mg(Al)/m³ (8).

B. **Environmental**

Reported in EPA TSCA Inventory 1980 (8).

VII. **DISPOSAL**

A. **Current Recommended Army Disposal Practices**

A recent programmatic life cycle environmental assessment indicates that incineration is the preferred method for disposal of smoke/obscurant munitions (3). Munitions containing aluminum chloride should be incinerated in a unit equipped with afterburner and a scrubber; scrubber overflow should be neutralized prior to discharge.

B. **Alternate Disposal Practices Under Consideration by the Army**

Data not available

C. **Other Disposal Practices Employed**

Data not available

VIII. **REFERENCES**


AMINOGUANIDINE CARBONATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: CH₆N₄·CH₂O₃
Molecular weight: 136.1

Structural Formula:

B. Alternate Names and Registry Numbers

CAS Registry Number: 2582-30-1

CA Name (9CI): Carbonic acid, compound with hydrazinecarboximidamide, hydrazinecarboximidamide, carbonate

CA Name (8CI): Guanidine, amino-, carbonate, carbonic acid compound with aminoguanidine

RTECS Number: Not available in RTECS

Other Significant Synonyms: Aminoguanidine bicarbonate

C. Chemical and Physical Properties

Physical State: Solid, powder (1)
Color: White or light yellow (1)
Odor: Odorless (1)
Melting Point: 170 - 172°C with decomposition (1)
AMINOGUANIDINE CARBONATE (cont.)

Solubilities:
Water: 0.3% at 30°C; 0.2% at 20°C
Nonaqueous Solvents: Data not available

Density (Crystal): 1.47 g/cc (1)

Vollatility: Not applicable

Vapor Pressure: Not applicable

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: No incompatibility (1)

Stability: Stable (1)

Flammability: No unusual fire or explosion hazards (1)

II. USES

A. Army Unique Use

Used in the manufacture of the explosive tetracene (2)

B. Other Uses

Chemical Intermediate

III. ANALYTICAL METHODS

A. Best Acceptable Method

Tanabe et al. (3) proposed a colorimetric method for guanidine and monosubstituted guanidines. The compounds were reacted with 0.04% 9,10-phenanthroquinone in dioxane:ethanol(1:4) and 2% 3,5-
dihydroxybenzoic acid in ethanol and 2N potassium hydroxide; the absorbance was measured at 615 nm. This method did not include any separation from other compounds.

B. Limit of Detection

Tanabe et al. (3) claimed 0.3 to 2 micrograms.
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF AMINO GUANIDINE CARBONATE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoguanidine bi-carbonate</td>
<td>Rat</td>
<td>oral (feed)</td>
<td>15 mg/g</td>
<td>Death in 3-4 days</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>Rat</td>
<td>oral</td>
<td>20 mg/kg</td>
<td>Specific diamine oxidase inhibitor; increased urinary excretion levels of histamine and tele-methylhistamine after L-tryptamine injection</td>
<td>(5)</td>
</tr>
<tr>
<td>Aminoguanidine</td>
<td>Rat</td>
<td>subcutaneous</td>
<td>1,258 LD50</td>
<td></td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td>Rat</td>
<td>intravenous</td>
<td>7.8 mm</td>
<td>50% inhibition of histidine decarboxylase activity by muscular stomach homogenate or partially purified enzyme preparation from stomach muscle</td>
<td>(7)</td>
</tr>
<tr>
<td>Mouse</td>
<td>subcutaneous</td>
<td>963 mg/kg</td>
<td>LD50</td>
<td></td>
<td>(6)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>intravenous</td>
<td>1.7 mM</td>
<td>50% inhibition of activity of histamine methyltransferase isolated from brain</td>
<td>(7)</td>
<td></td>
</tr>
<tr>
<td>Cat</td>
<td>intravenous</td>
<td>7.4-74 mg/kg</td>
<td>Augmented cholinergic-induced salivary excretion</td>
<td>(7)</td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>subcutaneous</td>
<td>1 mg/kg</td>
<td>Abolished heparin-induced inhibition of gastric secretion; 90-95% of plasma diamine oxidase activity was inhibited</td>
<td>(8)</td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>500 mg/kg</td>
<td>LD50</td>
<td></td>
<td>(7)</td>
</tr>
</tbody>
</table>

DAMD17-64-C-4133  3-3
V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of aminoguanidine bicarbonate.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Listed in EPA TSCA Inventory.

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (9).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by AFRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (10).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


DANDI7-83-C04153 3-4


ISO-AMYL ALCOHOL

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_5H_{12}O \)

Molecular Weight: 88.15 (1)

Structural Formula: \( (CH_3)_2CHCH_2CH_2OH \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 123-51-3

CA Name (9CI): 1-butanol, 3-methyl

CA Name (8CI): Isopentyl alcohol

RTECS Number: LV5600000, EL5425000

Other Significant Synonyms: Isobutyl carbinol (1); amyl alcohol

C. Chemical and Physical Properties

Physical State: Liquid (1)

Color: Clear, oily (2)

Odor: Disagreeable, pungent, repulsive, poisonous vapors (1)

Melting Point: \(-17.2^\circ C\) (1)

Boiling Point: \(28.5^\circ C\) (2)

Solubilities:

- Water: 2g/100 mL at \(14^\circ C\)
- Nonaqueous Solvents: Miscible with alcohol, ether, benzene, chloroform, petroleum ether, glacial acetic acid, oils (1); very soluble in acetone (2); soluble in most organic solvents (2).

Partition Coefficient: \( \text{Log P} = 0.46 \)

Hygroscopicity: Data not available

Specific gravity: 0.813 at \(15^\circ C\)

Vapor Pressure: 28 mm Hg at \(20^\circ C\) (2)
ISO-AMYL ALCOHOL (cont.)

Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Can react vigorously with reducing materials (2).
Stability: Explodes when exposed to flame (2).
Flammability: Flash point, closed cup 45°C; open cup 55°C (1)

II. USES

A. Army Unique Use
Preparation of isoamyl nitrite explosive

B. Other Uses
Solvent for fats, resins, alkaloids, etc.; manufacture of isoamyl compounds, isovaleric acid, mercury fulminate, pyroxylin, artificial silk, lacquers, and smokeless powders; in microscopy; for dehydrating collodion solutions; and for determining fat in milk (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Gas chromatography is the method of choice. Krull et al. (3) reported an extremely sensitive method using a photoionization detector to detect the pentafluorophenyl dimethylsilyl chloride (flophemsyl) derivative. Isoamyl alcohol was chromatographed on a Permabond PEG column with temperature programming. An electron capture detector (ECD) was also used.

Masuda et al. (4) reported a gas chromatographic method for underivatized iso-amyl alcohol on a 5% phenylmethyl silicone capillary column with a flame ionization detector (FID).

B. Limit of Detection

Krull et al. (3) reported 38.7 picograms for PID and 20 picograms for ECD for the flophemsyl derivatives and 0.852 nanograms for PID and 3.37 nanograms for ECD for the underivatized alcohol.

Masuda et al. (4), 0.5 mg/L or 500 ppb.
## IV. HEALTH EFFECTS

### TABLE IV-1. TOXICITY OF ISO-AMYL ALCOHOL

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>local</td>
<td>NS</td>
<td>Irritant; vapors rapidly produce intense irritation of nose, eyes, and throat</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>NS</td>
<td>High conc.</td>
<td>May cause central nervous system depression, narcosis, headache, and nausea</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1,300 mg/kg</td>
<td>LD$_{50}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>intraperitoneal</td>
<td>813 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>intraperitoneal</td>
<td>2.3 mmol/kg</td>
<td>Ataxia</td>
<td>(7)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>3,800 mg/kg (total dose)</td>
<td>Carcinogenic, producing liver and blood tumors** intermittently for 85 wk</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>233 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intravenous</td>
<td>234 mg/kg</td>
<td>LD$_{50}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse</td>
<td>subcutaneous</td>
<td>7,480 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse</td>
<td>inhalation</td>
<td>41,514 ppm</td>
<td>50% decrease in respiratory rate</td>
<td>(8)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>oral</td>
<td>4,250 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>intravenous</td>
<td>1,570 mg/kg</td>
<td>LD$_{Lo}$; behavioral symptoms</td>
<td>(6)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>3,212 mg/kg</td>
<td>LD$_{50}$</td>
<td>(6)</td>
</tr>
</tbody>
</table>
TABLE IV-1. TOXICITY OF ISO-AMYL ALCOHOL (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>20 mg/24 hr</td>
<td>Severe irritation</td>
<td>(6)</td>
</tr>
<tr>
<td>Cat</td>
<td>intra-venous</td>
<td>210 mg/kg</td>
<td>LD₀</td>
<td>(6)</td>
</tr>
</tbody>
</table>

** Conclusion taken from RTECS; studies were not evaluated

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF ISO-AMYL ALCOHOL

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharomyces cerevisiae</td>
<td>10 mmol/tube</td>
<td>Induction of chromosomal aberrations</td>
<td>(6)</td>
</tr>
<tr>
<td>Escherichia coli K12 infected with phage: lambda Tn9</td>
<td>&quot;drop&quot;</td>
<td>Negative results for stimulation of Tn9 transposition</td>
<td>(9)</td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- Data not available

A2. Transformation -- Data not available

A2a. Biodegradation -- Activated sludge BOD, 30 days acclimation, 20°C, 1-5 days observed, feed: 333 mg/L, 79% BOD removed (10).

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

DAMD17-84-C-4133 4-4
A2d. Other chemical reaction -- BOD₅: 0.150, normal sewage as seed material, standard dilution techniques; 0.162, normal sewage as seed material, standard dilution techniques; COD: 77% of ThOD; ThOD: 2.740 (10).

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species (fish and invertebrates) -- Data not available

C. Effects on plants

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Indication in Holston Installation Assessment that open burning is the only Army approved method for disposal of explosive wastes. Solvents containing up to 80-90% water are burned in clay lined pits at Holston (11).
B. Alternate Disposal Practices under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

AEHA: NSN 6810-00-142-8764, 106-8925, 2811999

Dispose of through a commercial contractor (12).

VIII. REFERENCES


ISO AMYL NITRITE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_5H_9NO_2 \)
Molecular Weight: 117.15 (1)
Structural Formula: \((CH_3)_2CHCH(CH_2)ONO\)

B. Alternate Names and Registry Numbers

CAS Registry Number: 110-46-3
CA Name (9CI): Nitrous acid, 3-methylbutyl ester
CA Name (8CI): Isopentyl alcohol, nitrite
RTECS Number: NT0187500
Other Significant Synonyms: Isoamyl nitrite, isopentyl nitrite, 3-methylbutanol nitrite, 3-methylbutyl nitrite.

C. Chemical and Physical Properties

Physical State: Liquid (2); decomposes on exposure to air, light or water.
Color: Clear yellowish (2)
Odor: Fragrant odor and pungent aromatic taste (3)
Melting Point: Data not available
Boiling Point: 96-99°C (2)
Solubilities:
Water: Very slightly soluble (1)
Nonaqueous Solvents: Miscible with alcohol, chloroform, ether, and light petroleum (4).
Density: 0.8528 g/cc at 4°C (2)
Octanol Water Partition Coefficient: Data not available
Hygroscopicity: Data not available
Density (Vapor): 4.0 (2)
(ISO) AMYL NITRITE (cont.)

Volutility: Volatilizes readily (1)
Vapor Pressure (p): 60 Torr (30°C)
Flash Point: 10°C
Specific Heat: Data not available
Heat of Combustion: 6,930 cal/g
Autoignition Temperature: In air 209°C; in oxygen 202°C (5)

Reactivity: Oxidizing material, can react with oxidizing or reducing materials (2). Dangerous fire risk (4). Floats on water. Produces poisonous gas on contact with water. Combustion products include toxic oxides of nitrogen. Decomposes on exposure to air, light, or water; evolving toxic oxides of nitrogen (6). Incompatible with alcohol, alkaline, carbonates, caustic alkalis, bromides, iodides, ferrous salts, and phenazone (3). Forms an explosive mixture with air or oxygen (1).

Stability: Unstable, decomposes on exposure to air and light (1)

Flammability: Very flammable (1); moderate fire hazard when exposed to heat or flame or by spontaneous chemical reaction. Vapor explodes when heated (2).

II. USES
A. Army Unique Use
   Explosive and chemical agent antidote.
B. Other Use
   Perfumes, diazonium compounds (4), vasodilator (10), treatment of cyanide poisoning and H₂S poisoning (3).

III. ANALYTICAL METHODS
A. Best Acceptable Method
   Carignan and Hickman published a quantitative infrared spectrophotometric method for the determination of isomyl nitrite (7). Das et al. reported a chemical ionization mass spectrometry, in conjunction with gas chromatography, that can be used for quantitative estimation of trace amounts (8).

B. Limit of Detection
   Data not available

DAMD17-84-C-4133  5-2
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF AMYL NITRITE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral or inhalation</td>
<td>NS*</td>
<td>Methemoglobinemia, tachycardia, headache, weakness, confusion, restlessness, faintness and loss of consciousness</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>skin</td>
<td>(Liquid)</td>
<td>Severe skin irritation and eye damage; second and third degree burns on short contact</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>Therapeutic level doses (0.18 or 0.3 mL)</td>
<td>Headache, dizziness, weakness, postural hypotension, skin rash, and methemoglobinemia</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>505 mg/kg</td>
<td>LD$_{50}$</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>1,274 ppm/1hr</td>
<td>LC$_{50}$</td>
<td>(10)</td>
</tr>
</tbody>
</table>

* Not specified

TABLE IV-2. MUTAGENICITY OF AMYL NITRITE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. typhimurium</td>
<td>NS*</td>
<td>Mutagenic with or without metabolic activation</td>
<td>(11)</td>
</tr>
</tbody>
</table>

* Not specified
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available
A1a. Adsorption -- Data not available
A1b. Volatilization -- Data not available
A1c. Leachability -- Data not available
A1d. Bioaccumulation -- No potential for concentration in the food chain (6).

A2. Transformation -- Data not available

A2a. Biodegradation -- Data not available

A2b. Hydrolysis -- Decomposes on exposure to water, evolving toxic oxides of nitrogen (6).

A2c. Photolysis -- Decomposes on exposure to light, evolving toxic oxides of nitrogen (6).

A2d. Other chemical reaction -- Decomposes on exposure to air, evolving toxic oxides of nitrogen (6).

A2e. Half-life -- Data not available

B. Effects on animals -- Data not available

C. Effects on plants -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been
IV. HEALTH EFFECTS

### TABLE IV-1. TOXICITY OF AMYL NITRITE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral or inhalation</td>
<td>NS*</td>
<td>Methemoglobinemia, tachycardia, headache, weakness, confusion, restlessness, faintness and loss of consciousness</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>skin</td>
<td>(Liquid)</td>
<td>Severe skin irritation and eye damage; second and third degree burns on short contact</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>Therapeutic level doses (0.18 or 0.3 mL)</td>
<td>Headache, dizziness, weakness, postural hypotension, skin rash, and methemoglobinemia</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>505 mg/kg</td>
<td>LD$_{50}$</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>1,274 ppm/1hr</td>
<td>LC$_{50}$</td>
<td>(10)</td>
</tr>
</tbody>
</table>

* Not specified

### TABLE IV-2. MUTAGENICITY OF AMYL NITRITE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. typhimurium (strain not stated in abstract)</td>
<td>NS*</td>
<td>Mutagenic with or without metabolic activation</td>
<td>(11)</td>
</tr>
</tbody>
</table>

* Not specified
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available
A1a. Adsorption -- Data not available
A1b. Volatilization -- Data not available
A1c. Leachability -- Data not available
A1d. Bioaccumulation -- No potential for concentration in the food chain (6).

A2. Transformation -- Data not available
A2a. Biodegradation -- Data not available
A2b. Hydrolysis -- Decomposes on exposure to water, evolving toxic oxides of nitrogen (6).
A2c. Photoysis -- Decomposes on exposure to light, evolving toxic oxides of nitrogen (6).
A2d. Other chemical reaction -- Decomposes on exposure to air, evolving toxic oxides of nitrogen (6).
A2e. Half-life -- Data not available

B. Effects on animals -- Data not available

C. Effects on plants -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been
confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (12).

B. **Alternate Disposal Practices under Consideration by the Army**

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot. (13)

C. **Other Disposal Practices Employed**

Data not available

VIII. REFERENCES


ANTIMONY TRISULFIDE

Update of Atlantic Research Corporation Study

SUMMARY OF PREVIOUS STUDY

The toxicological and environmental hazards of antimony trisulfide have been reported in the Atlantic Research Corporation's (ARC) report, A Preliminary Problem Definition Study of the Toxicological and Environmental Hazards of 48 Munitions Related Chemicals. The report concluded that the compound is not highly toxic to mammals, aquatic organisms, microorganisms or plants. A summary of chronic inhalation toxicity of antimony trisulfide to mammals was presented and the effects of antimony exposure on workers was summarized. Antimony trisulfide occurs in nature as stibnite ore. The acute toxicity of several antimony compounds to aquatic organisms was reported in the study. Phytotoxicity information is very limited.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{Sb}_2\text{S}_3$

Molecular Weight: 339.69

Structural Formula:

B. Alternate Names and Registry Numbers

Deleted CAS Registry Numbers: 12138-10-2; 28767-59-1

CAS Registry Number: 1345-04-6

CA Name (9CI): Antimony sulfide ($\text{Sb}_2\text{S}_3$)

DAMD17-84-C-4133 6-1
ANTIMONY TRISULFIDE (cont.)

CA Name (8CI): Antimony sulfide
RTECS Number: CC9450000

Other Significant Synonyms: Antimony sesquisulfide, antimonous sulfide, antimony glance, antimony orange, antimony trisulfide colloid, crimson antimony sulphide, needle antimony (8).

C. Chemical and Physical Properties

Physical State: Crystals or powder (1)
Color: Gray, gray-black, orange-red to black (1)
Odor: Data not available
Melting Point: 546°C (2)
Boiling Point: 1150°C (3)

Solubilities:
- Water: Insoluble (3), 0.0-0.00175 g/cc (18°C)
- Nonaqueous Solvents: Soluble in alcohol, hydrochloric acid, ammonium sulfide, potassium sulfide; insoluble in acetic acid (4); soluble in sulfide salts (5); soluble in fixed alkali hydroxides (1).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): 4.64 g/cc for gray crystals and 4.12 g/cc for yellow-red solid (6).

Vapour Pressure: 0.033 mm Hg at 400°C; 1.17 mm Hg at 500°C; 244.00 mm Hg at 850°C (2).

Specific Heat: Data not available
Heat of Combustion: Data not available

Reactivity: Can react vigorously with oxidizing materials and produce toxic fumes of oxides, sulfur, and antimony.

Stability: Stable in air at room temperature (2)

Flammability: Moderate fire and combustion hazard (2)
II. USES

A. Army Unique Use

Used in pyrotechnic and primer formulations, as well as camouflage paints (2).

B. Other Uses

Used in the manufacture of vermilion or yellow pigment, antimony salts, matches, percussion caps, fireworks, and ruby glass. Also used in flame-proofing formulations (2).

III. ANALYTICAL METHODS

A. Best Acceptable Method

No analytical methods have been found by surveying the chemical literature from 1983 until present that significantly replace or update the findings in the Atlantic Research Corporation study.

B. Limit of Detection

Data not available
IV. HEALTH EFFECTS

TABLE IV-1. HEALTH EFFECTS OF ANTIMONY TRISULFIDE* (7)

<table>
<thead>
<tr>
<th>Compound</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony trisulfide</td>
<td>Human</td>
<td>inhalation</td>
<td>0.58–5.5 mg/m³, 8–24 mo, urinary level: 0.8–9.6 mg/L</td>
<td>ECG changes, cardiac deaths, ulcers</td>
</tr>
<tr>
<td>Antimony trisulfide, metal, and</td>
<td>Human</td>
<td>inhalation</td>
<td>urinary level: 5–182 mg/L</td>
<td>Female reproductive problems, infant weight gain lower than normal</td>
</tr>
<tr>
<td>trioxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony trisulfide</td>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>Single sub-lethal dose</td>
<td>Chronic heart changes</td>
</tr>
<tr>
<td>Antimony trisulfide or trisulfide or trioxide</td>
<td>Rat</td>
<td>intra-tracheal</td>
<td>Single 20 mg</td>
<td>Weight reduction, macrophage reaction</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of antimony trisulfide which would update the Atlantic Research Corporation study.
VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 0.5 mg (Sb)/m^3 (8).

B. Environmental

Reported in the EPA TSCA Inventory 1983.

EPA TSCA 8(a) Preliminary Assessment Information, final rule (9).

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Data not available

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data Not available

VIII. REFERENCES


ANTIMONY TRISULFIDE (cont.)


Much of the available data on barium peroxide has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, *A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals*. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: BaO₂
Molecular Weight: 169.36
Structural Formula: \[ \text{Ba}^{+2} \text{...} \text{(-O-O-)}^{-2} \]

B. Alternate Names and Registry Numbers

CAS Registry Number: 1304-29-6
Alternate CAS Registry Number: 16678-58-3
Deleted CAS Registry Numbers: 55346-27-5; 61233-09-8

CA Name (9CI): Barium peroxide (BaO₂)
CA Name (8CI): Barium peroxide
RTECS Number: CR0175000

Other Significant Synonyms: Barium dioxide; barium superoxide; barium oxide.

C. Chemical and Physical Properties

Physical State: White Powder
Color: White or Grayish
Odor: Odorless (1)

Melting Point: 450°C
Boiling Point: 800°C; decomposes (2)

Solubilities:
- Water: Slightly, decomposes on contact with water (3)
- Nonaqueous Solvents: Slightly soluble in acid and soluble in acetone (4).
BARIIUM PEROXIDE (cont.)

Octanol Water Partition Coefficient: Not applicable

Hygroscopicity: Data not available

Density (Crystal): 4.96 g/cc at 20°C. (Solid) (1)

Volatility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Flash Point: Not flammable (1)

Heat of Combustion: Data not available

Reactivity: Can ignite spontaneously if mixed with finely divided metals. Oxidizer, will react with organics or reducing agents. Mixtures with oxidizable material are explosive and ignite easily by friction (5).

Stability: Slowly turns into BaO$_2$·8H$_2$O on contact with water (6). Decomposes slowly in air (3). Reacts with dilute or strong HCl to generate hydrogen peroxide (5).

Flammability: Not flammable (5), but container may explode in fire and may cause fire on contact with combustibles or increase intensity of fire (1).

II. USES

A. Army Unique Use

As an oxidizer in igniter, tracer and propellant formulae. Imparts a green color to pyrotechnics (5).

B. Other Uses

Bleaching animal substances, vegetable fibers and straw; glass decolorizer; manufacture H$_2$O$_2$ and oxygen; dyeing and printing textiles; with powdered aluminum in welding; in cathodes; in igniter compositions. Oxidizing agent in organic synthesis.
III. ANALYTICAL METHODS

A. Best Acceptable Method

A survey of the chemical literature from 1967 on did not result in any significant change from the Atlantic Research Corporation report.

B. Limit of Detection

Data not available

IV. HEALTH EFFECTS

<table>
<thead>
<tr>
<th>TABLE IV-1. TOXICITY OF BARIUM PEROXIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Human</td>
</tr>
<tr>
<td>Human</td>
</tr>
<tr>
<td>Human</td>
</tr>
<tr>
<td>Mouse</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
** Not specified

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport — Data not available

A1a. Adsorption — Data not available

A1b. Volatilization — Data not available

DAMD-7-84-0-4133 7-3
A1c. Leachability -- Leaching of barium was studied under controlled conditions similar to conditions in which barium-containing wastes are co-disposed with domestic waste in a landfill. Eighteen to 39% of the barium leached out of the material, probably mainly in the form of organic barium complexes. Leaching of barium is higher when the barium-containing salt is located below the groundwater level. Barium chloride was the salt used in the study (8).

A1d. Bioaccumulation -- Data not available

A2. Transformation -- Data not available

A2a. Biodegradation -- Data not available

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Data not available

A2e. Half-life -- Data not available

B. Effects on Animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- Data not available

C. Effects on Plants

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

TLV-TWA 0.5 mg (Ba)/m³ (7); OSHA standard--air 0.5 mg(Ba)/m³; DOT: oxidize.
VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involves open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (9).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (10).

Disposal Methods Suggested for Related Materials: Barium fluoride (careful precipitation with soda ash or slaked lime). The resulting sludge should be sent to a chemical waste landfill. Barium nitrate, barium sulfide (chemical reaction with water, caustic soda, and slaked lime). The precipitated metal sludge should be landfilled. Barite barium sulfate may be recovered for reuse in drilling muds (A-57) as an alternative to disposal (11).

C. Other Disposal Practices Employed

Disposal of Laboratory or other small amounts: Cover with at least double amount of sand to soda ash 9:1 mixture. Mix completely and uniformly. While stirring, add slowly to a large beaker of sodium sulfite solution with plastic spoon. Carefully neutralize with diluted sulfuric acid. After settling, decant the sulfate solution into a sewer with sufficient water and transport the sand to a landfill site (6).

VIII. REFERENCES


BATTERY LITHIUM
LITHIUM DITHIONITE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{Li}_2\text{S}_2\text{O}_4$ (1)
Molecular Weight: 135.06 (1)
Structural Formula:

\[
\begin{array}{c}
\text{O}^-\text{Li}^+ \\
\text{S} \\
\text{O}^-\text{Li}^+
\end{array}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 59744-77-3
CA Name (9CI): Dithionous acid, dilithium salt
CA Name (8CI): Data not available
RTECS Number: Not in RTECS
Other Significant Synonyms: Data not available

C. Chemical and Physical Properties

Physical State: Crystalline solid (1)
Color: White to grayish white (1)
Odor: Data not available
Melting Point: Data not available
BATTERY LITHIUM (cont.)

Solubilities:
- Water: Soluble in cold water, decomposes in hot water (1)
- Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Not applicable

Hygroscopicity: Data not available

Density (Crystal): Data not available

Volatile: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Is readily oxidized to bisulfite and bisulfate; when heated to decomposition in water, emits toxic vapors (1).

Stability: Data not available

Flammability: Data not available

II. USES

A. Unique Use

Lithium/sulfur dioxide battery; by-product formed within the lithium battery (1).

B. Other Uses

No commercial use found

III. ANALYTICAL METHODS

A. Best Acceptable Method

No method for lithium dithionite was found. Lithium could easily be detected by atomic absorption spectrocopy, but the determination would not specifically quantitate the amount present as the dithionite salt.

B. Limit of Detection

Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF LITHIUM DITHIONITE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium dithionite</td>
<td>Human</td>
<td>oral</td>
<td>No toxicity data located on the specific compound; related data follow below</td>
<td></td>
</tr>
<tr>
<td>Lithium</td>
<td>Human</td>
<td>oral</td>
<td>Nausea, vomiting, diarrhea, anorexia, dehydration, polyurea, apathy, lethargy, muscular weakness, ataxia, hand tremor, myoclonic twitchings, acne and exacerbation or precipitation of psoriasis, leukocytosis, headache, cogwheel rigidity; severe intoxication is associated with seriously impaired consciousness, hyperflexia, convulsions, epileptic seizures, coma, and kidney, brain, and heart damage</td>
<td>(2)</td>
</tr>
<tr>
<td>Rat</td>
<td>NS*</td>
<td></td>
<td>Polyurea leading to oliguria and azotemia; behavioral changes begin at plasma levels of approx. 3 mmol/L; deaths above 8 mmol/L</td>
<td>(3)</td>
</tr>
<tr>
<td>NS</td>
<td>NS</td>
<td></td>
<td>Implicated in the development of aplastic anemia</td>
<td>(4)</td>
</tr>
<tr>
<td>Sodium dithionite</td>
<td>NS</td>
<td>NS</td>
<td>Skin irritant; presumably shares the toxic potentials of bisulfite and sulfite to which it is rapidly oxidized</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>in vitro</td>
<td></td>
<td>Incubation of normal erythrocytes with sodium dithionite resulted in the formation of Heinz bodies; Heinz body formation was increased by superoxide dismutase and decreased by catalase</td>
<td>(6)</td>
</tr>
</tbody>
</table>
TABLE IV-i. TOXICITY OF LITHIUM DITHIONITE (Cont.)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium bisulfite</td>
<td>NS</td>
<td>NS</td>
<td>Concentrated solutions are irritating to the skin and mucous membranes; in fatal poisonings, death in 30-45 min following irritability, restlessness, clonic convulsions, apnea, cyanosis, and terminal respiratory and cardiovascular collapse</td>
<td>(5)</td>
</tr>
<tr>
<td>Microorganisms</td>
<td>in vitro</td>
<td></td>
<td>Mutagenic in several test systems</td>
<td>(7)</td>
</tr>
<tr>
<td>Sulfites</td>
<td>Human</td>
<td>inges-</td>
<td>May cause irritation of the stomach by liberating sulfurous acid</td>
<td>(4)</td>
</tr>
<tr>
<td>Animals</td>
<td>NS</td>
<td></td>
<td>Large doses have been shown to cause retarded growth, nerve irritation, atrophy of bone marrow, depression, and paralysis</td>
<td>(4)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- Data not available

A2. Transformation -- Data not available

A2a. Biodegradation -- Data not available

A2b. Hydrolysis -- Data not available
A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Lithium dithionite is easily oxidized to the bisulfite and the bisulfate salts in open air (8).

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- Lithium dithionite is expected to have toxicity similar to that of other lithium salts. Lithium chloride is the best documented in Table V-1 (below)

TABLE V-1. LETHAL FISH EXPOSURES (8)

<table>
<thead>
<tr>
<th>COMPOUND</th>
<th>ANIMAL</th>
<th>CONCENTRATION</th>
<th>EXPOSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>Goldfish</td>
<td>3750</td>
<td>22 to 27 Hours</td>
</tr>
<tr>
<td>Chloride</td>
<td>Mature Small</td>
<td>2600</td>
<td>24 Hours</td>
</tr>
<tr>
<td></td>
<td>Freshwater Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Freshwater Fish</td>
<td>1950-3770</td>
<td>24 Hours</td>
</tr>
</tbody>
</table>
TABLE V-2.
LETHAL EXPOSURES OF FRESHWATER INVERTEBRATE, PROTOZOA AND BACTERIA (8)

<table>
<thead>
<tr>
<th>COMPOUND</th>
<th>ANIMAL</th>
<th>PARAMETER</th>
<th>CONCENTRATION mg/L</th>
<th>EXPOSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>Daphnia magna</td>
<td>Immobilization</td>
<td>&lt;7.2</td>
<td>----</td>
</tr>
<tr>
<td>Chloride</td>
<td>Daphnia magna</td>
<td>Poison threshold</td>
<td>16</td>
<td>48 Hours</td>
</tr>
<tr>
<td>Chloride</td>
<td>Scenedesmus</td>
<td>No toxic effect</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>E. Coli</td>
<td>No toxic effect</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Microregna</td>
<td>Food intake</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Water beetle</td>
<td>Excitation</td>
<td>19500</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Fly larvae</td>
<td>Toxic effect</td>
<td>848</td>
<td></td>
</tr>
</tbody>
</table>

C. Effects on plants
C1. Phytotoxicity -- Concentrations of lithium ion above 30 ppm have been found to be toxic to plant species including soybeans, mustards, flax, vetch, corn, citrus, avocado and wheat (8).

C2. Uptake -- Data not available
C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS
A. Health
Data not available
B. Environmental
The EPA has proposed the following limits for lithium ion in irrigation water: max 2.5 mg/L, avg 0.075 mg/L (8)

VII. DISPOSAL METHODS
A report (1) recommends secured landfills or lined disposal ponds as recommended means of lithium battery disposal.
VIII. REFERENCES


5. Gosselin, Robert E., Dr., Dr. Roger P. Smith, Dr. Harold C. Hodge, and Jeannette E. Braddock. 1984. Clinical Toxicology of Commercial Products, 5th ed. Williams and Wilkins, Baltimore, MD.


BENZYL PEROXIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_{14}H_{10}O_4$
Molecular Weight: 242.22 (1)

Structural Formula:

B. Alternate Names and Registry Numbers

CAS Registry Number: 94-36-0
Deleted CAS Registry Number: 37370-29-9
CA Name (9CI): Peroxide, dibenzoyl
CA Name (8CI): Benzoyl peroxide
RTECS Number: DM575000

Other Significant Synonyms: Benzoyl superoxide

C. Chemical and Physical Properties

Physical State: Crystalline solid (1)
Color: White (2)
Odor: Bitter almond (2)
Melting Point: 103-106°C (1), decomposes (3)

Solubilities:
Water: Sparingly (1)
Nonaqueous Solvents: Soluble in benzene, chloroform, ether 1 g/40 mL;
carbon disulfide: g/50 mL olive oil (1).
BENZOYL PEROXIDE (cont.)

Octanol Water Partition Coefficient: \( \log P = 1.87 \) (estimated)

Hygroscopicity: Data not available

Density (Crystal): 1.334 g/cc (3)

Volatility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Spontaneously explodes when heated; highly reactive; sensitive to shock, heat and friction (3)

Stability: May explode when heated (1), autoignition point 68°C (3)

Flammability: Very flammable (3)

II. USES

A. Army Unique Use

Igniter formulations for explosives, pyrotechnics, and obscurants.

B. Other Uses

Oxidizer in bleaching oils, catalyst in the plastics industry, initiator in polymerization, keratolytic (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Purnell et al. (4) reported a high-performance liquid chromatography method to determine trace levels of benzoyl peroxide and other organic contaminants in workplace atmospheres. High performance liquid chromatography is used widely for quality assurance of products containing benzoyl peroxide in the pharmaceutical industry and many methods have been reported.

B. Limit of Detection

0.01 ppm (2)
IV. HEALTH EFFECTS

### TABLE IV-1. TOXICITY OF BENZOYL PEROXIDE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>0.5-5 g/kg</td>
<td>Estimated lethal dose</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>local</td>
<td>NS*</td>
<td>Eye and skin irritation, skin sensitization</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>1.34-17.0 mg/m³</td>
<td>Nose and throat irritation</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>2.58-82.5 mg/m³</td>
<td>Eye, nose, and throat irritation</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>7,710 mg/kg</td>
<td>LD₅₀</td>
<td>(7)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>950 mg/kg</td>
<td>No Mortality</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>2.8-2,800 ppm in diet (not clearly chemical-related)</td>
<td>(6)</td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>120 mg/rat</td>
<td>No effects</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>50 mg for 24 mo</td>
<td>No tumors attributed to benzoyl peroxide</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>24.3 mg/L for 4 hr</td>
<td>Eye squint, increased and decreased respiratory rates, salivation, lacrimation, erythema; no effects after 48 hr except lingering eye irritation</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>250 mg/kg</td>
<td>Mortality</td>
<td>(5)</td>
</tr>
<tr>
<td>Mouse (hybrid hairless albino; B and CBA)</td>
<td>intraperitoneal</td>
<td>4.8 mg/mouse</td>
<td>LD₅₀</td>
<td>(6)</td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 9-3
### TABLE IV-1. TOXICITY OF BENZOYL PEROXIDE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>intra-pertineal</td>
<td>54-62 mg/kg</td>
<td>No effects</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse</td>
<td>subcutaneous</td>
<td>50 mg/mouse</td>
<td>No effects</td>
<td>(6)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>dermal</td>
<td>Dry powder</td>
<td>Slight irritation</td>
<td>(5)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>dermal</td>
<td>10% solution in propylene glycol</td>
<td>Slight to moderate erythema and edema without systemic toxicity</td>
<td>(5)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>500 mg/24 hr</td>
<td>Severe irritation</td>
<td>(7)</td>
</tr>
</tbody>
</table>

* Not specified

### TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF BENZOYL PEROXIDE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>NS*</td>
<td>78% benzoyl peroxide was nonmutagenic; tested with tissue homogenate from mice, rats, and monkeys for metabolic activation; benzoyl peroxide was not soluble in the vehicle DMSO</td>
<td>(6)</td>
</tr>
<tr>
<td>Saccharomyces cerevisiae D4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse cells (type not specified)</td>
<td>1 umol/L</td>
<td>Mutagenic</td>
<td>(7)</td>
</tr>
<tr>
<td>Mouse (ICR/Ha Swiss) dominant lethal assay</td>
<td>54 and 62 mg/kg; ip</td>
<td>Negative</td>
<td>(6)</td>
</tr>
</tbody>
</table>

* Not specified
V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of benzoyl peroxide.

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 5 mg/m³ (7)

B. Environmental

Data not available

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (6).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (9).

C. Other Disposal Practices Employed

Submerge in alkali solution 10% NaOH at 4 times weight of peroxide. Waste pastes can be charged with 50% nonflammable material (i.e., Vermiculite), dried and burned under controlled conditions. Empty containers should never be used for other purposes, but should be burned (3).
VIII. REFERENCES


5. Gosselin, Robert Z., Dr., Dr. Roger P. Smith, Dr. Harold C. Hodge, and Jeannette E. Braddock. 1984. Clinical Toxicology of Commercial Products, 5th ed. Williams and Wilkins, Baltimore, MD.


CALCIUM RESINATE*

*Name does not refer to a specific compound but a group of compounds, which may include the calcium salts of abietic acid, dihydroabietic acid and dehydroabietic acid (1).

*Resin acids include abietic-type acids, the pimaric-type acids and other resin acids such as elliotinoic acid (5).

I. CHEMICAL AND PHYSICAL DATA
A. Structural and Chemical Formulas and Molecular Weight
*Chemical Formula: Not applicable
*Molecular Weight: Not applicable
*Structural Formula: See Exhibit 10-1.
B. Alternate Names and Registry Numbers
CAS Registry Number: 9007-13-0
Deleted CAS Registry Number: 68153-41-3
CA Name (9CI): Resin acids and rosin acids, calcium salts
CA Name (8CI): Same
RTECS Number: EW3970000, EW3971000
Other Significant Synonyms: Limed rosin
C. Chemical and Physical Properties
Physical State: Amorphous powder or lumps (2)
Color: Yellowish white (2)
Odor: Rosin odor (2)
Melting Point: Does not apply to mixtures
Solubilities:
Water: Insoluble (2)
Nonaqueous Solvents: Soluble in acid, amyl acetate, butyl acetate, ether, amyl alcohol (2)
Octanol Water Partition Coefficient: Not applicable
Hygroscopicity: Data not available
Density (Crystal): Data not available
CALCIUM RESINATE (cont.)

EXHIBIT 10-1

Abietic acid

Pimaric acid

Elliotinoic acid
CALCIUM RESINATE (cont.)

Volatility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Can react with oxidizing materials (3)
Stability: Data not available
Flammability: Flammable, dangerous fire risk, spontaneous heating (3)

II. USES

A. Army Unique Use

Fuel, binding and water-proofing agent in primers and tracers (5).

B. Other Uses

Waterproofing, manufacture of paint driers, porcelains, perfumes, cosmetics, enamels; coatings for fabrics, wood and paper; and tanning leather (4).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Data not available

B. Limit of Detection

Data not available
CALCIUM RESINATE (cont.)

IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF CALCIUM RESINATE*

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium resinate</td>
<td>NS**</td>
<td>ingestion</td>
<td>Irritation of nose and throat</td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>topical</td>
<td>Contact with eyes causes irritation</td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>NS</td>
<td>When rosin is heated, fumes are irritants</td>
<td>(11)</td>
</tr>
<tr>
<td>Resin acids:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>oral</td>
<td>Moderate acute toxicity</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
<td>intravenous</td>
<td>LD₅₀: 180 mg/kg</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>Rat</td>
<td>oral</td>
<td>LD₅₀: 1,710 mg/kg</td>
<td>(7)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
** Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of calcium resinate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1983.
VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (8).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (9).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


CALCIUM STEARATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_{36}H_{70}CaO_{4}$

Molecular Weight: 607.00

Structural Formula: $Ca^{+2}(CH_{3}(CH_{2})_{16}COO^{-})_{2}$

B. Alternate Names and Registry Numbers

CAS Registry Number: 1592-23-0.

CA Name (9CI): Octadecanoic acid, calcium salt, stearic acid, calcium salt

RTECS Number: None

Other Significant Synonyms: Calcium distearate

C. Chemical and Physical Properties

Physical State: Granular fatty powder

Color: White

Odor: Slightly fatty odor

Melting Point: 179-180°C

Solubilities:

Water: Practically insoluble


Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): 20 lb/ft$^3$

Vapor Pressure (p): Data not available

Specific Heat: Data not available
CALCIUM STEARATE (cont.)

Heat of Combustion: Data not available

Reactivity: Decomposed by many acids and alkalies (3)

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

Binder and waterproofing agent for explosive mixtures

B. Other Uses

Water repellent, paint flattening agent, lubricant in making tablets, emulsions, cements, stabilizer for vinyl resins, food additive, cosmetic ingredient (3).

Also used for waterproofing fabrics, cement, stucco; as a releasing agent for plastic molding powders; as a stabilizer for polyvinyl chloride resins; as a lubricant in pencils and wax crayons. Food grade calcium stearate, derived from edible tallow, is used as a conditioning agent in certain food and pharmaceutical products (3).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Hayashi et al. (4) described a high-performance liquid chromatography method using fluorescence pre-labeling with 4-(bromomethyl)-7-methoxycoumarin. The fluorescent derivatives of fatty acids were separated by reverse phase liquid chromatography followed by fluorometric detection.

B. Limit of Detection

Hayashi et al. (4) reported approximately 7 picomoles as the limit of detection in river water.
CALCIUM STEARATE (cont.)

IV. HEALTH EFFECTS

### TABLE IV-1. TOXICITY OF CALCIUM STEARATE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat, mouse</td>
<td>oral</td>
<td>Repeated dose, (conc. and duration NS*)</td>
<td>Not toxic</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat, mouse</td>
<td>dermal, eye application</td>
<td>NS</td>
<td>Not toxic</td>
<td>(5)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>dermal</td>
<td>Emulsion (conc. NS) in egg yolk and water, daily for 14 d</td>
<td>Significant decrease in body weight by day 6 relative to controls</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-tracheal</td>
<td>50 mg in 0.5 mL saline and 0.01 mL egg yolk; 2 or 6 mo</td>
<td>Severe lesions of blood vessels in pulmonary tissue at 2 mo; peribronchial sclerosis, foci of alveolar emphysema, single small areas of hemorrhage, and pigment aggregations at 6 mo; results in controls not reported</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-tracheal</td>
<td>10 mg in 0.5 mL saline and 0.01 mL egg yolk; 4 or 8 mo</td>
<td>Varying degrees of lung pathology including peribronchial sclerosis, alveolar telecstasis, and diffuse bronchiectasis; results in controls not reported</td>
<td>(6)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

No information was found on the environmental fate or effects of calcium stearate.
VI. STANDARDS AND REGULATIONS

A. Health

The Food and Drug Administration has affirmed that calcium stearate is generally recognized as safe as a direct human food ingredient (7).

B. Environmental

Listed in TSCA inventory.

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (8).

Pure or concentrated calcium stearate may not require conservative disposal methods.

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (9).

C. Other Disposal Practices Employed

Landfill in accordance with applicable local, state, and federal regulations (10).

VIII. REFERENCES


CERIC AMMONIUM NITRATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: CeH₈N₈O₁₈ (1)

Molecular Weight: 548.26 (1)

Structural Formula: \((\text{NH}_₄)_₂ \text{(Ce(NO}_₃)_₆\) (2)

B. Alternate Names and Registry Numbers

CAS Registry Number: 6774-21-3

Deleted CAS Registry Numbers: 25567-1-3; 15306-26-0

CA Name (9CI): Cerate(2-), hexakis(nitrate-0)-, diammonium (OC-6-11)–

CA Name (8CI): Cerate(2-), hexanitrate-, diammonium

RTECS Number: Data not available

Other significant synonyms: Ammonium cerium nitrate; Diammonium hexanitrato cerate; Ammonium hexanitritocerate; Diammonium cerium hexanitrate; Ammonium cerium hexanitrate; Ceric(IV) ammonium nitrate

C. Chemical and Physical Properties

Physical State: Crystalline solid; monoclinic (1)

Color: Orange-red (1)

Odor: Data not available

Melting Point: Data not available

Solubilities

Water: 141 g/100 mL at 25°C; 227 g/100 mL at 80°C
Nonaqueous Solvents: Soluble in alcohol, as well as nitric acid (2).

Octanol Water Partition Coefficient: Not applicable

Hygroscopicity: Data not available

Density (Crystal): Data not available
CERIC AMMONIUM NITRATE (cont.)

Volatile: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Data not available

II. USES

A. Army Unique Use

Explosive

B. Other Uses

Catalyst for polymerization of olefin; standard in oxidimetry (1).
III. ANALYTICAL METHODS

A. Best Acceptable Method

No methods of analysis for this compound have been reported in the last five years in Chemical Abstracts.

B. Limit of Detection

Data not available
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF CERIC AMMONIUM NITRATE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceric ammonium nitrate</td>
<td></td>
<td></td>
<td></td>
<td>No toxicity data located</td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>Human</td>
<td>oral</td>
<td>Large amounts</td>
<td>Dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, and collapse</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Small repeated doses May lead to weakness, general depression, headache, and mental impairment</td>
<td></td>
</tr>
<tr>
<td>Cerium nitrate Ce(NO₃)₃</td>
<td>Rat</td>
<td>oral</td>
<td>3,630 mg/kg</td>
<td>LD₅₀</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat intratesticular</td>
<td>Ce(NO₃)₃</td>
<td>intraperitoneal</td>
<td>26,092 mg/kg</td>
<td>LD₅₀; effects on spermatogenesis and sex organs</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat oral</td>
<td></td>
<td>oral</td>
<td>4,200 mg/kg</td>
<td>LD₅₀</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat intraperitoneal</td>
<td>Ce(NO₃)₃·6H₂O³</td>
<td>intraperitoneal</td>
<td>290 mg/kg</td>
<td>LD₅₀</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat intravenous</td>
<td></td>
<td></td>
<td>4 mg/kg</td>
<td>LD₅₀</td>
<td>(4)</td>
</tr>
<tr>
<td>Mouse intraperitoneal</td>
<td>NS*</td>
<td>NS</td>
<td>470 mg/kg</td>
<td>LD₅₀</td>
<td>(4)</td>
</tr>
<tr>
<td>Cerium salts NS* NS</td>
<td></td>
<td>NS</td>
<td>NS</td>
<td>Increase in blood coagulation rate</td>
<td>(3)</td>
</tr>
<tr>
<td>Cerium Human intravenous</td>
<td></td>
<td>3-12.5 mg/kg, single and</td>
<td>Anticoagulant effect for 8 hr; chills, fever, headache, muscle pains, abdomen</td>
<td>(5)</td>
<td></td>
</tr>
<tr>
<td>DAND17-84-C-4133</td>
<td></td>
<td>12-4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CERIC AMMONIUM NITRATE (cont.)

repeated
nal cramps, hemoglo-
daily
binemia, hemoglobin-
doses
uria

* Not specified

TABLE IV-1 TOXICITY OF CERIC AMMONIUM NITRATE (Cont.)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerium (cont.)</td>
<td>Rat</td>
<td>intra-venous</td>
<td>NS</td>
<td>Fatty infiltration of the liver characterized by an increase in neutral fat esters; total cholesterol and phospholipid of liver were unchanged; effects more pronounced in females</td>
<td>(5)</td>
</tr>
</tbody>
</table>

Lanthanide compound (not specified whether Ce was tested)

| Rat | oral (feed) | 0.01, 0.1, and 1% in diet for 12 wk | No influence on growth or hematologic variables; tissues of 8 internal organs showed no histological changes at 0.01 and 0.1%; animals given Gd, Tb, Tm and Yb showed nonspecific liver damage (perinuclear vacuolation and granular cytoplasm) at 1% | (5)       |

* Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of ceric ammonium nitrate.
CERIC AMMONIUM NITRATE (cont.)

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (6).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (7).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \((C_7H_7SO_2N(Cl))Na\)

Molecular Weight: 215.45

Structural Formula:

B. Alternate Names and Registry Numbers

CAS Registry Number: 127-65-1

Deleted CAS Registry Numbers: 75532-46-6; 72793-59-0; 1576-40-5; 8045-11-2

CA Name (9CI): Benzenesulfonamide, N-chloro-4-methyl-, sodium salt

CA Name (8CI): p-Toluenesulfonamide, N-chloro- sodium salt

RTECS Number: 217815

Other Significant Synonyms: Sodium tosylchloramide N-Chloro-4-methylbenzyl sulfonamide, sodium salt, halamid, chlorzone

C. Chemical and Physical Properties

Physical State: Trihydrated crystal; prisms (1)

Color: White or faintly yellow (11)

Odor: Data not available
CHLORAMINE-T (cont.)

Melting Point: 167-170°C (11)

Solubilities:
Water: Fairly soluble in water (1)
Nonaqueous Solvents: Practically insoluble in benzene, chloroform, ether; decomposes in alcohol (1).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): Data not available

Volatility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Reacts with water to release \( \text{HOCl} \)

Stability: Decomposes slowly upon exposure to air and under the influence of light (1). May decompose violently if heated above 130°C (15).

Flammability: Data not available

II. USES

A. Army Unique Use

Field water purification chemical

B. Other Uses

Antibacterial, veterinary antiseptic, laboratory detection of halogens and bromate (1).
III. ANALYTICAL METHODS

A. Best Acceptable Method

A titrimetric method for the determination of Chloramine-T and aldoses is based on Leipert determination of iodide by reduction with excess iodide and extraction and subsequent reduction of the iodine liberated (2).

B. Limit of Detection

0.01 mg/L (2)
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF CHLORAMINE-T**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloramine-T</td>
<td>Human</td>
<td>ingestion</td>
<td>Vomiting, cyanosis, circulatory collapse, frothing at the mouth, and respiratory failure can occur within a few minutes, fatalities have occurred</td>
<td>(3)</td>
</tr>
<tr>
<td>Human</td>
<td>intravenous</td>
<td></td>
<td>In tap water it has cause hemolysis in patients undergoing dialysis</td>
<td>(3)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td></td>
<td>Can cause vasomotor rhinitis and asthma</td>
<td>(4)</td>
</tr>
<tr>
<td>Human</td>
<td>occupational exposure</td>
<td></td>
<td>Nasal irritation and/or wheezing; fever; cough; asthmatic reactions</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>occupational exposure</td>
<td></td>
<td>Immediate asthmatic bronchial obstruction and/or a late-type asthmatic reaction accompanied by leukocytosis after inhalation tests of Chloramine-T; an immediate type of wheal and flare reaction followed by a late-type infiltrative reaction after prick tests; specific IGE antibodies occur in the sera of exposed patients</td>
<td>(5,6)</td>
</tr>
<tr>
<td>Human</td>
<td>ingestion</td>
<td></td>
<td>An occasional reaction is rapid and violent, suggesting hypersensitivity; poisoning characterized by pain, vomiting, sudden loss of consciousness, circulatory and respiratory collapse, and death; it has been suggested that Chloramine-T can react with some amino acids in the gastrointestinal tract to form toxic cyanogen compounds</td>
<td>(7)</td>
</tr>
</tbody>
</table>
TABLE IV-1. TOXICITY OF CHLORAMINE-T (Cont.)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypochlorous acid</td>
<td>Human</td>
<td>local</td>
<td>Highly irritating to skin, eyes, and mucous membranes</td>
<td>(4)</td>
</tr>
<tr>
<td>(available chlorine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human ingestion</td>
<td>Human</td>
<td>ingestion</td>
<td>Irritation and corrosion of mucous membranes with pain and vomiting; a fall in blood pressure, delirium, and coma may occur</td>
<td>(3)</td>
</tr>
<tr>
<td>Human inhalation</td>
<td>Human</td>
<td>inhalation</td>
<td>Coughing, choking; may cause severe respiratory tract irritation and pulmonary edema</td>
<td>(3)</td>
</tr>
</tbody>
</table>

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF CHLORAMINE T

<table>
<thead>
<tr>
<th>Test system</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>4-2,500 ug/plate</td>
<td>Nonmutagenic with Aroclor 254-induced rat liver S9</td>
<td>(8)</td>
</tr>
<tr>
<td>(TA98, TA100, TA1535, TA1538)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. typhimurium</td>
<td>several dose levels</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(9)</td>
</tr>
<tr>
<td>(TA98, TA100, TA1535, TA1537 TA1538)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drosophila melanogaster</td>
<td>25 μM; oral (approx. LD50)</td>
<td>No increase in frequency of sex-linked recessive lethal mutations</td>
<td>(9)</td>
</tr>
<tr>
<td>Base test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micronucleus test on mouse bone marrow</td>
<td>35 and 70 μg/kg; ip</td>
<td>No increase in frequency of micronuclei</td>
<td>(9)</td>
</tr>
<tr>
<td>Human lymphocytes in vitro</td>
<td>100 ppm/24 hr (Chlorammine-T trihydrate)</td>
<td>Induction of chromosomal aberrations</td>
<td>(10)</td>
</tr>
</tbody>
</table>

DANDL7-84-C-4133 13-5
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport — Data not available
A1a. Adsorption — Data not available
A1b. Volatilization — Data not available
A1c. Leachability — Data not available
A1d. Bioaccumulation — Data not available

A2. Transformation — Data not available
A2a. Biodegradation — Data not available
A2b. Hydrolysis — Releases hypochlorous acid (HOCI) in water (11)
A2c. Photolysis — Data not available
A2d. Other chemical reaction — Data not available
A2e. Half-life — Data not available

B. Effects on animals

B1. Avian species — Data not available
B2. Mammalian wildlife species — Data not available
B3. Terrestrial invertebrates — Data not available
B4. Reptiles — Data not available
B5. Amphibians — Data not available
B6. Microorganisms, aquatic and soil — Data not available

B7. Aquatic species, fish and invertebrates — After a 60-minute exposure at 25°C to 1.0 mg/L applied Chloramine-T significantly lower increases in dry weight and significant reductions in standard respiration rate were measured among exposed larval lobsters (Homarus americanus), compared to control organisms. Greater differences were detected among Chloramine-T-exposed organisms than were measured for organisms exposed to 1.0 mg/L applied free chlorine (12).
Chloramine-T was more toxic to rotifers (Brachionus plicatilis) than was the free chlorine form, with LC50 values for 30-minute exposures at 20 of 0.35 mg/L applied Chloramine-T and 1.20 mg/L applied free chlorine, 0.02 mg/L and 0.18 mg/L residual, respectively. Increased temperature had a synergistic effect on the toxicity of both Chloramine-T and free chlorine. Rotifers surviving exposure to either halogen toxicant had significantly lower filtration rates and egg production rates than control animals. The reduced reproductive rates were not sustained by the second generation (13).

Shrimp (Penaeus setiferus): In a 24-hour toxicity test at a concentration of 40,000 μg/L Chloramine-T, at 21 to 22°C, 6 of 140 shrimp died (14).

Lethal concentrations: Ptychocheilus oregonensis, 0-3 hour exposure, 11.7°C: 10 ppm; Coho and Chinook salmon, 1-2.5 hour exposure, 11.7°C: 1 ppm; Rainbow trout, 1/2 hour exposure, 12.8°C: 5 ppm; Bluegill, 5 hour exposure, 12.8°C: 5 ppm; Petromyzon marinus, 14 hour exposure, 12.8°C: 5 ppm (13).

C. Effects on plants

C1. Phytotoxicity — Data not available

C2. Uptake — Data not available

C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Data not available

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

DAMD17-84-C-4133 13-7
C. Other Disposal Practices Employed

The U.S. EPA recommends dilution in a flammable solvent followed by burning in an incinerator equipped with an afterburner and an effluent scrubber for Chloramine-T disposal. Scrubber overflow is to be neutralized prior to discharge. Incinerator ash should be buried in a hazardous or sanitary landfill (11).

VIII. REFERENCES


COPPER-8-QUINOLINOLATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{Cu}(C_9H_6\text{ON})_2 \)

Molecular Weight: 351.83

B. Alternate Names and Registry Numbers

CAS Registry Number: 10380-28-6

Deleted CAS Registry Numbers: 29713-19-7; 132-71-8; 37220-44-3; 37233-52-6

CA Name (9CI): Copper, bis(8-quinolinolato-N1,08)

CA Name (8CI): Copper, bis(8-quinolinolato)-

RTECS Number: VC5250000

Other Significant Synonyms: Copper-8-quinolinolate, copper quinolate, Copper oxinate, Copper 8-hydroxyquinoline, Quinolate (1)

C. Chemical and Physical Properties

Physical State: Powder (1)

Color: Yellow-Green

Odor: Odorless

Melting Point: Decomposes at 210°C (2)
COPPER-5-QUINOLINOLATE (cont.)

Solubilities:
Water: Insoluble (1)
Nonaqueous Solvents: Somewhat soluble in weak acids, soluble in strong acids; insoluble in most organic solvents (1).

Octanol Water Partition Coefficient: Log P = 2.70 (3)
Hygroscopicity: Nonhygroscopic (1)
Density (Crystal): Data not available
Volutility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Data not available

II. USES

A. Army Unique Use

Military anti-mildew agent

B. Other Uses

Fungicide and mildew-proofing of fabrics; reagent for the analysis of copper (1); wood preservative.

III. ANALYTICAL METHODS

A. Best Acceptable Method

No work has been done on the determination of trace amounts of this compound. 8-Quinolinoline is a strong chelating agent and may interfere with some methods of analysis of copper. Work has been done on the size exclusion (4) and thin-layer chromatographic behavior (5) of this compound. Application to trace analysis of this compound is difficult to predict. Potentiometric titration with N-bromophthalimide in aqueous acetic acid has been reported by Mohanadas and Indrasenan (6), but no method of separation was reported.

B. Limit of Detection

Data not available
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF COPPER 8-QUINOLINOLATE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper 8-quin-</td>
<td>Human, Animal</td>
<td>NS*</td>
<td>Low toxicity; does not irritate the skin</td>
<td>(7)</td>
</tr>
<tr>
<td>olinolate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper 8-quin-</td>
<td>Mouse</td>
<td>intra-</td>
<td>LD$_{50}$: 67 mg/kg</td>
<td>(8)</td>
</tr>
<tr>
<td>olinolate</td>
<td></td>
<td>peritoneal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-Hydroxyquin-</td>
<td>Animal</td>
<td>NS</td>
<td>CNS stimulant</td>
<td>(2)</td>
</tr>
<tr>
<td>oline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-Hydroxyquin-</td>
<td>Rat</td>
<td>oral</td>
<td>LD$_{50}$: 1200 mg/kg</td>
<td>(2)</td>
</tr>
<tr>
<td>oline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-Hydroxyquin-</td>
<td>Mouse</td>
<td>intra-</td>
<td>LD$_{50}$: 48 mg/kg</td>
<td>(2)</td>
</tr>
<tr>
<td>oline</td>
<td></td>
<td>peritoneal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper salts</td>
<td>Human</td>
<td>eyes</td>
<td>May cause conjunctivitis, ulceration and turbidity of the cornea</td>
<td>(9)</td>
</tr>
<tr>
<td>Human intake</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper salts</td>
<td>Human inhalation</td>
<td>May cause congestion of the nasal mucous membranes and pharynx, and ulceration with perforation of the nasal septum</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>Human ingestion</td>
<td>Salivation, nausea, vomiting, gastric pain, hemorrhagic gastritis, and diarrhea</td>
<td>(9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper salts</td>
<td>Human</td>
<td>ingestion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Not specified
COPPER-8-QUINOLINOLATE (cont.)

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF COPPER 8-QUINOLINOLATE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. typhimurium</td>
<td>5 ug/plate</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(10)</td>
</tr>
<tr>
<td>(TA98, TA100, TA1535, TA1537)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. typhimurium</td>
<td>0.5-50 ug/plate</td>
<td>Weakly mutagenic: 1.30 revertants/nmole in the presence of S9</td>
<td>(11)</td>
</tr>
<tr>
<td>(TA100)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. coli</td>
<td>up to 5,000 ug/plate</td>
<td>Nonmutagenic with or without S9</td>
<td>(11)</td>
</tr>
<tr>
<td>(WP2 hcr)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- 8-Hydroxyquinoline causes 75% inhibition of nitrification process in non-acclimated activated sludge at 73 mg/L (12).

B7. Aquatic species, fish and invertebrates, -- Snails: Cypangopaludina malleata: 48-hour LC50: 20,000 ug/L; Semisulcospira libertina: 48-hour LC50: 7700 ug/L; Indoplanorbis exustus: 48-hour LC50: 15,000 ug/L; Physa acuta: 48-hour LC50: 13,000 ug/L (13).

C. Effects on plants

C1. Phytotoxicity -- Treatment of seeds with copper 8-quinolinolate (wet dressing with 2 cc of 15% copper 8-quinolinolate per kg of wheat seed) is effective against fungi and has a low phytotoxicity (14).
COPPER-8-QUINOLINOLATE (cont.)

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory, 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for Copper Naphthenate, a related compound used for a related purpose, are to turn the bulk chemical into a pesticide collection center, to the original supplier or to a commercial waste disposal service (15). Data were not available on disposal of items treated with Copper Naphthenate.

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


5. Schnesweis, G. and K.H. Koenig. 1983. Chromatography of Metal Chelates. VII. Thin-Layer Chromatography of Metal Chelates of 8-


7. Ashland Chemicals. 1972. 8-Quinolinol and Its Derivatives-A Literature Review. Ashland Chemical Co., Columbus, OH.


COPPER NAPHTHENATE

*NAPHTHENE is a term used in petroleum chemistry to denote certain saturated hydrocarbons, specifically five- and six-carbon cycloparaffins and their alkyl derivatives, found in crude petroleum. It is sometimes used to include polycyclic members found in higher-boiling fractions (1). This is not a unique chemical substance (CAS) but represents the Copper (+2) salts of naphthene carboxylic acids.

I. Chemical and Physical Data

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: Undefined
Molecular Weight: Undefined
Structural Formula: Undefined

B. Alternate Names and Registry Numbers

CAS Registry Number: 1338-02-9
CA Name: Naphthenic acid, copper salt
RTECS Number: QK9100000
Other Significant Synonyms: Data not available

C. Chemical and Physical Properties

Physical State: Solid (2)
Color: Green-blue (2)
Odor: Gasoline-like (3)
Boiling Point: 154-202°C (3)
Solubilities:
  Water: Insoluble
  Nonaqueous Solvents: Soluble in gasoline, benzene and mineral oil distillates (4)
Octanol Water Partition Coefficient: Data not available
Hygroscopicity: Data not available
Density (Crystal): Data not available
COPPER NAPHTHENATE (cont.)

Volatility: Data not available
Flash Point: 41°C
Heat of Combustion: 9,8000 cal/g (3)
Autoignition Temperature: 282°C (mineral spirit) (3)
Reactivity: Data not available
Stability: Data not available
Flammability: Flammable, moderate fire risk (2), combustible (3)

II. USES
A. Army Unique Use
Military anti-mildew agent
B. Other Uses
Wood, canvas, and rope preservative; insecticide; fungicide; antifouling paints (2)

III. ANALYTICAL METHODS
A. Best Acceptable Method
No methods were found for either copper naphthenate or naphthenic acid in searching the Chemical Abstracts System back to 1967. Copper can be analyzed by either atomic absorption spectroscopy or atomic emission spectrometry. Recently, a method was reported by Hee et al. which enhances the detection of copper by simultaneous inductively coupled plasma atomic emission spectrometry (4).

B. Limit of Detection
The lower determination range for copper is 0.001-0.005 ug/L. The apparent linear range is 2-500 ug/L (4).
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF COPPER NAPHTHENATE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human skin</td>
<td>Liquid</td>
<td>If spilled on clothes and allowed to remain may cause smarting and redness of skin</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Human ingestion</td>
<td>Liquid</td>
<td>Irritation to stomach</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Human inhalation</td>
<td>Liquid</td>
<td>Mild irritation of the respiratory tract; aspiration causes severe lung irritation and rapidly developing pulmonary edema; central nervous system excitement followed by depression</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Human eye</td>
<td>Liquid</td>
<td>Mild irritation</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Rat oral</td>
<td>4,000-6,000 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Sprague-Dawley intra-peritoneal rat, 1-15 d preg</td>
<td>10,000 mg/kg</td>
<td>No signs of fetal toxicity or teratogenicity</td>
<td>(5)</td>
<td></td>
</tr>
<tr>
<td>Rat, mouse ingestion</td>
<td>Flaccidity and narcotic effects</td>
<td>(6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse oral</td>
<td>110 mg/kg</td>
<td>LD&lt;sub&gt;Lo&lt;/sub&gt;</td>
<td>(7)</td>
<td></td>
</tr>
</tbody>
</table>

* Not specified whether the chemical was liquid or solid

DAMD17-84-C-4133 15-3
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- Data not available

A2. Transformation

A2a. Biodegradation -- Data not available

A2b. Hydrolysis -- Under certain conditions can hydrolyze to copper hydroxide and naphthenic acid (8).

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Data not available

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- Freshwater blue-green algae: 72-hour LC$_{50}$: 2.0 ppm (3).

C. Effects on plants

C1. Phytotoxicity -- Burlap treated with up to 4.0% copper naphthenate was not phytotoxic to Cotoneaster divaricata when balled roots were wrapped in the burlap for 40 weeks (9).

C2. Uptake -- Data not available

C3. Metabolism -- Data not available
VI. STANDARDS AND REGULATIONS

A. Health
Data not available

B. Environmental
Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for copper naphthenate are to turn in to a pesticide collection center, to the original supplier or to a commercial waste disposal service (10).

B. Alternate Disposal Practices Under Consideration by the Army
Data not available

C. Other Disposal Practices Employed
Adsorb on filter aid or inert powder and incinerate in approved facility, not in closed container (8).

VIII. REFERENCES


COPPER NAPHTHENATE (cont.)


SUMMARY OF PREVIOUS STUDY

It has been reported that the Army has a need for research on the toxicological and environmental hazards of cyclohexanone (4). The report states that the compound is moderately toxic in acute doses by all routes of administration. Sublethal doses cause profound narcosis accompanied by central nervous system depression. Teratogenic effects had been reported in chick embryos. There was no information on carcinogenic or mutagenic potential of cyclohexanone. The few aquatic toxicity studies available indicated a low toxicity of cyclohexanone to aquatic life.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_6\text{H}_{10}\text{O} \)

Molecular Weight: 98.14

 Structural Formula:

\[
\begin{array}{c}
\text{O} \\
\text{H} \\
\text{C} \\
\text{H} \\
\text{H} \\
\text{C} \\
\text{C} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\end{array}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 108-94-1

Deleted CAS Registry Number: 48090-95-5

CA Name (9CI): Cyclohexanone
CYCLOHEXANONE (cont.)

CA Name (8CI): Cyclohexanone
RTECS Number: GW1050000

Other Significant Synonyms: Ketohexamethylene, pimelic ketone, pimelin ketone, sextone (1).

C. Chemical and Physical Properties

Physical State: Oily liquid (6)
Color: Colorless or pale yellow (6)
Odor: Peppermint and acetone (6)
Melting Point: -16.4°C
Freezing Point: -32.1°C
Boiling Point: 155.6°C at 760 mm Hg (2)

Solubilities:
- Water: 50g/L at 30°C (2)
- Nonaqueous Solvents: Soluble in alcohol, ether and other common organic solvents (2); acetone, benzene, chloroform (3), nitrobenzene, n-hexanone, naptha, xylene, ethylene glycol, isoamyl acetate, dimethylamine (4).

Octanol Water Partition Coefficient: Log P = 0.81 (5)

Hygroscopicity: Data not available

Specific Gravity (Liquid): 0.95 (18)

Vapor Pressure: 3.95 mm Hg at 20°C (4); 4.0 mm Hg at 20°C (5); 4.5 mm Hg at 20°C (5); 10 mm Hg at 38.7°C (6); 60 mm Hg at 77.5°C (6).

Flash Point: 54°C, open cup (4); 63°C (2).

Specific Heat: 0.433 cal/g at 15-18°C (4)

Heat of Combustion: -8570 cal/g (4)

Reactivity: Strong oxidizers will convert cyclohexanone to adipic acid. Susceptable to nucleophilic attack (4).

Refractive Index: (N 20/0) 1.4507 (7)

Autoignition Temp: 420°C

Stability: Stable under normal conditions (4)
CYCLOHEXANONE (cont.)

Flammability: Limits (%), 1.1-8.1, moderate, flash point, 63°C. combustion with moderate heating, slight explosive hazard in vapor form when exposed to flame (6).

II. USES

A. Army Unique Use

Recrystallization solvent for RDX (4)

B. Other Uses

Organic synthesis of adipic acid and caprolactam (8). Solvent for cellulose acetate, nitrocellulose, natural resins, vinyl resins, crude rubber, waxes, fats, shellac, DDT. Also used in the production of cyclohexanone resins (2).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Recent methods developed for monitoring cyclohexanone and its methylation products in aqueous solution involve introducing the sample is introduced into a tandem mass spectrometer through semipermeable capillary tubing with a membrane interface (9). Additional methods of analysis are reported in the Atlantic Research Corporation Report. Gas chromatography is still used in the monitoring of air and water samples.

B. Limit of Detection

Detection limits are reported to be 0.0004 - 0.0005 ppm (6).
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF CYCLOHEXANONE*

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effect</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1,535 mg/kg</td>
<td>LD$_{50}$</td>
<td>(1)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-venous</td>
<td>50 and 100 mg/kg, 1x/d for 28 d</td>
<td>No adverse effects on ophthalmologic, histopathologic, hematologic, or clinical chemistry parameters</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>2,170 mg/kg</td>
<td>LD$_{50}$</td>
<td>(1)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>105 mg/m$^{3}$/hr, days 1-20 of gestation</td>
<td>TC$_{50}$, effects on fertility</td>
<td>(1)</td>
</tr>
<tr>
<td>Mouse (CD-1)</td>
<td>oral</td>
<td>800 mg/kg days 8-12 of gestation</td>
<td>No fetotoxic effects</td>
<td>(11)</td>
</tr>
<tr>
<td>Mouse</td>
<td>subcutaneous</td>
<td>1,300 mg/kg</td>
<td>LD$_{50}$</td>
<td>(1)</td>
</tr>
<tr>
<td>Mouse (Swiss OFI)</td>
<td>inhalation</td>
<td>308 ppm/4 h'</td>
<td>50% decrease in immobility developed during a &quot;behavioral despair&quot; swimming test</td>
<td>(12)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>dermal</td>
<td>0.5 ml, 3x/wk for 3 wk</td>
<td>Cataracts</td>
<td>(13)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>subcutaneous</td>
<td>0.5 ml of 5% solution in saline, 3x/wk for 3 wk</td>
<td>Cataracts</td>
<td>(13)</td>
</tr>
<tr>
<td>Dog</td>
<td>intravenous</td>
<td>284 mg/kg/d in sodium chloride solution for 18-21 d</td>
<td>Signs of toxicity included: vocalization, lacrimation, scleral vasodilation, mydriasis, salivation, urination, defecation, restlessness, stupor and ataxia, occasional convulsive movements, hypernea and/or dyspnea, inflammation at injection site, hemolysis, bone marrow hyperplasia, and extramedullary hematopoiesis</td>
<td>(14)</td>
</tr>
</tbody>
</table>
### TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF CYCLOHEXANONE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effect</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human lymphocytes</td>
<td>5 ug/L</td>
<td>Mutagenic</td>
<td>(1)</td>
</tr>
<tr>
<td>Human leukocytes</td>
<td>100 umol/L</td>
<td>Mutagenic</td>
<td>(1)</td>
</tr>
<tr>
<td>Salmonella typhimurium TA98, TA100, TA1535, TA1537</td>
<td>? umol/plate</td>
<td>Not mutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(15)</td>
</tr>
<tr>
<td>S. typhimurium TA98, TA100</td>
<td>0.03-30 umol/ plate</td>
<td>Not mutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(15)</td>
</tr>
<tr>
<td>S. typhimurium TA98, TA100, TA1535, TA1537, TA1538</td>
<td>NS*</td>
<td>Mutagenic</td>
<td>(16)</td>
</tr>
<tr>
<td>Bacillus subtilis</td>
<td>NS</td>
<td>Mutagenic</td>
<td>(16)</td>
</tr>
</tbody>
</table>

* Not specified

### V. ENVIRONMENTAL EFFECTS

#### A. Environmental Fate

##### A1. Transport

- Adsorption — Data not available
- Volatilization — Data not available
- Leachability — Data not available

##### A1d. Bioaccumulation — Log of bioconcentration factor calculated from octanol/water partition coefficient: log BCF = 0.56 (17).

##### A2. Transformation

##### A2a. Biodegradation — Cyclohexanone is not biodegraded well (6).

DAMD17-84-C-4133 16-5
Biodegradation by adapted activated sludge—cyclohexanone as sole carbon source: 96.0% COD removal at 30.0 mg COD/g dry inoculum/hr (18).

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- \[ \text{BOD}_5: 1.232; \text{32\% of ThOD}; \text{COD: 100\% of ThOD}; \text{ThOD: 2.605 (18)}. \]

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Toxicity threshold by cell multiplication inhibition test: bacteria (Pseudomonas putida), 180 mg/L; algae (Microcystis aeruginosa), 52 mg/L; green algae (Scenedesmus quadricauda), 370 mg/L; protozoa (Entosiphon sulcatum), 545 mg/L; protozoa (Uronema parduczi Chatton-Lwoff), 280 mg/L (18).

B7. Aquatic species (fish and invertebrates) -- Fish: Leuciscus idus LC\(_{50}\) (exposure not reported): 536000 \(\mu\)g/L (19); Leuciscus idus LC\(_{50}\) (exposure not reported): 752000 \(\mu\)g/L (20); Invertebrate: Daphnia magna 24-hour LC\(_{50}\): 800,000 \(\mu\)g/L (21).

C. Effects on plants

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA: 25 ppm or 100 mg/m\(^3\); STEL: 100 ppm or 400 mg/m\(^3\) (22).
B. Environmental

Reported in EPA TSCA Inventory 1983.

Cyclohexanone has a statutory reportable quantity (RQ) of 1 lb under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (23).

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (24).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRDCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (26).

C. Other Disposal Practices Employed

Burn in a chemical incinerator equipped with an afterburner and scrubber (27).

Spray into incinerator or burn in paper packaging. Additional flammable solvent may be added (6).

AEHA: NSN 6810-00-234-1992, 664-0055, 695-3801, 962-1873

Dispose of through a commercial contractor (27).

The Holston AAP Installation Assessment (28) indicates that open burning is the only Army approved method for disposal of explosive wastes. Solvents containing up to 80-90% water are burned in clay lined pits at Holston.
VIII. REFERENCES


20. AQUIRE, Accession No. 202112.

21. AQUIRE, Accession No. 224952.


DI-n-PROPyl ADIPATE

Update of Atlantic Research Corporation Study

SUMMARY OF PREVIOUS STUDY

The Army's need for research on the toxicological and environmental hazards of di-n-propyl adipate is reported in A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. The report states that the compound has a low acute toxicity to mammals (g/kg), but that it has been shown to be teratogenic in rats receiving an acute dose. No information was found in the literature on the environmental fate of di-n-propyl adipate or on its toxicity to aquatic life, to microorganisms or to plants.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_{12}H_{22}O_4 \)
Molecular Weight: 230.34 (1)
Structural Formula: \( \text{CH}_3\text{CH}_2\text{CH}_2\text{OCO(CH}_2\text{)}_4\text{COOCH}_2\text{CH}_2\text{CH}_3 \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 106-19-4
CA Name (9CI): Hexanedioic acid, dipropyl ester
CA Name (8CI): Adipic acid, dipropyl ester
RTECS Number: AV1740000
Other significant synonyms: Dipropyl hexanedioate

C. Chemical and Physical Properties

Physical State: Liquid (1)
Color: Colorless (1)
Odor: Data not available
Boiling Point: \( 143-5^\circ \text{C at} \ 10 \text{ mm Hg} \) (1)

DAMD17-84-C-4133 17-1
DI-n-PROPYL ADIPATE (cont.)

Freezing Point: -20.3°C (1)

Solubilities
Water: Insoluble (1)
Nonaqueous Solvents: Soluble in ethanol and ether (1)

Melting Point: Data not available

Octanol Water Partition Coefficient: Log P = 2.88 (estimated)

Hygroscopicity: Data not available

Specific Gravity: 0.979 (1)

Density (Crystal): Data not available

Volutility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Data not available

Stability: Data not available

Flammability: Data not available

II. USES
A. Army Unique Use

Plasticizer in rocket propellants (1)

B. Other Uses

Data not available

III. ANALYTICAL METHODS
A. Best Acceptable Method

A gas chromatographic method of analysis has been reported that is in the semi-micro range. The oven was temperature programmed and a flame ionization detector was used (2).
DI-n-PROPYL ADIPATE (cont.)

B. Limit of Detection
Data not available

IV. HEALTH EFFECTS
No information updating that in the ARC report was located.

V. ENVIRONMENTAL EFFECTS
No information was found regarding the environmental fate or effects of di-n-propyl adipate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS
A. Health
Data not available
B. Environmental
Reported in the EPA TSCA Inventory 1980.

VII. DISPOSAL METHODS
A. Current Recommended Army Disposal Practices
Review of past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (3).

B. Alternate Disposal Practices under Consideration by the Army
Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (4).

C. Other Disposal Practices Employed
Data not available
VIII. REFERENCES


I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: C₆H₂N₄O₅

Molecular Weight: 210 (1)

Structural Formula: See Exhibit 18-1

B.1 Alternate Names and Registry Numbers (TSCA listing)

CAS Registry Number: 4682-03-5

Deleted CAS Registry Numbers: 90030-95-8; 7008-81-3; 28655-69-8

CA Name (9CI): 2,4-Cyclohexadien-1-one, 6-diazo-2,4-; (7CI) dinitro-

CA Name (8CI): Benzenediazonium, 2-hydroxy-3,5-dinitro-, hydroxide, inner salt

RTECS Number: Data not available

Other Significant Synonyms: DDNP

B.2 Alternate Names and Registry Numbers (RTECS listing)

CAS Registry Number: 87-31-0

CA Name (9CI): 1,2,3-Benzoxadiazole, 5,7-dinitro-

CA Name (8CI): Same

RTECS Number: DM2600000

Other Significant Synonyms: DDNP

C. Chemical and Physical Properties

Physical State: Crystalline solid, needles (1)

Color: Yellow (1)

Odor: Data not available

Melting Point: 157°C
DIAZODINITROPHENOL (cont.)

EXHIBIT 18-1

![Chemical Structure]

CAS No. 87-31-0  CAS No. 4682-03-5
DIAZODINITROPHENOL (cont.)

Solubilities:
Water: 0.08% at 25°C (2)
Nonaqueous Solvents: Soluble in nitroglycerin, nitrobenzene, aniline, pyridine, concentrated HCl and most organic solvents (1).
Solubility at 50°C in percentages (W:W) (1): Ethyl Acetate - 2.45%; Methanol - 1.25%; Ethanol - 2.43%; Ethylenedichloride - 0.79%; Carbon tetrachloride - trace; Chloroform - 0.11%; Benzene - 0.23%; Toluene - 0.15%; Petroleum ether - insoluble (at 20°C); Ethyl ether - 0.08% (at 30°C); Carbon disulfide - trace (at 30°C).

Octanol Water Partition Coefficient: Not applicable

Hygroscopicity: 0.04 at 90% relative humidity at 30°C (1)

Density (Crystal): 1.63 g/cc (1)

Volatility: Nonvolatile (1); unaffected; no weight loss at 50°C 30 months (2)

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: 3243 cal/g (1); 2243 cal/g (2)

Reactivity: Destroyed by 0.5% sodium hydroxide (2).

Stability: Stable after wet storage for five months (2). Explodes when shocked or heated to 180°C.

Flammability: Data not available

II. USES
A. Army Unique Use

Percussion caps (1)

B. Other Uses

Primary charge in blasting caps.
III. ANALYTICAL METHODS

A. Best Acceptable Method

Bratin et al. (3) described a reductive/oxidative electrochemical detection method with liquid chromatography that is sensitive and highly selective for explosive nitramine and nitrate compounds and diphenylamines.

B. Limit of Detection

Picomole range (3)

IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF DIAZODINITROPHENOL

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diazodinitrophenol</td>
<td>Unknown</td>
<td></td>
<td></td>
<td>(4)</td>
</tr>
<tr>
<td>2,4-Dinitrophenol</td>
<td>Human</td>
<td>oral</td>
<td>LD_{50}: 36 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>dermal</td>
<td>Yellow staining of skin; may cause primary irritation or allergic sensitivity</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>systemic</td>
<td>Disruption of oxidative phosphorylation causing increased metabolism, oxygen consumption, and heat production; chronic exposure may result in kidney and liver damage and cataract formation</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td></td>
<td>LD_{50}: 30 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat</td>
<td>intraperitoneal</td>
<td></td>
<td>LD_{50}: 20 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td></td>
<td>LD_{50}: 25 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>dermal</td>
<td></td>
<td>LD_{50}: 700 g/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>Wild birds</td>
<td>oral</td>
<td></td>
<td>LD_{50}: 13 mg/kg</td>
<td>(4)</td>
</tr>
</tbody>
</table>
V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of diazodinitrophenol.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (6).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (7).

C. Other Disposal Practices Employed

Data not available
VIII. REFERENCES


DICHLORODIMETHYLHYDANTOIN

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_5H_6Cl_2N_2O_2 \ (1)$

Molecular Weight: 197.03 (1)

Structural Formula:

B. Alternate Names and Registry Numbers

CAS Registry Number: 118-52-5

Deleted CAS Registry Number: 55945-60-3

CA Name (9CI): 2,4-Imidazolidinedione, 1,3-dichloro-5,5 dimethyl-

CA Name (8CI): Hydantoin, 1,3-dichloro-5,5-dimethyl-

RTECS Number: MU0700000

Other Significant Synonyms: Dantoin, dichlorantin, N'N'-dichloro-5,5-dimethylhydantoin

C. Chemical and Physical Properties

Physical State: Crystalline, four-sided, pointed prisms (1)

Color: Data not available

Odor: Data not available

Melting Point: 132$^\circ$C; sublimes at 100$^\circ$C; turns brown and conflagrates at 212$^\circ$C (1).

Solubilities:

Water: 0.21% at 25$^\circ$C; 0.6% at 60$^\circ$C (1)

Nonaqueous Solvents: Freely soluble in chlorinated and highly polar solvents at 25$^\circ$C: chloroform 14%, methylene chloride 30%, carbon tetrachloride 12.5%, ethylene dichloride 32%, sym-tetrachloroethane 17%, benzene 9.2% (1).

Octanol Water Partition Coefficient: $\log P = 1.63$ (estimated)

DAMD17-84-C-4133 19-1
Hygroscopicity: Data not available
Density (Crystal): 1.5 g/cc (1)
Volutility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: On contact with water, especially hot water, hypochlorous acid is liberated; at pH 9, nitrogen chloride is formed (1).
Stability: Dry crystals can be stored without much loss of available chlorine; after 14 weeks at 60°C, the chlorine loss was 1.5% (1).
Flammability: Data not available

II. USES
A. Army Unique Use
   Military anti-mildew agent
B. Other Uses
   Chlorinating agent, disinfectant, industrial deodorant; in water treatment; active ingredient of powder laundry bleaches; intermediate for amino acids, drugs, insecticides; stabilizer for vinyl chloride polymers and a polymerization catalyst (1).

III. ANALYTICAL METHODS
A. Best Acceptable Method
   No chemical means of detection was found in a search of Chemical Abstracts dating back to 1967.
B. Limit of Detection
   Data not available
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF 1,3-DICHLORO-5,5-DIMETHYLHYDANTOIN

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,3-Dichloro-5,5-dimethylhydantoin</td>
<td>Animals</td>
<td>local</td>
<td>Caustic and corrosive to the eyes, skin, and mucous membranes; may produce severe burns and irreversible cellular damage in the eye</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>Animals</td>
<td>inhalation</td>
<td>Irritating to lungs</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>Rabbit</td>
<td>oral</td>
<td>( \text{LD}_{50} : 1,520 \text{ mg/kg} ); behavioral and pulmonary system effects</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>Guinea pig</td>
<td>oral</td>
<td>( \text{LD}_{50} : 1,350 \text{ mg/kg} ); behavioral and pulmonary system effects</td>
<td>(3)</td>
</tr>
<tr>
<td>Hypochlorous acid</td>
<td>Human</td>
<td>local</td>
<td>Highly irritating to skin, eyes, and mucous membranes</td>
<td>(4)</td>
</tr>
<tr>
<td>(available chlorine)</td>
<td>Human</td>
<td>ingestion</td>
<td>Irritation and corrosion of mucous membranes with pain and vomiting; a fall in blood pressure, delirium, and coma may occur</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>inhalation</td>
<td>Coughing, choking; may cause severe respiratory tract irritation and pulmonary edema</td>
<td>(5)</td>
</tr>
<tr>
<td>Test System</td>
<td>Dose</td>
<td>Effects</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------</td>
<td>----------------------------------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Rat embryo cells</td>
<td>6,300 ng/plate</td>
<td>Oncogenic transformation</td>
<td>(3)</td>
<td></td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

Log BCF = 1.01 Estimated

No other information was found regarding the environmental fate or effects of dichlorodimethylhydantoin.

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 0.2 mg/m³; STEL 0.4 mg/m³ (3)

B. Environmental

Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Disposal practices recommended on an interim basis by the U.S. Navy in their Consolidated Hazardous Item List for a "Mildew Resistant Compound," a related compound used for a related purpose, are to bury in a hazardous waste disposal site (6).

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

The material is ignited in the presence of sodium carbonate and slaked lime (calcium hydroxide). The substance is mixed with vermiculite and then with dry caustics, wrapped in paper and burned in a chemical incinerator equipped with an afterburner and scrubber (7).
VIII. REFERENCES


DICHLOROPHENE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{C}_{13}\text{H}_{10}\text{Cl}_2\text{O}_2$

Molecular Weight: 269.13

B. Alternate Names and Registry Numbers

CAS Registry Number: 97-23-4

CA Name (9CI): Phenol, 2,2'-methylenebis [4-chloro-

CA Name (8CI): Same

RTECS Number: SMU175000

Other significant synonyms: [(Dihydroxydichlorodiphenyl)methane; 2,2'-
dihydroxy-5,5'-dichlorodiphenylmethane; 5,5'-dichloro-2,2'-
dihydroxydiphenylmethane; bis[5-chloro-2-hydroxyphenyl]methane; di[5-
chloro-2-hydroxyphenyl]methane

C. Chemical and Physical Properties

Physical State: Crystalline

Color: Data not available

Odor: Data not available

Melting Point: 177-178°C (1)
DICHLOROPHENE (cont.)

Solubilities:
Water: Insoluble. Soluble in alkaline aqueous solutions with decomposition (2).
Nonaqueous Solvents: Soluble in methanol, isopropyl alcohol and petroleum ether (2).

Octanol Water Partition Coefficient: Log P = 4.72 (estimated)

Hygroscopicity: Data not available
Density (Crystal): Data not available
Vapidity: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Data not available

II. USES

A. Army Unique Use

Military anti-mildew agent

B. Other Uses

Fungicide and bactericide; texture preservative; some dermatological and cosmetic applications; veterinary medicine; plant root growth inhibitor.
III. ANALYTICAL METHODS

A. Best Acceptable Method

High pressure liquid chromatography has been reported by Shah et al. (4) as a good method for quality control in veterinary products. A reverse-phase column was used with a variable wave-length detector set at 290 nm. The mobile phase was methanol-water (75:25). This is not a method for trace analysis, but could be adapted for environmental samples. Thin-layer chromatography has also been reported for quality control in the pharmaceutical industry.

B. Limit of Detection

Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF DICHLOROPHENE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>NS*</td>
<td>NS</td>
<td>Cramps, diarrhea</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>dermal</td>
<td>0.25% in a dermatologic preparation (Unna's boot material)</td>
<td>Caused allergic dermatitis; confirmed by patch tests of dichlorophene in petrolatum</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>dermal</td>
<td>1% in yellow petrolatum (patch)</td>
<td>22/4320 eczema patients had weak positive sensitization reactions; no patients showed irritation reactions</td>
<td>(3)</td>
</tr>
<tr>
<td>Human</td>
<td>dermal</td>
<td>Induction: 20% in petrolatum; challenge: 5% in petrolatum (patch)</td>
<td>1/110 individuals showed signs of sensitization; 0/208 at 5% induction concentration</td>
<td>(7)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>2,000 ppm in diet for 90 d</td>
<td>No toxicity</td>
<td>(8)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>2,690 mg/kg</td>
<td>LD$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>intravenous</td>
<td>17 mg/kg</td>
<td>LD$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>1,000 mg/kg</td>
<td>LD$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>1,250 mg/kg</td>
<td>LD$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>intradermal,</td>
<td>Induction: 5% in propylene glycol intradermally + 25% in yellow petrolatum topically; challenge: 1% in yellow petrolatum topically (patch)</td>
<td>Weak sensitizers</td>
<td>(3)</td>
</tr>
</tbody>
</table>

* Not specified
### TABLE IV-1. TOXICITY OF DICHLOROPHENE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guinea pig</td>
<td>dermal</td>
<td>25% in yellow petrolatum</td>
<td>Not irritating</td>
<td>(3)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>dermal</td>
<td>500 mg/24 hr</td>
<td>Mild irritation</td>
<td>(9)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>50 μg/24 hr</td>
<td>Severe irritation</td>
<td>(9)</td>
</tr>
<tr>
<td>Dog</td>
<td>oral</td>
<td>2,000 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(9)</td>
</tr>
<tr>
<td>Mammal</td>
<td>NS*</td>
<td>1,000 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(9)</td>
</tr>
</tbody>
</table>

* Not specified

### TABLE IV-2. MUTAGENICITY OF DICHLOROPHENE

<table>
<thead>
<tr>
<th>Test system</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella typhimurium</em> (TA1535)</td>
<td>50 nmol/plate</td>
<td>Mutagenic without Aroclor-induced rat liver S9</td>
<td>(10)</td>
</tr>
<tr>
<td>Drosophila Melanogaster (approx. Basal test LD&lt;sub&gt;50&lt;/sub&gt;)</td>
<td>12.5 mM; oral</td>
<td>No increase in frequency of sex-linked recessive lethal mutations</td>
<td>(10)</td>
</tr>
<tr>
<td>Micronucleus test on mouse</td>
<td>27, 54, or 81 mg/kg x2; ip</td>
<td>No increase in frequency of micronuclei</td>
<td>(10)</td>
</tr>
</tbody>
</table>
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

Al. Transport

Ala. Adsorption -- Data not available

Alb. Volatilization -- Data not available

Alc. Leachability -- Data not available

Ald. Bioaccumulation -- Log BCF: 3.36 (estimated)

A2. Transformation -- Data not available

A2a. Biodegradation -- After 3 weeks adaptation at 10 to 20 mg/L at 22°C:
under aerobic conditions, 25% degradation when dichlorophene is sole
 carbon source, 50% degradation with synthetic sewage; under anaerobic
 conditions, no degradation, even with synthetic sewage (8).

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Data not available

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Dichlorophene added to the food of ducks daily for 5
days at 0.5 g/kg body weight did not adversely affect the general
health or the serum protein levels (total and individual protein
fractions), even though the dose was the maximum therapeutic dose
used for treating helminthic infections in ducks (11).

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- The algicidal doses of
dichlorophene to four species of blue-green algae which are common in
swimming pools, impoundments, wastewater effluents, and receiving
waters at pH 6.5 ranged from 4.0 to 9.0 ppm. The algicidal dosage
increased with increasing pH (12).
B7. Aquatic species, fish and invertebrates -- Harlequin fish (Rasbora heteromorpha) flow-through bioassay: 24-hour LC$_{50}$: 5.4 mg/L (sodium salt); 48-hour LC$_{50}$: 4.8 mg/L (sodium salt); 96-hour LC$_{50}$: 3.6 mg/L (sodium salt) (8).

C. Effects on plants

C1. Phytotoxicity -- Dichlorophene is used for inhibiting root growth and preventing root twisting in containerized seedlings of pine and spruce (3).

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Based on the disposal practices recommended by the U.S. Navy for a similar compound, "mildew preventive," dichlorophene should be buried in a hazardous waste disposal site (13).

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber (14).

VIII. REFERENCES


7. TOXLINE, Accession No. 0561810.


11. TOXLINE, Accession No. 000790P.

12. TOXLINE, Accession No. 092242V.


Much of the available data on diethylene glycol dinitrate has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_4H_8N_2O_7 \)
Molecular Weight: 196.14
Structural Formula: \( O_2NOCH_2CH_2OCH_2CH_2ONO_2 \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 693-21-0
CA Name (9CI): Ethanol, 2,2'-oxybis-dinitrate
CA Name (8CI): Diethylene glycol, dinitrate
RTECS Number: ID6825000
Other Significant Synonyms: DEGN, diglycol nitrate, dinitroglycol

C. Chemical and Physical Properties

Physical State: Liquid
Color: Yellow
Odor: Data not available
Melting Point: \(-11.3^\circ C\) (1)
Boiling Point: \(161^\circ C\), Decomposes (2)

Solubilities:
Water: Slightly 0.40 g/100g (20^\circ C) and 0.60 g/100g (60^\circ C) (3).
Nonaqueous Solvents: Slightly soluble in alcohol and water soluble in ether (3). Insoluble in ether alcohol, 2:1 ether:alcohol, acetone (2).

Octanol Water Partition Coefficient: Data not available
Hygroscopicity: Data not available
Density (Crystal): 1.377 (4)
Volatility: Data not available
Vapor Pressure: 0.0036 mm Hg 20°C
Specific Heat: Data not available
Reactivity: Reacts vigorously with oxidizing or reducing material (5).
Heat of Combustion: 2792 cal/g (4)
Stability: Relatively stable at room temperature (6)
Flammability: Highly explosive when shocked or exposed to heat. Emits toxic fumes of NO when heated (5).

II. USES
A. Army Unique Use
   Plasticizer in solid rocket propellants
B. Other Uses
   Data not available

III. ANALYTICAL METHODS
A. Best Acceptable Method
   In addition to the methods previously reported in the Atlantic Research Corporation Report, an HPLC/mass spectroscopy method for forensic and trace analysis is the most recent method for this compound. Yinon (1) described a custom-built mass spectrometer interfaced with a high pressure liquid chromatograph that can successfully analyze DEGN and other explosives.
B. Limit of Detection
   Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF DIETHYLENE GLYCOL DINITRATE* (7)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>Above 5 mg/m³</td>
<td>Coronary occlusion in 4 workers who died suddenly (29-47 yr old, 5-7 yr exposure); 37 of 45 other workers reported precordial pain, headaches, and rarely collapse conditions with loss of consciousness; signs of coronary sclerosis in 3, symptoms of intermediary coronary syndrome in 8, and 1 myocardial infarction; cholesterol blood level was at the upper borderline of normal (220 mg%) in most and reached 300 mg% in some</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>777 mg/kg</td>
<td>LD⁵⁰</td>
</tr>
<tr>
<td>White rats</td>
<td>oral</td>
<td>1,180 mg/kg</td>
<td>LD⁵⁰; central nervous system damage and acute cyanosis</td>
</tr>
<tr>
<td>(male)</td>
<td>in vegetable oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White rats</td>
<td>oral</td>
<td>6x/wk for 6 mo</td>
<td>No effects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.05 mg/kg</td>
<td>Minimum effective dose; changes in conditional reflex activity and immunobiological response</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5 mg/kg</td>
<td>Decrease in blood pressure by 5th to 6th month; change in the mitotic activity of the bone marrow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0 mg/kg</td>
<td></td>
</tr>
<tr>
<td>White mice</td>
<td>oral</td>
<td>1,250 mg/kg</td>
<td>LD⁵⁰; central nervous system damage and acute cyanosis</td>
</tr>
<tr>
<td></td>
<td>in vegetable oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>1,250 mg/kg</td>
<td>LD⁵⁰; central nervous system damage and acute cyanosis</td>
</tr>
<tr>
<td></td>
<td>in vegetable oil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
DIETHYLENE GLYCOL DINITRATE (DEGN) (cont.)

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF DIETHYLENE GLYCOL DINITRATE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em> W3110/polA', p3478/polA' DNA repair assay</td>
<td>100 ug- 10 mg</td>
<td>Not active with or without Aroclor 1254-induced rat liver S9</td>
<td>(8)</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em> TA100, TA1535, TA1537, TA1538</td>
<td>NS*</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(8)</td>
</tr>
<tr>
<td><em>Saccharomyces cerevisiae</em></td>
<td>NS</td>
<td>Did not produce mitotic recombination with or without Aroclor 1254-induced rat liver S9</td>
<td>(8)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of diethylene glycol dinitrate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in the EPA TSCA Inventory 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and

DAMD17-84-C-4133 21-4
landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (9).

B. Alternate Disposal Practices Under Consideration by the Army

Future plans of disposal of waste explosives and propellants are projected to emphasize fluid bed incineration. This method has been tested successfully by ARRADCOM and is planned to be used at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (10).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


DIETHYLENE TRIAMINE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_4H_{13}N_3 \)

Molecular Weight: 103.17

Structural Formula: \( H_2NCH_2CH_NHCH_2CH_2NH_2 \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 111-40-0 (current)

Deleted CAS Registry Numbers: 59135-90-9, 54018-92-7, 26915-78-6

CA Name (9CI): 1,2-Ethanediamine, N-(2-aminoethyl)-

CA Name (8CI): Diethylenetriamine

RTECS Number: IE1225000

Other Significant Synonyms: 3-azapentane-1,5-diamine, bis[\( \cdot \)beta, aminoethyl]amine, 2,2'-diaminodiethylamine, bis(2-aminoethyl)amine

C. Chemical and Physical Properties

Physical State: Liquid (1)

Color: Yellow (1)

Odor: Ammoniacal (2)

Melting Point: -39\( ^\circ \)C (1)

Boiling Point: 208\( ^\circ \)C (1)

Solubilities:

Water: Miscible (1)

Nonaqueous Solvents: Miscible with alcohol; insoluble in ether; soluble in ligroin (1).

Octanol Water Partition Coefficient: Log P = -1.27 (estimated)
DIETHYLENE TRIAMINE (cont.)

Hygroscopicity: Hygroscopic (1)
Specific Gravity: 0.9542 (1)
Volutility: Data not available
Vapor Pressure: 0.2 Torr at 20°C; 0.75 Torr at 20°C (3)
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Corrosive
Stability: Stable (4)
Flammability: Slight; combustion requires preheating (4); flash point-101°C (2).

II. USES

A. Army Unique Use

A component of DS2, a decontaminant for chemical agents (5).

B. Other Uses

Reactive hardener in epoxy formulations (6). Solvent for sulfur, acid gases, resins, dyes, fuel component.

III. ANALYTICAL METHODS

A. Best Acceptable Method

Ng (6) recently reported a gas chromatographic/mass spectroscopic method for the detection of the tert-butyldimethylsilyl derivative.

B. Limit of Detection

Data not available
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF DIETHYLENETRIAMINE (DETA)**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>NS*</td>
<td>Moderate, temporary irritation</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>long exposure</td>
<td></td>
<td>May cause asthma</td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>skin</td>
<td>short exposure</td>
<td>Smarting and first-degree burns</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>long exposure</td>
<td></td>
<td>May cause secondary burns</td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>skin</td>
<td>NS*</td>
<td>Can produce rash and sensitization</td>
<td>(7, 8)</td>
</tr>
<tr>
<td>Human</td>
<td>skin (2 workers)</td>
<td>10 and almost 20 yr</td>
<td>Allergic contact dermatitis from DETA in a detergent</td>
<td>(9)</td>
</tr>
<tr>
<td>Human</td>
<td>eye</td>
<td>NS*</td>
<td>Produces burns</td>
<td>(7)</td>
</tr>
<tr>
<td>Human</td>
<td>NS</td>
<td>NS*</td>
<td></td>
<td>(10)</td>
</tr>
</tbody>
</table>

- "There are existing data which indicate a theoretical potential for the conversion of DETA to nitrosamines in the environment and that persons may be exposed to these nitrosamines as a result of release of DETA to the environment. Nitrosamines have been shown to be carcinogenic."

<table>
<thead>
<tr>
<th>Rat</th>
<th>oral</th>
<th>1,080 mg/kg</th>
<th>LD$_{50}$; convulsions</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>74 mg/kg</td>
<td>LD$_{50}$; convulsions, peritonitis</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>Concentrated vapor and 300 ppm</td>
<td>No effect</td>
<td>(8)</td>
</tr>
</tbody>
</table>

* Not specified
TABLE IV-1. TOXICITY OF DIETHYLENETRIAMINE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>intra-peritoneal</td>
<td>71 mg/kg</td>
<td>LD$_{50}$; convulsions, peri-tonitis</td>
<td>(11)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>skin</td>
<td>162 mg/kg</td>
<td>LD$_{50}$</td>
<td>(11)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>10 mg/24 hr</td>
<td>Severe irritation</td>
<td>(11)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>500 mg (open)</td>
<td>Moderate irritation</td>
<td>(11)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>1,090 mg/kg</td>
<td>LD$_{50}$</td>
<td>(11)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>750 ug</td>
<td>Severe irritation</td>
<td>(11)</td>
</tr>
</tbody>
</table>

* Not specified

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF DIETHYLENETRIAMINE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat or Syrian hamster liver S9</td>
<td>(12)</td>
</tr>
<tr>
<td>Salmonella typhimurum</td>
<td>Slight mutagenic activity</td>
<td>(13)</td>
</tr>
<tr>
<td>TA100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonella typhimurum</td>
<td>Mutagenic without metabolic activation; may be due to impurity</td>
<td>(14)</td>
</tr>
<tr>
<td>TA100, TA1535</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport

A1a. Adsorption -- Data not available
A1b. Volatilization -- Data not available
A1c. Leachability -- Data not available
A1d. Bioaccumulation -- Data not available

A2a. Biodegradation -- Bio-oxidation in fresh water in 15 days: 4% with non-acclimated microbial cultures, up to 70% at 20 days with acclimated microbial cultures (15).

A2b. Hydrolysis -- Data not available
A2c. Photolysis -- Data not available
A2d. Other chemical reaction -- ThOD: 1.55 (15)

A2e. Half-life -- Data not available

B. Effects on animals

B1. Alien species -- Data not available
B2. Mammalian wildlife species -- Data not available
B3. Terrestrial invertebrates -- Data not available
B4. Reptiles -- Data not available
B5. Amphibians -- Data not available
B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- Brine shrimp TL₅₀ = 710 mg/L at 24 hours (15)

C. Effects on plants

C1. Phytotoxicity -- Data not available
C2. Uptake -- Data not available
C3. Metabolism -- Data not available
VI. STANDARDS AND REGULATIONS

A. Health
TLV: TWA(skin): 4 mg/m³ or 1 ppm (16).

B. Environmental
Data not available

VII. DISPOSAL

A. Current Recommended Army Disposal Practices
Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for "Decontaminating Agent," a related mixture used for a related decontamination, are to bury in a sanitary landfill (17).

B. Alternate Disposal Practices Under Consideration by the Army
Data not available

C. Other Disposal Practices Employed
Emits highly toxic vapors when burned. Solution can be sprayed into an incinerator with afterburner and scrubber (16).

VIII. REFERENCES


DIETHYLENE TRIAMINE (cont.)


DINITROPHENYL AZIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_6H_3N_3O_4$

Molecular Weight: Data not available

Structural Formula:

\[
\begin{align*}
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\text{N} & \quad \text{N} \\
\end{align*}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 4096-88-2

CA Name (9CI): Benzene, 1-azido-2,4-dinitro-

CA Name (8CI): Same

RTECS Number: CY6610000

*Under Benzene, 1-azido-2,4-dinitro- on the ICIS System the following information was obtained:

CAS Registry Number: 17508-17-7

CA Name (9CI): Hydroxylamine, O-(2,4-dinitrophenyl)-

DAMD17-84-C-4133 23-1
CA Name (8CI): Same as above.

RTECS Number: CY6610000

Other Significant Synonyms: Benzene, 1-azido-2,4-dinitro, Dinitrophenylazide, DNPA

The structure displayed in the CIS System is not an azide; the structure displayed in CAS under that Registry Number is not the same, but it is also not an azide. For sake of completeness, this Registry Number should be included in further search schemes with the caveat that the search results will have to be screened for the correct compound.

C. Chemical and Physical Properties

Physical State: Data not available

Color: Data not available

Odor: Data not available

Melting Point: Data not available

Solubilities:
  Water: Data not available
  Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Log P = 3.22 (1), 3.50 (2), 3.59 (3), 3.72 (2)

Hygroscopicity: Data not available

Density (Crystal): Data not available

Vapdility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Data not available

Stability: Data not available

Flammability: Data not available
II. USES

A. **Army Unique Use**
   Initiator for explosives.

B. **Other Uses**
   Data not available

III. ANALYTICAL METHODS

A. **Best Acceptable Method**
   No methods of analysis were found in Chemical Abstracts, searching back to 1967.

B. **Limit of Detection**
   Data not available
IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF DINITROPHENYL AZIDE**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinitrophenyl azide</td>
<td>NS*</td>
<td>NS</td>
<td>No toxicity data located other than mutagenicity (see following table)</td>
<td></td>
</tr>
<tr>
<td>2,4-Dinitroaniline</td>
<td>NS</td>
<td>NS</td>
<td>Irritating to skin and mucous membranes; highly toxic if absorbed</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat oral</td>
<td>LD$_{50}$: 418 mg/kg</td>
<td></td>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td>Rat intraperitoneal</td>
<td>LD$_{50}$: 250 mg/kg</td>
<td></td>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td>Rabbit eye</td>
<td>Severe irritation</td>
<td></td>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td>Dinitrobenzene (all isomers)</td>
<td>NS</td>
<td>NS</td>
<td>Anoxia due to methemoglobin formation; respiratory tract irritation and anemia in prolonged exposure</td>
<td>(6)</td>
</tr>
</tbody>
</table>

* Not specified
DINITROPHENYL AZIDE (cont.)

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF DINITROPHENYL AZIDE*

<table>
<thead>
<tr>
<th>Test system</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium (TA98, TA100, TA1535, TA1537, TA1538)</td>
<td>5-20 ug/plate</td>
<td>Mutagenic without liver microsomes</td>
<td>(7)</td>
</tr>
<tr>
<td>Escherichia coli (WP2s)</td>
<td>1-400 ug/plate</td>
<td>Nonmutagenic</td>
<td>(7)</td>
</tr>
</tbody>
</table>

* 2,4-Dinitrophenyl azide

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of dinitrophenyl azide.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (8).
DIPHENYLAMINE

Much of the available data on diphenylamine has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \((C_6H_5)_2NH\)
Molecular Weight: 169.24

Structural formula:

![Structural formula of diphenylamine](image)

B. Alternate Names and Registry Numbers

CAS Registry Number: 122-39-4
CA Name (9CI): Benzenamine, N-phenyl
CA Name (8CI): Diphenylamine
RTECS Number: JJ 7800000

Other Significant Synonyms: Aniline, N-phenyl; N,N-diphenylamine; N-phenylaniline; N-phenylbenzenamine.

C. Chemical and Physical Properties

Physical State: crystals
Color: colorless
Odor: floral (1)
Melting Point: 52.85°C
DIPHENYLAMINE (cont.)

Boiling Point: 302°C at 760 mmHg (2)

Solubilities:
Water: Slightly soluble-0.03 g/100 g at 2°C (3)
Nonaqueous Solvents: Soluble in alcohol 44 g/100 g, very soluble in ether. Methyl alcohol 57.5 g/100 g (3). Acetone-very soluble.
Very soluble in carbon disulfide (4), glacial acetic acid.

Octanol Water Partition Coefficient: Log P = 3.5

Hygroscopicity: Data not available

Density (Crystal): 1.1559 g/cc (5)

Vapor Pressure: 1 mm Hg at 108.3°C (4)

Flash Point: 153°C (5)

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: inflammable

Stability: Data not available

Flammability: Data not available

Vapor Density: 5.82 g/m³

Autoignition temp: 619.67°C (4).

II. USES

A. Army Unique Use

Used as an explosive and a stabilizing compound for propellants and explosives.

B. Other Uses

Manual dyes; stabilizing nitrocellulose explosives and celluloid. In analytical chemistry for the detection of NO₃⁻, Cl⁻ and other oxidizing substances with which, in the presence of H₂SO₄, it gives a deep-blue color. In veterinary medicine, it is used topically in anti-screwworm mixtures and in tests for nitrate and nitrite poisoning.
III. ANALYTICAL METHODS

A. Best Acceptable Method

High pressure liquid chromatography has become the method of choice for this stabilizer for quality control of propellants. Bender (6) reported a qualitative and quantitative determination using UV (ultraviolet) or TEA (thermal energy analyzer) detectors. Barth and Zierath (7) reported HPLC, TLC, (thin-layer chromatography) and HP-TLC methods for analysis in double-based powers. For determining diphenylamine in waste water, Svechnikova (8) reported a chloroform extraction followed by gas chromatography for the analysis of effluents from antioxidant manufacturing. The applicability of this method to propellant manufacturing effluent cannot be extrapolated.

B. Limit of Detection

Data not available
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF DIPHENYLAMINE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral, dermal, inh</td>
<td>NS*</td>
<td>Headache; fatigue; cyanosis; fast pulse; hypertension; bladder injury; chemical asphyxia from methemoglobinemia</td>
<td>(9)</td>
</tr>
<tr>
<td>Human</td>
<td>inh or contact with dust</td>
<td>NS</td>
<td>Eye and mucous membrane irritation</td>
<td>(9)</td>
</tr>
<tr>
<td>Human</td>
<td>dermal</td>
<td>1% in petrolatum (patch)</td>
<td>No sensitization or irritation reactions</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1.2-3.2 g/kg</td>
<td>LD$_{50}$</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1.6 g/kg</td>
<td>Decreased hemoglobin and oxyhemoglobin levels; increased methemoglobin and Heinz-body formation</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>2.5% in feed for 3-6 wk to 0.1% in feed for 2 yr</td>
<td>Renal cystic disease</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>7,500 mg/kg given during gestation days 17-22</td>
<td>TD$_{50}$ for developmental abnormalities</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>3,000 mg/kg</td>
<td>LD$_{50}$</td>
<td>(11)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>300 mg/kg</td>
<td>LD$_{50}$</td>
<td>(11)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>dermal (intact or for 24 hr abraded skin) (patch)</td>
<td></td>
<td>Not irritating</td>
<td>(10)</td>
</tr>
</tbody>
</table>
### TABLE IV-1 TOXICITY OF DIPHENYLAMINE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>oral</td>
<td>1% in feed for 2 yr (99.9% pure)</td>
<td>Severe growth inhibition, low hemoglobin levels and red cell counts, crenated red cells, increase in red cell fragility, fatty livers, hemosiderosis of the spleen, kidney, and bone marrow</td>
<td>(10)</td>
</tr>
<tr>
<td>Cat</td>
<td>oral</td>
<td>1 mmol/kg in aqueous suspension</td>
<td>Methemoglobin formation</td>
<td>(10)</td>
</tr>
</tbody>
</table>

* a. Not included in ARC Report
  * Not specified
DIPHENYLAMINE (cont.)

TABLE IV-2 MUTAGENICITY AND RELATED EFFECTS OF DIPHENYLAMINE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em> W3110/poLA, p3478/poLA</td>
<td>10 mg</td>
<td>100 ug-Not active with or without Aroclor 1254-induced rat liver S9</td>
<td>(12)</td>
</tr>
<tr>
<td><em>Escherichia coli</em> W3110/poLA, p3478/poLA, DNA repair assay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Escherichia coli</em> W3110/poLA, p3478/poLA, DNA repair assay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em> TA100, TA1535, TA1537, TA1538</td>
<td>NS*</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(12)</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em> TA100, TA1535, TA1537, TA1538</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em> (11 strains), <em>Escherichia coli</em> (2 strains)</td>
<td>10,000-fold conc.</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(12)</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em> (11 strains), <em>Escherichia coli</em> (2 strains)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Saccharomyces cerevisiae</em> D5</td>
<td>NS</td>
<td>Did not produce mitotic recombination with or without Aroclor 1254-induced rat liver S9</td>
<td>(12)</td>
</tr>
<tr>
<td><em>Primary rat hepatocyte cultures</em></td>
<td>up to 1 mmol/mL</td>
<td>Did not induce unscheduled DNA synthesis</td>
<td>(13)</td>
</tr>
<tr>
<td><em>Rat kidney cells infected with murine sarcoma virus</em></td>
<td>2.5-20 ug/mL</td>
<td>Did not significantly increase the frequency of viral transformation with or without Aroclor-induced rat liver S9</td>
<td>(14)</td>
</tr>
<tr>
<td><em>Not specified</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport — Data not available

A1a. Adsorption — Data not available

A1b. Volatilization — Data not available
DIPHENYLAMINE (cont.)

A1c. Leachability — Diphenylamine's relatively low solubility in water (18 mg/L at 10°C) and moderately high octanol/water partition coefficient indicate a relatively high tendency to associate with sediments in the hydrosphere and to migrate slowly in soils containing organic matter (15).

A1d. Bioaccumulation — Bioconcentration factor (BCF) = 30, determined with the fathead minnow (Pimephales promelas) in 32-day exposure (16).

A2. Transformation — Data not available

A2a. Biodegradation — Diphenylamine undergoes progressive oxidative metabolism by sewage sludge organisms. Some of the metabolites (4-hydroxy-diphenylamine, indole and aniline) are more acutely toxic than the parent compound, but these metabolites are not persistent in the sludge mixed liquor after they are formed. After 6 hours incubation (common digestion period in sewage treatment plants) the microbial degradation of diphenylamine was incomplete, with more than 35% undegraded (17).

A2b. Hydrolysis — Data not available

A2c. Photolysis — Photochemical reactions may be possible since diphenylamine does absorb light around 285 nm (15).

A2d. Other chemical reaction — COD: 90% of ThOD (0.05 Cr₂O₇)
ThOD: 2.39 (18). When used as a propellant stabilizer, diphenylamine undergoes oxidation with nitrous acid to form diphenyl-N-nitrosamine. Subsequent reactions with nitrogen oxides in the propellants can take place (if mineral acids are present) with the eventual formation of 2,4,4'-trinitrodiphenylamine (15).

A2e. Half-life — Data not available

B. Effects on Animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available
DIPHENYLAMINE (cont.)

B6. Microorganisms, aquatic and soil -- Impact on biodegradation processes: At 100 mg/L, no inhibition of NH₃ oxidation by *Nitrosomonas sp.* (18). In 7-day test at 25°C, 5 mg/L resulted in death of algae (unspecified) cultures (15). The median growth-inhibiting dose (ID₅₀) of diphenylamine to the ciliate *Tetrahymena pyriformis* was 25 ug/mL (10). Diphenylamine was found to be inactive in bacterial DNA repair and reversion tests and yeast mitotic recombination assays made to assess the qualitative nature of the compound’s genotoxic potential (12). Numerous studies have been conducted on the effect of diphenylamine on various biochemical reactions in microorganisms. Particular attention has been paid to the stimulation or inhibition of carotenoid (pigment) synthesis and the resulting altered photosensitivity of the organisms. Inhibition of growth has been noted for some organisms with concentrations of about 10⁻⁴ M. Several investigators have observed that diphenylamine is taken up in the plasma membrane and that certain adverse effects on the membrane result (15). Diphenylamine is applied to the surface of apples and pears to be kept in long cold storage to control the microorganisms associated with scald and rot (15).

B7. Aquatic species, fish and invertebrates -- Bluegill sunfish: 96-hour LC₅₀ = 1.18 mg/L at 21°C. (*Cyclocypris sp.): 48-hour LC₅₀ = 2.53 mg/L at 21°C (15).

C. Effects on Plants

C1. Phytotoxicity -- Diphenylamine has been shown to affect the foliar morphogenesis, germination, rhizogenesis, heteroblastic development and senescence in the tomato (*Lycopersicon esculentum* Mill) (15).

C2. Uptake -- Data not available

C3. Metabolism -- Diphenylamine has been shown to be an effective inhibitor of overall carotene synthesis in a soluble tomato plastid enzyme system; and in pumpkin cotyledons, the compound also reduced carotene accumulation (15).

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 10 mg/m³
STEL 20 mg/m³ (11)

The Food and Drug Administration (21 CFR 175 and 176) has placed restrictions on the use of diphenylamine in food packaging materials (15).
DIPHENYLAMINE (cont.)

B. Environmental

Reported in EPA TSCA Inventory, 1980.

The EPA has established (40CFR 180.190) tolerances for the residues of the fungicide diphenylamine as follows:

10 ppm in or on apples from preharvest or postharvest use, including use of impregnated wraps, for scald control;

Zero (0) in milk and meat (apple processing residues – cores, skins, etc. – are sometimes used as a feed supplement for cows) (15).
VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (18).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (19).

C. Other Disposal Methods Employed

Disposal Method Suggested: Burn in admixture with flammable solvent in furnace equipped with afterburner and scrubber (20).

SAFETY AND CONTROL MEASURES. Disposal personnel handling these items shall wear safety glasses, impervious gloves, and a protective laboratory coat. A NIOSH respirator approved for this item should be available.

VIII. REFERENCES


DIPHENYLAMINE (cont.)


Much of the available data on ethyl centralite has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, *A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals*. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{C}_{17}\text{H}_{9}\text{ON}_{2}$

Molecular Weight: 268.39

B. Alternate Names and Registry Numbers

CAS Registry Number: 85-98-3

CA Name (9CI): Urea, N,N'-diethyl-N,N'-diphenyl

CA Name (8CI): Carbanilide, N,N'-diethyl

RTECS Number: FE0350000

Other Significant Synonyms: Bis(N-ethyl-N-phenyl)urea; carbamite; centralite; centralite-1; sym-diethyldiphenylurea; centralite; urea, 1,3-diethyl-1,3-diphenyl.

C. Chemical and Physical Properties

Physical State: Crystalline solid (1)

Color: White (1)

Odor: Peppery (1)

Melting Point: 79°C (1)
ETHYL CENTRALITE (cont.)

Boiling Point: 325-330°C (1)

Solubilities:
  Water: Insoluble
  Nonaqueous Solvents: Soluble in organic solvents.

Octanol Water Partition Coefficient: Log P = 5.02 (2)

Hygroscopicity: Data not available

Density (Crystal): 1.12 g/cc at 20°C (3)

Vapour Pressure: Data not available

Flash Point: 150°C

Specific Heat: Data not available

Heat of Combustion: 8409.3 cal/g (4)

Reactivity: Data not available

Stability: Severe explosion hazard when shocked or heated (1)

Flammability: Data not available

II. USES

A. Army Unique Use

   Stabilizer for nitrocellulose-based smokeless powder in rocket propellants (3).

B. Other Uses

   Proposed retarder for preventing aging of vulcanized rubber (5).

III. ANALYTICAL METHODS

A. Best Acceptable Method

   Little work has been done on the quantitative analysis of ethyl centralite at trace levels. Most methods have been developed for quality control and stability analysis of propellants. In addition to the methods described in the Atlantic Research Corporation report, there is a gas-liquid chromatography method by Alley and Dykes (6) reported in 1972 that successfully separated and identified the components of double-based propellants including ethyl centralite.
ETHYL CENTRALITE (cont.)

Alley and Dykes used a flame ionization detector and a silicone-based stationary phase.

Additionally, a high-pressure liquid chromatographic method was developed to study the stability of double-base powders. Ethyl centralite, along with 29 other components and derivatives, was detected under isocratic conditions within 35 minutes, or 50 minutes running a gradient (7). This method could possibly be adapted for trace analysis of environmental and other samples.

B. Limit of Detection

Data not available

IV. HEALTH EFFECTS

TABLE IV-1. MUTAGENICITY AND RELATED EFFECTS OF ETHYL CENTRALITE*

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli W3110/pola-</td>
<td>100 ug-</td>
<td>Not active with or without Aroclor 1254- induced rat liver S9</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>10 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. typhimurium TA100, TA1535, TA1537, TA1538</td>
<td>NS**</td>
<td>Nonmutagenic with or without Aroclor 1254- induced rat liver S9</td>
<td>(8)</td>
</tr>
<tr>
<td>S. cerevisiae D5</td>
<td>NS</td>
<td>Did not produce mitotic recombination with or without Aroclor 1254- induced rat liver S9</td>
<td>(8)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
** Not specified

V. ENVIRONMENTAL EFFECTS

No information was found on the environmental fate or effects of ethyl centralite which would update the Atlantic Research Corporation document.
ETHYL CENTRALITE (cont.)

VI. STANDARDS AND REGULATIONS

A. Health

Toxic (1)

B. Environmental

Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or occasionally, hauling by a licensed contractor and landfiling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (9).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (10).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


ETHYL CENTRALITE (cont.)


ETHYLENE GLYCOL

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: C₂H₆O₂ (1)
Molecular Weight: 62.07 (1)

Structural Formula: HOCH₂CH₂OH

B. Alternate Names and Registry Numbers

CAS Registry Number: 107-21-1
Deleted CAS Registry Number: 71767-64-1, 37221-95-7

CA Name (9CI): 1,2-Ethanediol
CA Name (8CI): Ethylene glycol
RTECS Number: KW2975000

Other Significant Synonyms: Glycol, monoethylene glycol, 1,2-dihydroxyethane, 2-hydroxyethanol

C. Chemical and Physical Properties

Physical State: Liquid (slightly viscous) (1)
Color: Clear
Odor: Sweet (2)

Melting Point: -13°C (1)
Boiling Point: 198°C (1)

Solubilities:
Water: Miscible with water (1)
Nonaqueous Solvents: Miscible with lower aliphatic, alcohols, glycerol, acetic acid, acetone and similar ketones, aldehydes, pyridine and similar coal tar bases; slightly soluble in ether (1:200); practically insoluble in benzene and its homologs, chlorinated hydrocarbons, petroleum ether and oils (1).

Octanol Water Partition Coefficient: -1.93 to -1.36 (3,4)
ETHYLENE GLYCOL (cont.)

Hygroscopicity: Very hygroscopic, adsorbs twice its weight of water at 100% relative humidity (1).

Specific Gravity: 1.1088 (5)

Vapour Pressure: Data not available

Volatility: Data not available

Vapor Pressure: 0.05 Torr at 20°C (6), 0.12 Torr at 30°C (7), 0.2 Torr at 30°C (6)

Specific Heat: 0.561 cal/g°C (1)

Heat of Combustion: Data not available

Reactivity: Reacts violently with chlorosulfonic acid and oleum (2)

Stability: May be explosive when heated (2)

Flammability: Slight, combustion requires preheating (8), flash point, open cup: 111°C (8)

II. USES

A. Army Unique Use

Intermediate in the production of explosive ethylene glycol dinitrate.

B. Other Uses

Antifreeze; hydraulic brake fluids; industrial humectant; ingredient in electrolytic condensers, where it serves as solvent for boric acid and borates; solvent in the paint and plastics industry; formulation of printers' inks, stamp pad inks, inks for ball point pens; softening agent for cellophanes; stabilizer for soybean foam used to extinguish oil and gasoline fires; synthesis of safety explosives, glyoxal, unsaturated ester-type alkyd resins, plasticizers, elastomers and synthetic fibers (Terylene and Dacron) and synthetic waxes (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Gas chromatography would be the method of choice and many have been reported. Two of the most recent methods apply to environmental and health effects studies respectively. Nevinnaya and Kofanov (9) formed the acetyl derivative, and used an XE-60 column with flame ionization detection to determine ethylene glycol in wastewater. A capillary
ETHYLENE GLYCOL (cont.)

gas chromatographic method has been developed by Smith (10) to
determine ethylene glycol in human blood serum. Smith formed the
butylboronate derivative before injection onto a methylsilicone bonded
fused silica column.

B. Limit of Detection

Nevinnaya and Kofanov reported 10 ppb as the lower limit of detection (9).
IV. HEALTH EFFECTS

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>1.4 mL/kg</td>
<td>Approx. lethal dose</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100 mL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>NS*</td>
<td>Transient stimulation of the central nervous system followed by depression; vomiting, drowsiness, coma, respiratory failure, convulsions; exudative pathological changes in the brain; renal damage which may proceed to anuria, uremia, death</td>
<td>(1, 11)</td>
</tr>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>&quot;Sip&quot; to approx. 120 mL (antifreeze solution)</td>
<td>Neuromuscular disturbance with myositis after deposition of calcium oxalate crystals; circulatory depression with rapid breathing, cyanosis, and edema of the lungs; renal failure; death after consumption of 90-120 ml</td>
<td>(12)</td>
</tr>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>710 mg/kg</td>
<td>LD₉₀</td>
<td>(13)</td>
</tr>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>7,400 mg/kg</td>
<td>TD₉₀</td>
<td>(13)</td>
</tr>
<tr>
<td>Human</td>
<td>local Liquid</td>
<td></td>
<td>Irritating to skin and eyes</td>
<td>(14)</td>
</tr>
<tr>
<td>Human</td>
<td>contact with vapor</td>
<td>NS</td>
<td>Not irritating to the eyes and throat</td>
<td>(14)</td>
</tr>
</tbody>
</table>

* Not specified
### TABLE IV-1. TOXICITY OF ETHYLENE GLYCOL (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>10,000 mg/m$^3$</td>
<td>TC$_{Lo}$</td>
<td>(13)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>Vapors above 100°C chronic</td>
<td>Nystagmus and recurrent attacks of unconsciousness</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>4,700 mg/kg</td>
<td>LD$_5$0</td>
<td>(13)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>0.0-1.0 g/kg/day, days 6-15 of gestation</td>
<td>No maternal toxicity, embryotoxicity, or increased incidence of malformations in fetuses of dosed dams</td>
<td>(15)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-</td>
<td>5,220 mg/kg</td>
<td>LD$_5$0</td>
<td>(13)</td>
</tr>
<tr>
<td>Rat</td>
<td>peritoneal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>intravenous</td>
<td>2,800 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(13)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>5,300 mg/kg</td>
<td>LD$_5$0</td>
<td>(13)</td>
</tr>
<tr>
<td>Rat</td>
<td>intramuscular</td>
<td>3,300 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(13)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>12 mg/m$^3$</td>
<td>Corneal damage and apparent blindness without signs of systemic intoxication</td>
<td>(11)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>7,500 mg/kg</td>
<td>LD$_5$0</td>
<td>(13)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>5,614 mg/kg</td>
<td>LD$_{Lo}$; chronic pulmonary edema or congestion, effects on the spleen, kidney tubules and glomeruli</td>
<td>(13)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intravenous</td>
<td>3,000 mg/kg</td>
<td>LD$_5$0</td>
<td>(13)</td>
</tr>
<tr>
<td>Mouse</td>
<td>subcutaneous</td>
<td>2,700 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(13)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>6,610 mg/kg</td>
<td>LD$_5$0</td>
<td>(13)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>subcutaneous</td>
<td>5,000 mg/kg</td>
<td>LD$_{Lo}$</td>
<td>(13)</td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 26-5
TABLE IV-1. TOXICITY OF ETHYLENE GLYCOL (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbit</td>
<td>intra-peritoneal</td>
<td>1,000 mg/kg</td>
<td>LD_{Lo}</td>
<td>(13)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>intra-venous</td>
<td>5,000 mg/kg</td>
<td>LD_{Lo}</td>
<td>(13)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>intra-muscular</td>
<td>5,500 mg/kg</td>
<td>LD_{Lo}</td>
<td>(13)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>19,530 mg/kg</td>
<td>LD_{50}</td>
<td>(13)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>555 mg (open)</td>
<td>Moderate irritation</td>
<td>(13)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>100 mg/1 hr</td>
<td>Mild irritation</td>
<td>(13)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>1,440 mg/6 hr</td>
<td>Moderate irritation</td>
<td>(13)</td>
</tr>
<tr>
<td>Cat</td>
<td>oral</td>
<td>2,000 mg/kg</td>
<td>LD_{50}</td>
<td>(13)</td>
</tr>
<tr>
<td>Cat</td>
<td>subcutaneous</td>
<td>2,000 mg/kg</td>
<td>LD_{Lo}</td>
<td>(13)</td>
</tr>
</tbody>
</table>

* Not specified

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF ETHYLENE GLYCOL

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human lymphocytes</td>
<td>320 mmol/L</td>
<td>DNA synthesis inhibition</td>
<td>(13)</td>
</tr>
<tr>
<td>Mouse lymphocytes</td>
<td>100 mmol/L</td>
<td>Mutagenic</td>
<td>(13)</td>
</tr>
</tbody>
</table>
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

Al. Transport — Data not available

Ala. Adsorption — Data not available

Alb. Volatilization — Data not available

A1c. Leachability — The adsorption of ethylene glycol onto different soil types was studied at 60°C. No adsorption was observed onto samples of subhorizons of sandy till, clayey till, and melt water sand. Leaching experiments with undisturbed soil cores of sandy till showed that C\textsubscript{16} labelled ethylene glycol closely followed the movement of water when chloride ion was used as a water tracer (16).

Ald. Bioaccumulation — Data not available

A2. Transformation — Data not available

A2a. Biodegradation — Adapted activated sludge, with ethylene glycol as sole carbon source: 96.8% removal at 41.7 mg COD/g dry inoculum/hr (6). Biooxidation of ethylene glycol was 96% in 20 days in a lightly seeded dilution-bottle test without prior acclimation of microorganisms (17). Anaerobic metabolism of ethylene glycol by culture from sludge of municipal anaerobic digester is dominated by two morphological types of bacteria, tentatively identified as a Methanobacterium sp. and a Desulfovibrio sp. Decomposition products are acetate and ethanol. Formation of methane as a product of ethanol oxidation apparently occurs only after ethylene glycol degradation is complete (18).

A2b. Hydrolysis — Data not available

A2c. Photolysis — Data not available

A2d. Other chemical reactions — BOD\textsubscript{5}: 38% of ThOD, COD: 94% of ThOD, ThOD: 1.26

A2e. Half-life — Data not available

B. Effects on animals

Bl. Avian species — Data not available

B2. Mammalian wildlife species — Chimpanzees exposed to an ethylene glycol-saturated atmosphere for 28 days displayed no seriously harmful effects. Serious behavioral disturbances, such as have been observed in both man and the chimpanze following ingestion or injection of ethylene glycol, did not occur during the periods of glycol inhalation (19).
ETHYLENE GLYCOL (cont.)

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Toxicity threshold (cell multiplication inhibition test): bacteria >10,000 mg/L; algae = 2,000 mg/L; green algae >10,000 mg/L; protozoa >10,000 mg/L; bacteria (toxic) at 250 mg/L (6).

B7. Aquatic species (fish and invertebrates) -- guppy: 7 day LC$_{50}$, 49,300 ppm (6); shrimp: 48 hour LC$_{50}$, greater than 100 ppm (8).

C. Effects on plants

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Listed in EPA TSCA Inventory 1980.

VII. DISPOSAL METHODS

AEHA: NSN 6850-00-181-7929, 7940

A. Current Recommended Army Disposal Practices (20)

1. Sanitary Sewer -- Ethylene glycol/water mixtures of the following strengths shall be disposed in the sanitary sewer system assuming an allowable daily increase of 25 ppm biological oxygen demand (BOD) loading for a flow of 1,000,000 gallons per day. The allowable daily increase is only applicable where the installation is meeting its National Pollution Discharge Elimination System Permit with a comfortable margin approaching 2 mg/L of BOD. The discharge shall be coordinated with treatment plant operations to ensure proper performance during discharge.
ETHYLENE GLYCOL (cont.)

TABLE VIIA-1. DISCHARGE/TREATMENT PLANT OPERATION

<table>
<thead>
<tr>
<th>% Mixture (Ethylene Glycol/Water)</th>
<th>Gallons/1 mgd for 25mg/L BOD Increase*</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td>20</td>
<td>120</td>
</tr>
<tr>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

* Smaller allowable BOD increases will result in proportionally less waste loading.

The above material shall be metered uniformly over a 12-hour period with enough water to assure adequate flushing. An easy way to determine the percent ethylene glycol in the solution would be with an antifreeze tester and the chart given below. Thoroughly mix the antifreeze/water solution and test with the antifreeze tester; determine the percent ethylene glycol from the chart.

TABLE VIIA-2. ETHYLENE GLYCOL/TEMPERATURE (20)

<table>
<thead>
<tr>
<th>% Ethylene Glycol</th>
<th>Temperature Protected Degrees Fahrenheit</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>+23</td>
</tr>
<tr>
<td>20</td>
<td>+12</td>
</tr>
<tr>
<td>30</td>
<td>-01</td>
</tr>
<tr>
<td>40</td>
<td>-24</td>
</tr>
<tr>
<td>50</td>
<td>-54</td>
</tr>
</tbody>
</table>

2. Safety and Control Measures -- Particular attention should be given to preventing skin contact. Disposal personnel should wear at least mid-arm impervious gloves and a full-length impervious apron. A faceshield and/or full face respirator approved for this item should be available if any odor is noticed during mixing or loading (20).

3. Incineration -- Do not incinerate (20).

4. Sanitary Landfill -- Do not bury (20).
B. Alternative Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


DAMD17-84-C-4133 26-10


ETHYLENE GLYCOL DINITRATE

Much of the available data on ethylene glycol dinitrate has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_2\text{H}_4\text{N}_2\text{O}_6 \)

Molecular Weight: 152.08

Structural Formula: \( 0\text{NCH}_2\text{CH}_2\text{NO}_3 \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 628-96-6

CA Name (9CI): 1,2-Ethanediol, dinitrate

CA Name (8CI): Ethylene glycol, dinitrate

RTECS Number: KW5600000

Other Significant Synonyms: Dinitroglycol, EGDN, ethanediol dinitrate, ethylene dinitrate

C. Chemical and Physical Properties

Physical State: Oily liquid (l)

Color: Yellow

Odor: Data not available

Melting Point: -22.3°C
ETHYLENE GLYCOL DINITRATE (cont.)

Solubilities:
Water: 6.2 g/L at 15°C (2)
Nonaqueous Solvents: Soluble in ether, acetone, chloroform, benzene, nitrobenzene, and toluene. Slightly soluble in carbon tetrachloride and benzine (2).

Octanol Water Partition Coefficient: Log P = 0.55

Hygroscopicity: Not hygroscopic (2)

Density (Crystal): Data not available

Specific Gravity: 1.488 at 20°C (2)

Volutility: Volatile. 0.14% loss at 20°C after 24 hours; 0.37% loss after 48 hours. 100% loss after 40 days at 35°C (2).

Vapor Pressure: 0.00025 mm Hg at 20°C (1)

Specific Heat: 0.4 cal/g (2)

Heat of Combustion: 1764 kcal/kg (3)

Stability: Stable at 75°C (2)

Flammability: Ignites when contacted with flame, may explode (1).
Autoignition Temperature: 114-116°C (4). Explosive Temperature: 257°C.

II. USES

A. Army Unique Use

Liquid high explosive — Class A explosive (4)

B. Other Uses

Used with nitroglycerin to make dynamite and other explosives. Occupational exposure involves mixing ethylene glycol dinitrate and nitroglycerin and considering the two chemicals together (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Many analytical methods have been reported recently for this compound and choice of method depends on the purpose of the analysis. Cohon et al. (6) reported an Ion Mobility Spectrometer (IMS) which can detect parts per trillion of explosive in air.
Lloyd reported a high performance liquid chromatography method that uses a pendant mercury drop electrode at the detector. This method compares favorably with electron capture detection in gas chromatography and was developed for forensic analysis, but could be applied for other types of trace analysis (7).

Yu et al. (8) reported a method to determine this compound with nitro/nitroso specific detector with either a gas or liquid chromatograph. This method can be used in the analysis of wastewater or biological fluids. The detector is a Thermal Energy Analyzer (TEA) and can also be applied to metabolites of nitrate esters.

Cumming and Park reported a gas chromatography/single ion monitoring mass spectroscopy method (9).

B. Limit of Detection

Lloyd reported a detection limit of 2-20 picogram/10 microliters of injected sample (7).
**ETHYLENE GLYCOL DINITRATE (cont.)**

### IV. HEALTH EFFECTS

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation, dermal</td>
<td>NS**</td>
<td>May cause severe, throbbing headache with small exposures, and nausea, vomiting, cyanosis, coma, and death with heavier exposures</td>
<td>(1)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>0.5 mL/kg bw, 10% EGDN in olive oil, daily for 9 wk</td>
<td>Increased liver, kidney, and spleen weight to body weight ratios; increased serum glutamic oxaloacetic transaminase and acetylcholinesterase activities; methemoglobin not detected</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat, Mouse, Guinea pig</td>
<td>inhalation</td>
<td>500-1,500 mg/m³ for 3 wk to 3 mo</td>
<td>Sleepiness, Heinz body formation, anemia, increased reticulocyte count</td>
<td>(11)</td>
</tr>
<tr>
<td>Mouse</td>
<td>inhalation</td>
<td>800 mg/m³, 8 hr/d, 6d/week, for 10 wk</td>
<td>Lethargy, cyanosis, Heinz body formation, increased reticulocyte count, hemolytic anemia, skin erosion, thin coats, spasms; 23/30 animals dead after 24 wk</td>
<td>(11)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>subcutaneous</td>
<td>1.5 mL/kg bw, 10% EGDN in olive oil, once</td>
<td>Increased plasma activities of lactic dehydrogenase, alkaline phosphatase, and aldolase; inhibition of plasma monoamine oxidase activity</td>
<td>(12)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>subcutaneous</td>
<td>3.0 mL/kg bw, 10% EGDN in olive oil, once</td>
<td>Methemoglobin formation, highest levels at 2-4 hr after administration</td>
<td>(14)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report

** Not specified
ETHYLENE GLYCOL DINITRATE (cont.)

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of ethylene glycol dinitrate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA: 0.05 ppm or 0.3 mg/m³; STEL: 0.1 ppm or 0.6 mg/m³ (15).

B. Environmental

Reported in TSCA Inventory 1983.

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (16).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRAWCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (17).

C. Other Disposal Practices Employed

Spills and leakage: Overspread sufficient sodium hydroxide and sprinkle water. Drain into the sewer with abundant water.

(a) Disposal and Waste Treatment: Dissolve in a combustible solvent such as alcohol, etc. Burn in an open furnace by igniting from a safe distance with the utmost care or sprinkle into the fire chamber of a furnace with afterburner and scrubber.

(b) Laboratory Scale Quantities: Pour into sodium bisulfate in a large evaporating dish. Sprinkle water and neutralize. Drain into the sewer with sufficient water.
ETHYLENE GLYCOL DINITRATE (cont.)

(c) Disposal Method Suggested: Controlled incineration in the scrubber equipped Deactivation Furnace incinerator (The Chemical Agent Munition Disposal System) (A-31). Also, ethylene glycol dinitrate can be recovered from wastewaters (A-58) (18).

VIII. REFERENCES


I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_4\text{H}_{10}\text{O}_2 \)
Molecular Weight: 90.12 (1)

Structural Formula:

```
H H H H
HO C--C--C--C--H
H H H H
```

B. Alternate Names and Registry Numbers

CAS Registry Number: 110-80-5
CA Name (9CI): Ethanol, 2-ethoxy-
CA Name (8CI): Same
RTECS Number: KK8050000

Other Significant Synonyms: ethyl cellosolve, cellosolve, ethyl 2-hydroxyethyleneether, Ethylethylene glycol, glycol ethyl ether, hydroxy ether, 2-ethoxyethyl alcohol, monomethyl ether of ethylene glycol

C. Chemical and Physical Properties

Physical State: Liquid (1)
Color: Colorless (1)
Odor: Odorless (1)

Melting Point: \(-70^\circ\text{C}\) (1)
Boiling Point: \(135^\circ\text{C}\) (1)
ETHYLENE GLYCOL MONOETHYL ETHER (cont.)

Solubilities:
Water: Completely miscible (1)
Nonaqueous Solvents: Miscible with alcohol, ether, acetone and liquid esters (1).

Octanol Water Partition Coefficient: Log P = -0.17(2); -0.54(3).
Hygroscopicity: Data not available
Specific Gravity: 0.931 at 20\(^{\circ}\)C (1)
Volatility: Vapor density of 3 g/L (4)
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Flammable; flash point: 44\(^{\circ}\)C, open cup; 49\(^{\circ}\)C, closed cup(1). Autoignition temperature, 273\(^{\circ}\)C (4).

II. USES
A. Army Unique Use
Solvent for nitrocellulose

B. Other Uses
Solvents for lacquers and dopes; in various removers, cleansing solutions and dye baths; finishing leather with water pigments and dye solutions; and increasing the stability of emulsions (1).
III. ANALYTICAL METHODS

A. Best Acceptable Method

Gas chromatography is the method of choice. Sidhu (6) reported a gas chromatography method for 2-ethoxyethanol in air. Samples were first obtained by adsorption onto activated carbon followed by desorption with carbon disulfide/isopropyl alcohol. Detection was by flame ionization detector. An FFAP column was used isothermally at 130°C. Sakai et al. (5) also used FFAP mixed with BX-10 to determine and separate paint thinner components in air, including 2-ethoxyethanol. Smallwood et al. (6) reported a gas chromatographic method of monitoring 2-ethoxyethanol in blood and its urinary metabolites by determining the pentafluorobenzyl derivatives.

B. Limit of Detection

Sidhu (6) reported 0.1 ppm as the limit of detection in air samples.
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF ETHYLENE GLYCOL MONOETHYL ETHER

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>0.5-5 g/kg</td>
<td>Estimated lethal dose</td>
<td>(7)</td>
</tr>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>NS*</td>
<td>Central nervous system depression; kidney injury; hematuria</td>
<td>(7)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>NS*</td>
<td>May cause moderate irritation of the respiratory tract</td>
<td>(8)</td>
</tr>
<tr>
<td>Human</td>
<td>contact with vapor</td>
<td>0.6% vapor</td>
<td>Irritation of the eyes</td>
<td>(9)</td>
</tr>
<tr>
<td>Human</td>
<td>eye</td>
<td>NS*</td>
<td>Pain, mild irritation, and transient corneal injury</td>
<td>(8)</td>
</tr>
<tr>
<td>Human</td>
<td>skin</td>
<td>Prolonged or repeated exposures</td>
<td>Mild irritation</td>
<td>(8)</td>
</tr>
<tr>
<td>Test animals</td>
<td>inhalation</td>
<td>0.6% vapor for 18-24 hr</td>
<td>Congestion and edema of the lungs and congestion of the kidneys</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>3,000 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1,890 mg/kg</td>
<td>Mortality</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>1,200 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
</tbody>
</table>

*Not specified
<table>
<thead>
<tr>
<th>Species</th>
<th>Route描述</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>intravenous</td>
<td>2,400 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>4,000 ppm/4 hr</td>
<td>LC₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat, mouse rabbit</td>
<td>various</td>
<td></td>
<td>Teratogenic</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>4,300 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>1,707 mg/kg</td>
<td>LD₅₀; chronic pulmonary edema or congestion, effects on kidney tubules and the spleen</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intravenous</td>
<td>3,900 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>subcutaneous</td>
<td>5,000 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>inhalation</td>
<td>1,820 ppm/7 hr</td>
<td>LC₅₀; analgesia, dyspnea, hematuria</td>
<td>(10)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>1,400 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>eye</td>
<td>10 µg</td>
<td>Mild irritation</td>
<td>(10)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>inhalation</td>
<td>3,000 ppm/24 hr</td>
<td>LC₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>oral</td>
<td>3,100 mg/kg</td>
<td>LD₅₀; anesthesia, hemolysis</td>
<td>(10)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>3,500 mg/kg</td>
<td>LD₅₀</td>
<td>(10)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>500 mg (open)</td>
<td>Mild irritation</td>
<td>(10)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>50 mg</td>
<td>Moderate irritation</td>
<td>(10)</td>
</tr>
<tr>
<td>Dog</td>
<td>inhalation</td>
<td>840 ppm, 7 hr/day for 12 wk</td>
<td>Slight decrease in red cells and hemoglobin and an increase in immature white cells</td>
<td>(10)</td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133  28-5
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport

A1a. Adsorption — Data not available

A1b. Volatilization — Data not available

A1c. Leachability — Data not available

A1d. Bioaccumulation — Data not available

A2. Transformation — Data not available

A2a. Biodegradation — Bio-oxidation in 20 days with non-acclimated microbial cultures: 100% in fresh water; 62% in synthetic salt water (11).

A2b. Hydrolysis — Data not available

A2c. Photolysis — Data not available

A2d. Other chemical reaction — BOD₅: 1.58 at 5-10 ppm, normal sewage as seed material, standard dilution technique; COD: 1.92 (12); Freshwater BOD₅: 36% of theoretical, with sewage seed; Saltwater BOD₅: 5% of theoretical, with sewage seed (4); THOD: 1.80 (11).

A2e. Half-life — Data not available

B. Effects on animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — Data not available

B7. Aquatic species, fish and invertebrates — Fish: Lepomis macrochirus 96-hour LC₅₀ >10,000 ppm; Menidia beryllina 96-hour LC₅₀ >10,000 ppm; guppy, Poecilia reticulata, 7-day LC₅₀: 16,400 ppm (4); goldfish, Carassius auratus, 24-hour LC₅₀ >5,000,000 ug/L (13).
ETHYLENE GLYCOL MONOETHYL ETHER (cont.)

C. Effects on plants
   C1. Phytotoxicity — Data not available
   C2. Uptake — Data not available
   C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS
A. Health
   TLV: TWA 5 ppm (skin) (10)
B. Environmental
   Reported in TSCA Inventory 1980.

VII. DISPOSAL METHODS
A. Current Recommended Army Disposal Practices
   Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHANA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (14).

B. Alternate Disposal Practices under Consideration by the Army
   Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (15).

C. Other Disposal Practices Employed
   Spray into incinerator or burn in paper packaging. Flammable solvent may be added (4).
VIII. REFERENCES


3. ISHOW, Accession No. 305434.


ETHYLENE OXIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_2\text{H}_4\text{O} \) (1)

Molecular Weight: 44.05 (1)

Structural Formula:

```
      H
     / \     \
    H C O
   /   \   /   \ 
  H     C   H   H
```

B. Alternate Names and Registry Numbers

CAS Registry Number: 75-21-8

Deleted CAS Registry Number: 19034-08-3

CA Name (9CI): Oxirane

CA Name (8CI): Ethylene oxide

RTECS Number: MX2450000

Other significant synonyms: Dihydrooxirene, dimethylene oxide, 1,2-epoxyethane, oxycyclopropane, oxirene, dihydro-

C. Chemical and Physical Properties

Physical State: Gas at room temperature and pressure; liquid below 12°C.

Color: Colorless (1)

Odor: Sweet, ether-like. Minimum detectable by odor is 700 ppm (2)

Melting Point: -111°C (1)

Boiling Point: 10.7°C (1)
ETHYLENE OXIDE (cont.)

Solubilities:
Water: Soluble in water (1)
Nonaqueous Solvents: Soluble in alcohol and ether (1), soluble in benzene (3).

Octanol Water Partition Coefficient: Log = -0.3 (4)

Hygroscopicity: Data not available

Vapor Density (Gas): 1.52 (5)
Specific Gravity (Liquid): 0.882 at 10°C (3)

Volatile: Gas at room temperature.

Vapor Pressure: 779.1 Torr at 11°C, 1,305 Torr at 25°C (6)

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: May rearrange chemically and/or polymerize violently with evolution of heat on contact with catalytic surfaces (5).

Stability: Explosive (1). Do not expose to sunlight (2).

Flammability: Very flammable, flash point -18°C (1).

II. USES

A. Army Unique Use

Chemical intermediate in production of explosives.

B. Other Uses

Fumigant; sterilization of surgical instruments; agricultural fungicide; organic synthesis, especially in the production of ethylene glycol and the starting material for the manufacture of acrylonitrile and nonionic surfactants (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Gas chromatography is the method of choice. The official National Institute of Occupational Safety and Health (NIOSH) method uses activated charcoal and carbon disulfide to collect and absorb ethylene oxide (ETO) onto a gas chromatography with a flame ionization detector. Esposito et al. (6) reported a U.S. Army Environmental Hygiene Agency (USA-EHA) gas chromatography method using a chemically impregnated
ETHYLENE OXIDE (cont.)

sampling tube to collect the ETO before chromatography. Ambersorb 347 was treated with HBr and placed in air sampling tubes. Air was drawn through the tubes where ETO was converted to 2-bromoethanol. The tubes are desorbed with a mixture of acetonitrile and toluene and chromatographed on diethylene glycol succinate on Chromosorb WHP column with an electron capture detector (ECD).

B. Limit of Detection

Esposito et al. reported 0.5 ppm (6).

IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF ETHYLENE OXIDE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>50-500 mg/kg</td>
<td>Estimated lethal dose</td>
<td>(7)</td>
</tr>
<tr>
<td>Human,</td>
<td>skin, inhalation</td>
<td>Acute</td>
<td>Primary irritation or burns of skin, eyes, lungs, and respiratory tract; skin sensitization; vomiting; diarrhea</td>
<td>(8)</td>
</tr>
<tr>
<td>animals</td>
<td>ingestion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human,</td>
<td>eye</td>
<td>Liquid or vapor</td>
<td>Severe irritation</td>
<td>(8)</td>
</tr>
<tr>
<td>animals</td>
<td>skin, inhalation</td>
<td>Min dose:</td>
<td>Potential adverse effects on lungs, liver, kidneys, adrenal glands, testes, blood, and the central nervous system</td>
<td>(8)</td>
</tr>
<tr>
<td>Human,</td>
<td>skin, inhalation</td>
<td>Min dose:</td>
<td>Evidence of reversible peripheral neuropathy</td>
<td>(8)</td>
</tr>
<tr>
<td>rat, rabbit, monkey</td>
<td>inhalation</td>
<td>1 ppm avg. exposure for 15 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>occupational exposure</td>
<td>4-10 yr</td>
<td>Increased rate of leukemia</td>
<td>(9)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>12,500 ppm, 10 sec</td>
<td>TC_{L0}; effects on sense organs</td>
<td>(10)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>500 ppm, 2 min</td>
<td>TC_{L0}; convulsions, nausea, respiratory</td>
<td>(10)</td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 29-3
ETHYLENE OXIDE (cont.)

changes

Rat oral 30 or 7.5 mg/kg 2x/wk for up to 150 wk
Squamous-cell carcinomas of the forestomach; hyperkeratosis, hyperplasia, papillomas of the stomach squamous epithelium

Rat oral 72-330 mg/kg LD_{50}

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>inhal-</td>
<td>1,462 ppm,</td>
<td>LC_{50}; lacrimation, salivation, diarrhea</td>
<td>(10)</td>
</tr>
<tr>
<td></td>
<td>acation</td>
<td>4 hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat, mouse</td>
<td>various</td>
<td>0, 50, or</td>
<td>Teratogenic</td>
<td>(10)</td>
</tr>
<tr>
<td></td>
<td>inhal-</td>
<td>100 ppm for</td>
<td>Increased incidences of mononuclear cell leukemia, peritoneal mesothelioma, and mixed cell brain glioma</td>
<td>(10)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>104 wk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat, mouse</td>
<td>inhal-</td>
<td>Min. dose:</td>
<td>Testicular atrophy; dominant lethal effects</td>
<td>(8)</td>
</tr>
<tr>
<td>guinea pig</td>
<td>various</td>
<td>1.98 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>inhal-</td>
<td>for 66 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>intra-</td>
<td>100 mg/kg</td>
<td>LD_{lo}</td>
<td>(10)</td>
</tr>
<tr>
<td></td>
<td>peritoneal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>intravenous</td>
<td>290 mg/kg</td>
<td>LD_{50}</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>sub-</td>
<td>292-2,576 mg/kg, total dose, intermittently for 95 wk</td>
<td>Lymphomas and injection-site tumors</td>
<td>(10)</td>
</tr>
<tr>
<td></td>
<td>cutaneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>inhal-</td>
<td>836 ppm, 4 hr</td>
<td>LC_{50}</td>
<td>(10)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>270 mg/kg</td>
<td>LD_{50}</td>
<td>(10)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>inhal-</td>
<td>7,000 ppm,</td>
<td>LC_{lo}</td>
<td>(10)</td>
</tr>
</tbody>
</table>

DAND17-84-C-4133 29-4
ETHYLENE OXIDE (cont.)

<table>
<thead>
<tr>
<th>Animal</th>
<th>Treatment</th>
<th>Dose</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>18 mg, 6 hr</td>
<td>Moderate irritation</td>
</tr>
<tr>
<td>Rabbit</td>
<td>intravenous</td>
<td>175 mg/kg</td>
<td>LD_{Lo}</td>
</tr>
<tr>
<td>Dog</td>
<td>intravenous</td>
<td>125 mg/kg</td>
<td>LD_{50}</td>
</tr>
<tr>
<td>Dog</td>
<td>inhalation</td>
<td>960 ppm, 4 hr</td>
<td>LC_{50}: lacrimation, nausea, diarrhea</td>
</tr>
</tbody>
</table>

**TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF ETHYLENE OXIDE**

<table>
<thead>
<tr>
<th>Test System</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria, Drosophila melanogaster, mammalian cells in vitro, mammals in vivo</td>
<td>Produces mutagenicity and related effects in many test systems</td>
<td>(10)</td>
</tr>
<tr>
<td>Human</td>
<td>Chromosomal aberrations in workers accidentally exposed to ethylene oxide at approx. 1,500 ppm for 2 hr</td>
<td>(8)</td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS
A. Environmental Fate
Al. Transport
Ala. Adsorption — Data not available
Alb. Volatilization — The desorption rate of ethylene oxide from natural waters is about 0.36 times that of oxygen under the same conditions (12).
Aic. Leachability — Data not available
Aid. Bioaccumulation — Data not available
A2. Transformation — Data not available
A2a. Biodegradation — Possible metabolites include ethylene glycol, ethylene chlorohydrin and glyoxal. Biooxidation of ethylene oxide proceeds at rates indicating nonpersistence. In a lightly seeded BOD test, 52% of ethylene oxide was oxidized in 20 days without prior treatment.
ETHYLENE OXIDE (cont.)

acclimation. In a biological waste treatment system with a high concentration of adapted microorganisms, biooxidation would be much faster, perhaps a matter of hours (12).

A2b. Hydrolysis — In fresh water ethylene oxide hydrolyzes to ethylene glycol. In salt water systems, ethylene chlorohydrin is also formed; the ratio of chlorohydrin to glycol formed is directly proportional to the salt concentration (about 0.2 at 3% NaCl) (12).

A2c. Photolysis — Degrades in atmosphere by free radical processes; intermediate radicals include CH₂ and HCO or H + CO₂ (13).

A2d. Other Chemical Reaction — Data not available

A2e. Half-life — The hydrolysis half-life of ethylene oxide is about 14 days in fresh water at 25°C. Temperature effects are greater than pH effects at pH levels usually encountered. The hydrolysis/hydrochlorination half-life of ethylene oxide in salt water is about 9 days at 25°C (12).

B. Effects on Animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — The adverse effect level of ethylene oxide on activated sludge microorganisms or the LC₅₀ (concentration that inhibited growth 50%) was determined to be in the range of 10 to 100 mg/L (12).

B7. Aquatic species, fish and invertebrates — 96-hour LC₅₀ for fathead minnow: 84 mg/L, 48-hour LC₅₀ for Daphnia magna: 212 mg/L, 48-hour LC₅₀ for brine shrimp: 745 mg/L (12).

C. Effects on Plants

C1. Phytotoxicity — One percent aqueous abstracts of manure, activated sludge and digested sludge, stored for 2, 26, 27 or 65 days, inhibited seed germination and root growth in Brassica parachinensis. Inhibition appeared to be associated with high levels of ammonia, and to a lesser extent, ethylene oxide (14).

C2. Uptake — Data not available

C3. Metabolism — Data not available
ETHYLENE OXIDE (cont.)

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in TSCA Inventory 1983.

EPA TSCA 8(a) Preliminary Assessment Information, final rule (15).

Ethylene oxide has a statutory reportable quantity (RQ) of 1 lb under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (16).

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Data not available

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Dissolve in higher alcohol, benzene, or petroleum ether. Incinerate.

Ether of long standing may contain peroxides. Transport to isolated area in padded containers. Uncover and arrange excelsior train. From distance, puncture with rifle fire and ignite excelsior (5).

AEHA: NSN 6505-00-C99-3878, 3962, 3405, 5298

Dispose of through a commercial contractor (17).

VIII. REFERENCES


HALAZONE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_7H_5Cl_2NO_4S$

Molecular Weight: 270.09

Structural Formula:

```
O
C-OH

SO_2NCl_2
``` 

B. Alternate Names and Registry Numbers

CAS Registry Number: 80-13-7

CA Name (9CI): Benzoic acid, 4-[(dichloroamino)sulfonyl]

CA Name (8CI): Benzoic acid, p-[(dichlorosulfamoyl]

RTECS Number: DG8050000

Other Significant Synonyms: Carboxybenzenesulfonylchloroamide; p-N,N-
dichlorosulfamyl benzoic acid; p-sulfonedichloramidobenzoic acid.

C. Chemical and Physical Properties

Physical State: Crystalline powder (1)

Color: White (1)

Odor: Strong chlorine odor

Melting Point: 195°C (decomposition) (1)
HALAZONE (cont.)

Solubilities:
Water: slightly (1)
Nonaqueous Solvents: soluble in glacial acetic acid, benzene;
slightly soluble in chloroform; insoluble in petroleum ether (1).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): Data not available

Volutility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Data not available

Stability: Data not available

Flammability: Data not available

II. USES
A. Army Unique Use
Field water treatment

B. Other Uses
Water disinfectant (1)

III. ANALYTICAL METHODS
A. Best Acceptable Method
No appropriate methods were found for trace analysis of this compound.

B. Limit of Detection
Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF HALAZONE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>3,500 mg/kg</td>
<td>LD_{50}</td>
<td>(2)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra venous</td>
<td>300 mg/kg</td>
<td>LD_{Lo}</td>
<td>(2)</td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

This material releases free chlorine on reaction with water. While little information on specific environmental fate of halazone is available, the compound is believed to have effects similar to that of high levels of free chlorine.

A. Environmental Fate

A1. Transport — Data not available

A2. Transformation — Data not available

B. Effects on animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — Halazone was found to have a considerable disinfecting action in river water. Doses ranging from 1.0 to 50.0 mg/L of halazone reduced bacterial counts, on average, by 73.31% to 99.41% after 48 hours' incubation. At doses of less than 1.0 mg/L the bacterial count generally increased (3).

B7. Aquatic species, fish and invertebrates — Data not available

C. Effects on plants — Data not available
VI. STANDARDS AND REGULATIONS

A. Health
   Data not available

B. Environmental
   Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

   Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for Water Purification Kit (the principal use of halazone) is burial in a sanitary landfill (4).

B. Alternate Disposal Practices Under Consideration by the Army
   Data not available

C. Other Disposal Practices Employed
   Data not available

VIII. REFERENCES


HYDRAZINE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

   Chemical Formula: $N_2H_4$
   Molecular Weight: 32.06
   Structural Formula:

   \[
   \begin{array}{c}
   \text{H} \quad \text{H} \\
   \text{H-N-N-H}
   \end{array}
   \]

B. Alternate Names and Registry Numbers

   CAS Registry Number: 302-02-2
   CA Name (9CI): Hydrazine
   CA Name (8CI): Hydrazine
   RTECS Number: MU7175000
   Other Significant Synonyms: Diamine

C. Chemical and Physical Properties

   Physical State: Fuming, colorless, hygroscopic, liquid (1) or white crystals (2)
   Color: Colorless
   Odor: Penetrating, resembling that of ammonia (3)
   Odor Index: 5,300 at 20°C (4)
   Threshold Odor Concentration: 3-4 ppm (4)
   Melting Point: 2.0°C (3)
   Boiling Point: 113.5°C (3)
HYDRAZINE (cont.)

Solubilities:

Water: Miscible with water (3).
Nonaqueous Solvents: Miscible with methyl, ethyl, propyl, and isobutyl alcohols (3). Slightly miscible with hydrocarbons and halogenated hydrocarbons (5). Insoluble in chloroform and ether (1).

Octanol Water Partition Coefficient: Log P = -1.11 (6)

Hygroscopicity: Hygroscopic; readily forms hydrate, \( \text{N}_2\text{H}_4\cdot\text{H}_2\text{O} \) (7)

Specific Gravity: 1.0083 at 4\(^\circ\)C (5)

Volatile: Data not available

Vapor Pressure: 10.4 mm Hg at 20\(^\circ\)C (8)

Flash Point: 38-52\(^\circ\)C (Open cup) (8)

Saturation Concentration: 18,900 ppm at 25\(^\circ\)C (8)

Refractive Index: \( n (35\,^\circ\text{C}) = 1.4644 \) (5)

Autoignition Temperature: 24\(^\circ\)C, iron-rust surface; 270\(^\circ\)C glass surface (8).

Heat of Combustion: 148.6 cal/mol (1)

Reactivity: Explosion hazard when exposed to heat or flame or by chemical reaction with alkali metals, \( \text{NH}_3 \), \( \text{Cl}_2 \), chromates, \( \text{CuO} \), \( \text{Cu}^{++} \) salts, \( \text{P}_2 \), \( \text{H}_2\text{O}_2 \), iron rust, metallic oxides, \( \text{N}_2 \), \( \text{Ni} \) (\( \text{Cl}10 \)), \( \text{HNO}_3 \), \( \text{N}_2\text{O}_5 \), \( \text{K}_2\text{Cr}_2\text{O}_7 \), \( \text{Na}_2\text{Cr}_2\text{O}_7 \), tetryl, zinc, dithione, and \( \text{Zn} \) (\( \text{C}_2\text{H}_5 \)) (2). Explodes during distillation if traces of air are present; also affected by UV. Strong reducing agent, diacidic base (pKB=5.52) (3).

Stability: Thermodynamically unstable and may decompose to hydrogen, ammonia and nitrogen; the reaction rate is reportedly slow at room temperature but is rapid at elevated temperatures, particularly in the presence of metals such as copper (8). If air is excluded, hydrazine can be stored, preferably in the form of the hydrate, without decomposition for a long time in paraffin bottles (5). Can be stored sealed in glass and kept in a cool, dark place (3). Usually stored under nitrogen (9).

Flammability: Fire hazard dangerous, when exposed to heat, flame or oxidizing agents (2). Combustion highly exothermic (1).

Flammable limits: 4.7-100\% by volume in air, combustion produces toxic vapor (10).
II. USES

A. Army Unique Use

Propellant

B. Other Uses

Hydrazine is used as a polymerization catalyst, blowing agent, reducing agent, oxygen scavenger, and short-stopping agent. Other uses include Spandex fibers, explosives, antioxidants (petroleum, detergents), plating metals on glass and plastics, fuel cells, solder fluxes, scavenger for gases, photographic developers, corrosion inhibitors, oil-well drilling in soils containing kaolinite, buoyancy agent for undersea salvage, diving equipment, boiler feedwater, and reactor cooling water. Hydrazine is used in the synthesis of agricultural chemical (maleic hydrazide) and the manufacture of pharmaceuticals (antibacterial and antihypertensive agents) (1).

III. ANALYTICAL METHODS

Hydrazine can be determined by titration, colorimetry, potentiometry, or gas chromatography. Small quantities (less than 1 ppm) can be determined photometrically after reaction with p-dimethylaminobenzaldehyde to yield an intense red color with a minimum transmittance at 445 nm or 455 nm (6).

A. Best Acceptable Method

For the analysis of hydrazine, methylhydrazine, 1,1-dimethylhydrazine, and phenylhydrazine in workroom air, the National Institute of Occupational Safety and Health (NIOSH) (8) recommends the Wood-Anderson gas chromatographic method because of its high sensitivity and specificity. With this method, air samples are collected in a sulfuric acid-coated silica gel sorbent and the hydrazinium hydrogen sulfates are desorbed from the gel with water. The resulting solution is neutralized with sodium acetate and reacted with 2-furaldehyde. The derivatives formed are extracted into ethyl acetate and determined by gas chromatography with flame ionization detection.

Recently, two rapid methods easily adapted for field monitoring, have been reported. Holtzclaw et al. (11) reported a simplified trapping system using a chilled acetone collection medium, where a stable derivative of hydrazine is formed. The acetone solution can then be directly injected into a gas chromatograph equipped with thermionic and a TEA nitrogen analyzer (11). Anderson et al. reported a high pressure liquid chromatographic method using chemisorption tubes containing benzaldehyde-coated XAD-2 resin (12).
B. Limit of detection

4 ppb (11)
5 ug/m³ (12)

IV. HEALTH EFFECTS

TABLE IV-1. ACUTE TOXICITY OF HYDRAZINE* (13)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>LD₅₀ or LC₅₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>60 mg/kg</td>
</tr>
<tr>
<td>Rat</td>
<td>ip</td>
<td>59 mg/kg</td>
</tr>
<tr>
<td>Rat</td>
<td>iv</td>
<td>55 mg/kg</td>
</tr>
<tr>
<td>Rat</td>
<td>inh</td>
<td>570 ppm/4hr</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>59 mg/kg</td>
</tr>
<tr>
<td>Mouse</td>
<td>ip</td>
<td>62 mg/kg</td>
</tr>
<tr>
<td>Mouse</td>
<td>iv</td>
<td>57 mg/kg</td>
</tr>
<tr>
<td>Mouse</td>
<td>inh</td>
<td>252 ppm/4hr</td>
</tr>
<tr>
<td>Mouse</td>
<td>unknown</td>
<td>200 mg/kg</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>skin</td>
<td>190 mg/kg**</td>
</tr>
<tr>
<td>Rabbit</td>
<td>iv</td>
<td>20 mg/kg</td>
</tr>
<tr>
<td>Rabbit</td>
<td>skin</td>
<td>91 mg/kg</td>
</tr>
<tr>
<td>Dog</td>
<td>iv</td>
<td>25 mg/kg</td>
</tr>
</tbody>
</table>

*Data from RTECS (1984) except **from NIOSH (8)
TABLE IV-2. TOXIC EFFECTS OF HYDRAZINE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhal-</td>
<td>NS</td>
<td>Eye and upper respiratory sensitization-type dermatitis, eye and skin</td>
<td>(9)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td></td>
<td>burns, lethargy, tremors, vomiting, diarrhea</td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>inhal-</td>
<td>20-225 ppm, 6</td>
<td>Death of 83% in 1-6 wk</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>hr/d, 5 d/wk,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>x6 wk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>inhal-</td>
<td>5-14 ppm, 6 hr</td>
<td>Some deaths</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>/d, 5 d/wk, x6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>wk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>intra-</td>
<td>25-100 mg/kg</td>
<td>Hypoglycemia, convulsions</td>
<td>(8)</td>
</tr>
<tr>
<td>Dog</td>
<td>intra-</td>
<td>16-20 mg/kg</td>
<td>Impaired kidney function</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>venous</td>
<td>single dose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>subcu-</td>
<td>16-25 mg/kg</td>
<td>Elevated plasma ammonia levels without significant elevation of blood</td>
<td>(14)</td>
</tr>
<tr>
<td></td>
<td>taneous</td>
<td>single dose</td>
<td>urea nitrogen</td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>inhal-</td>
<td>150-168 ppm-hr</td>
<td>Weight loss, fatty liver, anemia</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>hr/wk x6 mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>inhal-</td>
<td>14 ppm, 6 hr/</td>
<td>Fatty liver, anemia, death in 2 of 4</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>d, 5 d/wk, x6 mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>inhal-</td>
<td>5 ppm, 6 hr/</td>
<td>Weight loss, vomiting, irregular breathing</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>d, 5 d/wk, x6 mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhesus</td>
<td>intra-</td>
<td>5-20 mg/kg, 25</td>
<td>Weight loss, slight anemia, fatty liver, kidney, and heart</td>
<td>(8)</td>
</tr>
<tr>
<td>monkey</td>
<td>perito-</td>
<td>33 doses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>teneal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhesus</td>
<td>intra-</td>
<td>32 mg/kg, 2</td>
<td>Inhibition of insulin release</td>
<td>(8)</td>
</tr>
<tr>
<td>monkey</td>
<td>perito-</td>
<td>doses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>teneal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE IV-3. TERATOGENIC/REPRODUCTIVE EFFECTS OF HYDRAZINE* (13)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Duration</th>
<th>TD&lt;sub&gt;LO&lt;/sub&gt; or TC&lt;sub&gt;LO&lt;/sub&gt;</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>Gestation days</td>
<td>100 mg/kg</td>
<td>Effects on fertility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>Gestation days</td>
<td>50 mg/kg</td>
<td>Embryotoxicity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>Gestation days</td>
<td>30 mg/kg</td>
<td>Developmental abnormalities, effects on fertility, embryotoxicity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>sub-cutaneous</td>
<td>Gestation days</td>
<td>80 mg/kg</td>
<td>Embryotoxicity, newborn effects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>skin</td>
<td>Gestation day</td>
<td>50 mg/kg</td>
<td>Effects on fertility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>Gestation days</td>
<td>1 mg/m&lt;sup&gt;3&lt;/sup&gt;/24 hr</td>
<td>Embryotoxicity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>intra-peritoneal</td>
<td>Gestation days</td>
<td>48 mg/kg</td>
<td>Developmental abnormalities, embryotoxicity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>intra-peritoneal</td>
<td>Gestation days</td>
<td>80 mg/kg</td>
<td>Developmental abnormalities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE IV-4. CARCINOGENICITY OF HYDRAZINE* (13)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Duration</th>
<th>TD$<em>{Lo}$ or TC$</em>{Lo}$</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>6 hr, 1 yr</td>
<td>1 ppm</td>
<td>Equivical evidence for nasal tumors</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>2 yr, continuously</td>
<td>1951 mg/kg</td>
<td>Neoplastic effects: pulmonary system, blood</td>
</tr>
<tr>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>5 wk, intermittently</td>
<td>400 mg/kg</td>
<td>Carcinogenic effects: blood</td>
</tr>
<tr>
<td>Mouse</td>
<td>inhalation</td>
<td>6 hr, 1 yr</td>
<td>1 ppm</td>
<td>Equivical evidence for nasal tumors</td>
</tr>
<tr>
<td>Hamster</td>
<td>inhalation</td>
<td>6 hr, 1 yr,</td>
<td>5 ppm</td>
<td>Equivical evidence for nasal tumors</td>
</tr>
</tbody>
</table>

### TABLE IV-5. MUTAGENICITY AND RELATED EFFECTS OF HYDRAZINE* (13)

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>10 umol/L</td>
<td>DNA damage</td>
</tr>
<tr>
<td>S. typhimurium</td>
<td>12 gm/L</td>
<td>Microsomal-mediated mutation</td>
</tr>
<tr>
<td>B. subtilis</td>
<td>10 mmol/L</td>
<td>Not specified</td>
</tr>
<tr>
<td>X. influenzae</td>
<td>2 mmol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td>D. melanogaster</td>
<td>20 mmol/L(oral)</td>
<td>Specific locus mutation</td>
</tr>
<tr>
<td>D. melanogaster</td>
<td>10 mmol/L(oral)</td>
<td>Nondisjunction</td>
</tr>
<tr>
<td>S. cerevisiae</td>
<td>200 mmol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td>Human liver cells</td>
<td>80 ug/L</td>
<td>Oncogenic transformation</td>
</tr>
<tr>
<td>Rat liver cells</td>
<td>3 mmol/L</td>
<td>DNA damage</td>
</tr>
<tr>
<td>Rat lung cells</td>
<td>250 ug/L</td>
<td>Unscheduled DNA synthesis</td>
</tr>
<tr>
<td>Mouse lymphocytes</td>
<td>1 mmol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td>Mouse host-mediated assay with S. typhimurium</td>
<td>3100 ug/kg</td>
<td>Mutation</td>
</tr>
<tr>
<td>Hamster kidney cells</td>
<td>80 ug/L</td>
<td>Oncogenic transformation</td>
</tr>
<tr>
<td>Hamster ovary cells</td>
<td>350 ug/L</td>
<td>Unscheduled DNA synthesis</td>
</tr>
<tr>
<td>Hamster lung cells</td>
<td>250 ug/L</td>
<td>Unscheduled DNA synthesis</td>
</tr>
<tr>
<td>Hamster ovary cells</td>
<td>1 mmol/L</td>
<td>Sister chromatid exchange</td>
</tr>
<tr>
<td>Hamster lung cells</td>
<td>1 mmol/L</td>
<td>Sister chromatid exchange</td>
</tr>
</tbody>
</table>

*Data from AIECE.
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

Al. Transport

A1a. Adsorption -- Data not available

A1b. Volatilization -- MacNaughton et al. reports that hydrazine evaporation rates from liquid pools ranged from 16 to 100 mg/cm²/hr. These rates were considered sufficient to generate hazardous atmospheric concentrations (greater than 3 ppm) up to 2 km downwind under worst-case meteorological conditions, following release of hydrazine into the environment. Hydrazine evaporation decreases as a function of time due to absorption of H₂O and CO₂ (15).

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- None of the hydrazines on which metabolic studies have been conducted seem to preferentially concentrate the chemicals or metabolites in specific organs (16). Hydrazine does not concentrate in the food chain (11).

A2. Transformation -- Data not available

A2a. Biodegradation -- About 50% of hydrazine administered to laboratory mammals has been observed to be excreted unchanged in the urine (16). Hydrazine is co-metabolized to nitrogen gas by *Nitrosomonas* with the major product being nitrogen (17).

A2b. Hydrolysis -- Decomposition slow in water at room temperature (9). (See A2e). Degradation in fresh or saline water is rather slow; therefore, degradation will not be a significant sink for hydrazine in aqueous environments, and downstream concentration of hydrazine will be a function of dilution and dispersion (15).

A2c. Photolysis -- Hydrazine does not photolyze in the solar actinic region (λ > 290 nm) (18).

A2d. Other chemical reaction -- Based on simulated atmosphere studies, consumption by ozone and hydroxyl radicals is expected to dominate the fate of hydrazine in the atmosphere. The half-life for the reaction of hydrazine with ozone is expected to range from less than 10 minutes in ozone pollution to less than 2 hours in the natural atmosphere; the major reaction product is hydrogen peroxide. For reactions with OH*, the tropospheric half-life for hydrazine should range from less than one hour in polluted urban atmospheres to 3 to 6 hours in unpolluted atmospheres. Due to the apparent efficient conversion of hydrazine nitrogen to N₂, hydrazine release should have
HYDRAZINE (cont.)

relatively little impact on the levels of NO<sub>x</sub>, nitrates, or other forms of active nitrogen in the atmosphere (18). Hydrazine degradation was faster in hard water than in soft water samples and also in relatively polluted samples which were rich in organic matter (19).

A2e. Half-life

In air, at 25°C: approximately 6 hours; in oxygenated aqueous solutions (pond and sea water): 5 days (15).

B. Effects on Animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Adequate studies in different species of laboratory mice have demonstrated that hydrazine given mainly as the hydrazine sulphate (HS) produces a high incidence of multiple pulmonary adenomas and adenocarcinomas (6).

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — The teratogenic effect of hydrazine on embryos of toad (20) and frog (17) was 10 mg/L and 40 mg/L, respectively.

B6. Microorganisms, aquatic and soil — EC<sub>50</sub> values (concentrations necessary to reduce substrate metabolism by 50%): Nitrobacter 14.6 mg/L; Nitrosomonas 94.8 mg/L denitrifying bacteria 65 mg/L anaerobic bacteria 145 mg/L (17). At a concentration of 48 mg/L, hydrazine produced a 75% inhibition of the nitrification process of non-acclimated activated sludge (5).

B7. Aquatic species, fish and invertebrates — For Daphnia, LC<sub>50</sub> = 1.2 mg/L. For several species of fish, the 24-hour LD<sub>50</sub> was about or less than 4mg/L (17). Perturbation of trout was detected at 0.7 mg/L after 24-hour exposure, and a concentration of 146 mg/L was fatal to rainbow trout after 22 minutes exposure (5). Fertilized eggs of fathead minnow Pimephales promelas were exposed to hydrazine for 48 hours at various concentrations; 5 mg/L was lethal and 1.0 mg/L caused such deformation that the larvae which did hatch had little chance of survival. For bluegill, Lepomis macrochirus, 96 hour LC<sub>50</sub> = 1080 mg/L (21).

C. Effects on Plants

Cl. Phytotoxicity — Hydrazine is mutagenic in higher plants (22).
C2. Uptake — Data not available
C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS
A. Health
   TWA 0.04 mg/m$^3$ (0.03 mg/L, free base) (9).
B. Environmental
   TLV 1 ppm (1.3 mg/m$^3$), 1974 (5).

VII. DISPOSAL
A. Current Recommended Army Disposal Practices

   Review of past Installation Assessment Reports indicates that current
   methods of disposal of waste explosives and propellants involve open
   burning, open detonation or hauling by a licensed contractor and
   landfilling. Current use of methods discussed above has also been
   confined by private communications from the U.S. Army Toxic and
   Hazardous Materials Agency (USATHAMA), who have the responsibility to
   review current disposal practices and to develop plans for future
   disposal practices (23).

B. Alternate Disposal Practices Under Consideration by the Army

   Future plans for disposal of waste explosives and propellants are
   projected to emphasize fluid-bed incineration. This method has been
   tested successfully by ARRADCOM and is planned for use at installations
   such as Savanna Army Depot, Tooele Army Depot and Hawthorne Naval
   Ammunition Depot (24).

C. Other Disposal Practices Employed

   (a) Dilute with water to produce a 40% solution. Neutralize
       with sulfuric acid. Drain into the sewer with abundant water (25).

   (b) Dissolve in a combustible solvent (alcohols, benzene, etc.). Burn
       in an open pit with utmost care. Ignite from a safe distance (25).

   Lunn and Sansone report a one-step approach to conversion of hydrazines
   to innocuous products in laboratory wastes or in the environment, using
   one of two nickel-based catalytic reduction procedures (26).
VIII. REFERENCES


22. Clayton et al., p. 2791.


HYDROXYL AMMONIUM NITRATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{NH}_4\text{H}_2\text{O}_4 \)

Molecular Weight: 96.04 \( (1) \)

Structural Formula: \( \text{HONH}_3^+\text{NO}_3^- \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 13465-08-2

CA Name (9CI): Hydroxylamine, nitrate (salt)

CA Name (8CI): Same

RTECS Number: Data not available

Other Significant Synonyms: Hydroxylamine mono nitrate

C. Chemical and Physical Properties

Physical State: Crystal \( (1) \)

Color: White \( (1) \)

Odor: Data not available

Melting Point: 48\(^\circ\)C \( (1) \)

Solubilities:

Water: Very soluble (cold); decomposes (hot) \( (1) \).

Nonaqueous Solvents: Very soluble in alcohol \( (1) \)

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): Data not available

Volatility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available
HYDROXYL AMMONIUM NITRATE (cont.)

Heat of Combustion: Data not available
Reactivity: Reacts with inorganic and organic soil components. (2)
Stability: Decomposes at 100°C (1). Unstable in water (2).
Flammability: Data not available

II. USES
A. Army Unique Use
   Propellant
B. Other Uses
   Data not available

III. ANALYTICAL METHODS
A. Best Acceptable Method
   Kaplan et al. (2) determined hydroxylammonium nitrate by
   spectrophotometer at 705 nm. The aqueous solutions were 50 ppm and
   below. No separation was performed.
B. Limit of Detection
   Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF HYDROXYLAMMONIUM NITRATE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxylammonium nitrate</td>
<td>Rat</td>
<td>oral</td>
<td>882 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(3)</td>
</tr>
<tr>
<td>(grade not specified)</td>
<td>Rat,</td>
<td>NS*</td>
<td>NS</td>
<td>Cyanosis, respiratory distress, and convulsions</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>rabbit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rabbit</td>
<td>oral</td>
<td>100 mg/kg</td>
<td>Approximate lethal dose</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>Rabbit</td>
<td>dermal</td>
<td>70 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(unoccluded)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydroxylammonium nitrate</td>
<td>Rabbit</td>
<td>dermal</td>
<td>5 d/wk</td>
<td>Chronic and ulcerative dermatitis</td>
<td>(3)</td>
</tr>
<tr>
<td>(technical grade; 80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aqueous solution)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5-11.7 mg/kg</td>
<td>Red blood cell destruction and Heinz body formation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.9-11.7 mg/kg</td>
<td>Splenic hematopoiesis; increased spleen-to-body weight ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.9-11.7 mg/kg</td>
<td>Hepatic hematopoiesis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11.7 mg/kg</td>
<td>Increased heart-to-body weight ratio</td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>Human</td>
<td>oral</td>
<td>Large amounts</td>
<td>Dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, and collapse</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Small repeated doses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May lead to weakness, general depression, headache, and mental impairment</td>
<td></td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 32-3
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyl-amine</td>
<td>Rat</td>
<td>intra-venous</td>
<td>59 mg/kg</td>
<td>LD$_{50}$</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>Rat</td>
<td>subcutaneous</td>
<td>29 mg/kg</td>
<td>LD$_{50}$</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>60 mg/kg</td>
<td>LD$_{50}$</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
<td>unknown</td>
<td>175 mg/kg</td>
<td>LD$_{50}$</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>local NS</td>
<td>NS</td>
<td>A moderate irritant to skin, eyes, and mucous membranes</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>systemic NS</td>
<td>NS</td>
<td>Can cause methemoglobinemia</td>
<td>(4)</td>
</tr>
</tbody>
</table>

* Not specified
HYDROXYL AMMONIUM NITRATE (cont.)

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF HYDROXYLANEINE(5)

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella typhimurium</em></td>
<td>5 pph</td>
<td>Mutation; effects on DNA repair</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>5 pph</td>
<td>Mutation</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>50 mmol/L</td>
<td>DNA damage</td>
</tr>
<tr>
<td><em>Bacillus subtilis</em></td>
<td>1 mol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td><em>B. subtilis</em></td>
<td>100 mmol/L</td>
<td>DNA damage</td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td>140 mmol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td>5 min</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Microorganisms</em></td>
<td>10-1,000 mmol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td><em>Microorganisms</em></td>
<td>1 mol/L</td>
<td>Unscheduled DNA synthesis</td>
</tr>
<tr>
<td><em>Drosophila melanogaster</em></td>
<td>30 mmol/L</td>
<td>Sex chromosome loss and nondisjunction</td>
</tr>
<tr>
<td><em>Neurospora crassa</em></td>
<td>1 mol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td><em>Schizosaccharomyces pombe</em></td>
<td>1 mol/L</td>
<td>Mutation</td>
</tr>
<tr>
<td><em>Human lymphocytes</em></td>
<td>360 umol/L</td>
<td>DNA synthesis inhibition</td>
</tr>
<tr>
<td><em>Human fibroblasts</em></td>
<td>300 umol/L</td>
<td>Chromosomal aberrations</td>
</tr>
<tr>
<td><em>Human leucocytes</em></td>
<td>25 mg/L</td>
<td>Chromosomal aberrations</td>
</tr>
<tr>
<td><em>Mouse embryo cells</em></td>
<td>50 umol/L</td>
<td>Chromosomal aberrations</td>
</tr>
<tr>
<td><em>Hamster lung cells</em></td>
<td>5 mmol/L</td>
<td>Sister chromosome exchange</td>
</tr>
<tr>
<td><em>Hamster ovary cells</em></td>
<td>150 ug/L/16 hr</td>
<td>Mutation</td>
</tr>
<tr>
<td><em>Monkey kidney cells</em></td>
<td>25 ug/L</td>
<td>Chromosomal aberrations</td>
</tr>
<tr>
<td><em>Monkey kidney cells</em></td>
<td>50 ug/L</td>
<td>Induction of micronuclei</td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- Data not available

A2. Transformation -- Data not available

DAMD17-84-C-4133  32-5
HYDROXYL AMMONIUM NITRATE (cont.)

A2a. Biodegradation -- Data not available

A2b. Hydrolysis -- Hydroxlammonium nitrate was stable at pH 4.9 and below. The compound was found to be chemically unstable above a pH of about 5.9 (2).

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Reports in the literature indicate that hydroxylamine rapidly disappears from soils through a number of chemical reactions with inorganic and organic soil components (2).

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- Data not available

C. Effects on plants

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health -- Data not available

B. Environmental

Reported in EPA TSCA Inventory.
HYDROXYL AMMONIUM NITRATE (cont.)

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation or occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (6).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (7).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


DAMD17-84-C-4133 32-7
HYDROXYL AMMONIUM NITRATE (cont.)


SUMMARY OF PREVIOUS STUDY

The Army's need for research on the toxicological and environmental hazards of lead azide was reported in A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals by the Atlantic Research Corporation (ARC). Specific data on the toxicity or environmental effects of lead azide were not reported. It was concluded, however, that lead azide is toxic to man, based on the toxicities of both lead and the azide ions, hydrazoic acid. Toxicity to aquatic organisms was expected to be low due to the insolubility of lead azide in water. The report concluded that the compound will accumulate in sediments. Some information was provided on the phytotoxicity and effects on microorganisms of other insoluble lead compounds, which may be related to the environmental effects of lead azide. The report documented that before the Army disposes of lead azide, it is treated with either sodium hydroxide or sodium nitrite and acetic acid to eliminate the explosion hazard. Thus, little if any lead azide enters the environment (1).

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: PbN₆

Molecular Weight: 291.25

Structural Formula: Pb⁺² (N=N=N)₂⁻¹

B. Alternate Names and Registry Numbers

CAS Registry Number: 13424-46-9

CA Name (9CI): Lead Azide, Pb(N₃)₂

CA Name (8CI): Lead Azide, Pb(N3)2

RTECS Number: OF8670000

Other Significant Synonyms: Initiating explosive, lead azide

C. Chemical and Physical Properties

Physical state: Crystalline solid; alpha form is orthorombic, beta form is monoclinic. Beta form slowly converts to alpha form at 160°C (2).

Color: Colorless

Odor: Data not available
LEAD AZIDE (cont.)

Melting Point: 245-250°C - decomposes when heated slowly

Solubility: Insoluble in aqueous ammonia; 0.125 g in 100 mL of concentrated sodium nitrate at 18°C; 0.487 g/100mL at 80°C 1.542 g per 100 mL of concentrated sodium acetate; 2.020 g per 100 mL at 80°C (2).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: 90% Rh and 30°C

Density: 4.71 g/cc alpha form; 4.93 g/cc beta form (2).

Vapor Pressure: Data not available

Specific heat: 0.110 cal/g at -50 to 50°C; 0.100 cal/g at 100°C (1).

Heat of Combustion: 630 kcal/kg (3)

Reactivity: Violent reaction with brass, explosion hazard severe when shocked or exposed to heat or flame. Detonates at 350°C (4).

Stability: Decomposes slowly by ultraviolet light (1). Should always be handled under water. Explosions have occurred where azide compounds have reacted with Pb in plumbing after being washed down a sink (4).

Flammability: Data not available

II. USES

A. Army Unique Use

Initiating explosive in detonators, priming compositions, and commercial blasting caps.

B. Other Uses

Primary detonator for high explosives. Information storage on styrene-butadiene resins, preparation of electrophotographic layers.

III. ANALYTICAL METHODS

A. Best Acceptable Method

Forensic scientists are currently using X-ray photoelectron spectroscopic (XPS) detection for this compound in explosive residues (5). Differential pulse polarography is used for analysis for specifications (6), but not for trace analysis. Asplund (7) reported a voltammetric method of determination that can be used for both quality
LEAD AZIDE (cont.)

control and trace environmental samples. Trace analysis was reported for azide as the sodium azide. Boehm (8) reported a TLC (thin-layer chromatography) method.

B. Limit of Detection

Sharma reports ng/cc for XPS (5).

Asplund (7) reports 0.05 mg per cubic meter of air as the sodium azide.

IV. HEALTH EFFECTS

No information updating that in the ARC report was located.

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of lead azide which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 0.15 mg (Pb)/m^3; STEL 0.45 mg(Pb)/m^3 (9).

The Occupational Safety and Health Administration standard - airborne, 8-hour TWA is 50 ug(Pb)/m^3.

B. Environmental

Reported in the EPA TSCA Inventory 1983.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Data not available

B. Alternate Disposal Practices Under Consideration by the Army

A method for disposal of large quantities of lead azide by electrolytic decomposition has recently been developed and has been implemented at Savannah Army Depot. In this technique, lead azide is dissolved in the electrolyte NaOH; lead is plated out on the cathode and nitrogen is released at the anode (10).
LEAD AZIDE (cont.)

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


LEAD STYPHNATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{C}_6\text{H}_3\text{N}_3\text{O}_8 \cdot \text{Pb}$ (1)

Molecular Weight: Anhydrous 450.30; monohydrate 468.3 (1)

Structural formula: See Exhibits 34-1, 34-2 and 34-3.

B. Alternate Names and Registry Numbers

CAS Registry Number: 15245-44-0

Deleted CAS Registry Numbers: 59286-40-7; 4219-19-6

CA Name (9CI): 1,3-Benzenediol, 2,4,6-trinitro-, lead(2+) salt (1:1)

CA Name (8CI): Resorcinol, 2,4,6-trinitro-, lead (2+) salt (1:1)

RTECS Number: 0G6425000

Other significant synonyms: Initiating explosive lead styphnate, lead tricinate; lead trinitroresorcinate (2).

C. Chemical and Physical Properties

Physical State: Monoclinic crystals

Color: Orange-yellow

Odor: Data not available

Melting Point: Data not available

Boiling Point: Data not available

Solubilities: Data not available

- Water: Very slightly soluble in water (0.04% at room temperature)(1)
- Nonaqueous Solvents: Insoluble in ether, chloroform, CCl$_4$, HCl. Slightly soluble in 10% aqueous ammonia acetate. Decomposed by concentrated nitric or sulfuric acid (1).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available
LEAD STYPNATE (cont.)

EXHIBIT 34-1

Lead styphnate compound I: lead trinitroresorcinate

Lead styphnate compound II: Dibasic lead styphnate

Lead styphnate compound III: Monobasic lead styphnate
LEAD STYPHNAKE (cont.)

Volatile: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: 1251 kcal/kg (1)
Reactivity: Data not available
Stability: Very sensitive explosive. Shock-sensitive, has detonated when dry (1).
Flammability: Easily ignited by flame or electric spark (1).

II. USES
A. Army Unique Use
Primer initiating explosive (1)

B. Other Uses
A weak primary explosive, used in non-corrosive ignition cups such as Sinoxid. It is added to lead azide detonators to facilitate ignition and is used as a covering layer to protect lead azide against carbon dioxide (3). Used in primer blends for non-military ammunition (4).

III. ANALYTICAL METHODS
A. Best Acceptable Method
Voltammetry is now the method of choice for process control, and product control (5). Differential Pulse Polarography, a voltammetric method, is described by Semel (4). No methods for trace analysis were reported.

B. Limit of Detection
Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF LEAD STYPHATE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead styphate</td>
<td></td>
<td></td>
<td>No toxicity data located; data on chemical classes and structural analogues follow below</td>
<td>(6)</td>
</tr>
<tr>
<td>Lead</td>
<td>Human</td>
<td></td>
<td>General: Fallor, weakness, loss of weight, malnutrition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>inges-</td>
<td>Gastrointestinal: Metallic taste, increased salivation, pyorrhea, anorexia, nausea, vomiting, constipation, abdominal colic and tenderness, Burton's lead line on gums</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>tion</td>
<td>Genitourinary: Nocturia, albuminuria and hematuria, increased bilirubinuria, secondary hyperuricemia, azotemia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>inhal-</td>
<td>Neuromuscular: Numbness and tingling of extremities and associated sensory disturbance; extensor weakness of wrists and ankles, brachial palsy has also been described; loss of muscle tone, tremor, increased deep-tendon reflexes, muscular cramps and aching, arthralgia, muscular atrophy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ation</td>
<td>Central nervous system: Visual disturbances, headache, dizziness, nervousness or depression, insomnia, mental confusion and delirium, convulsions, coma; encephalopathy may be acute or chronic - acute usually associated with blood levels above 120 ug Pb; retinal hemorrhages and optic neuritis; gray stippling of lead pigment about the optic disc has also been reported</td>
<td></td>
</tr>
</tbody>
</table>
TABLE IV-1. TOXICITY OF LEAD STYPHNATE (Cont.)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>Human</td>
<td>Ingestion,</td>
<td>Hematopoietic: Erythrocyte stippling, hypochromic normocytic anemia, increased peripheral reticulocytes</td>
<td>(7)</td>
</tr>
<tr>
<td>(cont.)</td>
<td>(cont.)</td>
<td>Inhalation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Styphnic</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown (see following table for mutagenicity data)</td>
<td>(8)</td>
</tr>
<tr>
<td>acid</td>
<td>(2,4,6-Trinitroresorcinol)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>Human</td>
<td>Oral</td>
<td>Large amounts produce dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, and collapse; small repeated doses may lead to weakness, general depression, headache, and mental impairment</td>
<td>(8)</td>
</tr>
<tr>
<td>(As analogue for Styphnic acid)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picric</td>
<td>Human</td>
<td>Topical</td>
<td>Local or generalized allergic reactions</td>
<td>(9)</td>
</tr>
<tr>
<td>acid</td>
<td>(2,4,6-Trinitrophenol)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(As analogue for Styphnic acid)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Various</td>
<td>Oral, Animal</td>
<td>Absorption</td>
<td>High acute toxicity</td>
<td>(10)</td>
</tr>
<tr>
<td>species sc</td>
<td>skin,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(8)</td>
</tr>
</tbody>
</table>
LEAD STYPHNATE (cont.)

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF STYPHNIC ACID

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium TA98, TA100, TA1535, TA1537 TA1536</td>
<td>NS*</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver fraction or treatment with ozone or chlorine</td>
<td>(11)</td>
</tr>
<tr>
<td>Salmonella typhimurium TA98, TA100, TA1535, TA1537 TA1538</td>
<td>up to 25 mmol/plate</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(12)</td>
</tr>
<tr>
<td>Saccharomyces cerevisiae D3</td>
<td>NS</td>
<td>Did not produce mitotic inhibition with or without Aroclor 1254-induced rat liver fraction or treatment with ozone or chlorine</td>
<td>(11)</td>
</tr>
</tbody>
</table>

* No mutagenicity data located on lead styphnate
* Not specified

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport — Data not available
A1a. Adsorption — Data not available
A1b. Volatilization — Data not available
A1c. Leachability — Data not available
A1d. Bioaccumulation — Data not available
A2. Transformation — Data not available
A2a. Biodegradation — Data not available
A2b. Hydrolysis — Data not available
A2c. Photolysis — Data not available
A2d. Other chemical reaction — Data not available
A2e. Half-life — Data not available
LEAD STYPHNATE (cont.)

B. Effects on animals
B1. Avian species — Data not available
B2. Mammalian wildlife species — Data not available
B3. Terrestrial invertebrates — Data not available
B4. Reptiles — Data not available
B5. Amphibians — Data not available
B6. Microorganisms, aquatic and soil — Concentration of 2,4,6-trinitroresorcinol (styphnic acid) at which inhibition of cell multiplication starts: Bacteria (Pseudomonas putida); 100 mg/L Algae (Microcystis aeruginosa): 0.32 mg/L (12).
B7. Aquatic species, fish and invertebrates — A survey of literature from July, 1974 to the present revealed no data concerning the toxicity of lead styphnate or styphnic acid (trinitroresorcinol) to aquatic organisms (14). The effects of 2,4,6-trinitroresorcinol on fish are LC₅₀, 96 hours; 2.58 mg/L EC₅₀, 96 hours; 0.46 mg/L, behavioral response (12).

C. Effects on Plants
C1. Phytotoxicity — Data not available
C2. Uptake — Data not available
C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS
A. Health
Recommended air standard: TWA 0.10 mg(Pb)/m³.

B. Environmental
Reported in EPA TSCA Inventory 1983.
LEAD STYPHNATE (cont.)

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (15).

B. Alternate Disposal Practices Under consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (16).

C. Other Disposal Practices Employed

Destruction of lead styphnate by chemical decomposition: dissolve in at least 40 times its weight of 20% NaOH solution (or in 100 times its weight of 0% ammonium acetate solution) and add sodium dichromate equal to half the weight of lead styphnate, dissolved in 10 parts of tap water (1).

VIII. REFERENCES

LEAD STYPHNAE (cont.)


LEAD THIOCYANATE

Much of the available data on lead thiocyanate has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: PbC₂N₂S₂ (1)

Molecular Weight: 323.38 (1)

Structural Formula: \( \text{N} \overline{\text{C}} - \text{S} \ldots \text{Pb} \ldots \text{S} - \text{C} \equiv \text{N} \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 592-87-0

Deleted CAS Registry Number: 10382-36-2

CA Name (9CI): Thiocyanic acid, lead (2+) salt

CA Name (8CI): Same

RTECS Number: Not available on RTECS

Other Significant Synonyms: Lead sulfocyanate (1)

C. Chemical and Physical Properties

Physical State: Powder (1)

Color: White (1)

Odor: Odorless (1)

Melting Point: 190°C decomposes (2)

Solubilities:
- Water: in about 200 parts cold; in about 50 parts boiling with decomposition; soluble in alkali hydroxide, nitric acid, and thiocyanate solutions (1).
- Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: N/A

Hygroscopicity: Data not available

Density (Crystal): 3.82 g/cc (1)
LEAD THIOCYANATE (cont.)

Volutility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available

Reactivity: Interaction with calcium and magnesium (2). May react with aqueous chlorine to form the highly toxic compound cyanogen chloride (3).

Stability: Data not available
Flammability: Slight, flammable when exposed to heat or flame (2).

II. USES
A. Army Unique Use
   Fuel used in detonators, primers and igniters (3).
B. Other Uses
   Reverse dyeing with aniline black; manufacture of safety matches and cartridges (1).

III. ANALYTICAL METHODS
A. Best Acceptable Method
   This compound must be analyzed by determination of the component parts. Lead can be determined by atomic absorption, polarography or colorimetrically as stated in the ARC report (3). For thiocyanate, colorimetric, atomic absorption, and high performance liquid chromatography have been reported. All three methods rely on the formation of a dithiocyanatodipyridyl copper (II) complex, which is detected by each method (4).
B. Limit of Detection
   Ingersoll et al. (4) reported 100 ppb.

IV. HEALTH EFFECTS
   No data updating the ARC report was found.
LEAD THIOCYANATE (cont.)

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of lead thiocyanate which would update the Atlantic Research Corporation document. The environmental effects of the compound are chiefly related to the effects of lead, which is highly toxic and bioconcentrative. Toxic combustion products of thiocyanate include cyanide and sulfur oxides.

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 0.15 mg/m³ as lead; STEL 0.45 mg/m³ as lead (5).

B. Environmental

Reported in EPA TSCA Inventory 1983.

Lead thiocyanate has a statutory reportable quantity (RQ) of 5000 lbs under the Comprehensive Environmental Response, Compensation, and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (6).

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (7).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (8).

C. Other Disposal Practices Employed

Convert to nitrates with a minimum of nitric acid (concentrated). Evaporate in a fume hood to a thin paste. Add about 500 mL water and saturate with hydrogen sulfide filter wash and dry the precipitate. Package and ship to the supplier (9).
VIII. REFERENCES


MAGNESIUM THORIUM ALLOY

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{Mg}_2\text{Th} \)

Molecular Weight: Data not available

Structural Formula: \( \text{Mg}----\text{Th}----\text{Mg} \)

B. Alternate Names and Registry Numbers

CAS Registry Number: 12438-53-8

CA Name (9CI): Magnesium, compound with thorium (2:1); thorium, compound with magnesium (1:2)

CA Name (8CI): Same

RTECS Number: Not available in RTECS

Other Significant Synonyms: None

C. Chemical and Physical Properties

Physical State: Data not available

Color: Data not available

Odor: Data not available

Melting Point: Data not available

Solubilities:
- Water: Data not available
- Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): Data not available

Volatility: Data not available

Vapor Pressure: Data not available
MAGNESIUM THORIUM ALLOY (cont.)

Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Data not available

II. USES

A. Army Unique Use
Casing for electronic weapons systems

B. Other Uses
Data not available

III. ANALYTICAL METHODS

A. Best Acceptable Method
No analytical methods were found for this compound in a search of the chemical literature from 1967 to the present.

B. Limit of Detection
Data not available
IV. HEALTH EFFECTS

Data on Magnesium thorium alloy was not found. Toxicity of separate parts of the alloy, used as analogues, appears below.

**TABLE IV-1. TOXICITY OF MAGNESIUM THORIUM ALLOY**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium (metal or alloy)</td>
<td>Human</td>
<td>Skin</td>
<td>Partic-perfo-ration form</td>
<td>May produce a severe local lesion characterized by the evolution of gas and acute inflammatory reaction, frequently with necrosis; may cause lymphangitis that is very slow to heal</td>
<td>(1)</td>
</tr>
<tr>
<td>Magnesium salts</td>
<td>Human</td>
<td>Intra-venous</td>
<td>Plasma Mg conc. above 2 mmol/L</td>
<td>Symptoms of hypermagnesemia which may occur include flushing of the skin, thirst, hypotension due to vasodilation, drowsiness, loss of tendon reflexes due to neuromuscular blockade, weakness, respiratory depression, cardiac arrhythmias, coma, and cardiac arrest</td>
<td>(2)</td>
</tr>
<tr>
<td>Thorium</td>
<td>Human</td>
<td>NS*</td>
<td>Acute</td>
<td>Has caused dermatitis</td>
<td>(3)</td>
</tr>
<tr>
<td>Thorium and thorium compounds</td>
<td>Human</td>
<td>occup. exposure</td>
<td>30 yrs; conc. in excess of current standards</td>
<td>No reported toxic effects</td>
<td>(4)</td>
</tr>
<tr>
<td>Colloidal thorium dioxide (Thorotrast)</td>
<td>Human, animal</td>
<td>Injection NS*</td>
<td>Tumors at various sites attributed to radioactivity</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Thorium compounds</td>
<td>Animal</td>
<td>Various</td>
<td>Acute routes</td>
<td>Low toxicity</td>
<td>(4)</td>
</tr>
<tr>
<td>DAMD17-84-C-4133</td>
<td></td>
<td></td>
<td>36-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE IV-1. TOXICITY OF MAGNESIUM THORIUM ALLOY (Cont.)

<table>
<thead>
<tr>
<th>Chemical Species Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorium compounds (cont.) Dog Inhalation</td>
<td>26-76 mg/m³ for 2-10 wk; mean particle diameter 1 um</td>
<td>Only toxic effect: abnormal leucocytes</td>
<td>(4)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of the alloy of magnesium and thorium.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Data not available

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

DAMD17-84-C-4133 36-4
VIII. REFERENCES


Much of the available data on Mirex has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_{10}Cl_{12}$
Molecular Weight: 545.59 (1)

B. Alternate Names and Registry Numbers

CAS Registry Number: 2385-85-5
Alternate CAS Registry Number: 6842-16-6
Deleted CAS Registry Numbers: 20594-49-4; 56449-78-6; 12357-88-9; 12707-43-6; 12766-04-0

CA Name (9CI): 1,3,4-Metheno-1H-cyclobuta[cj]pentalene, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachloro-octahydro-

CA Name (8CI): Same

RTECS Number: PC8225000

Other Significant Synonyms: Dechlorane (1), perchloropentacyclodecane, perchlorodihomocubane, hexachlorocyclopentadiene dimer

C. Chemical and Physical Properties

Physical State: Crystal (1)
Color: Snow-white (1)
MIREX (cont.)

Odor: Odorless (1)

Melting Point: Decomposes at $485^\circ$C (1)

Solubilities:
Water: Practically insoluble
Nonaqueous Solvents: Dioxane 15.3% (room temp.), xylene 14.3% (room temp.), benzene 12.2% (room temp.), carbon tetrachloride 7.2% (room temp.), methyl ethyl ketone 5.6% (room temp.) (1).

Octanol Water Partition Coefficient: $\log P = 6.89$ (2)

Hygroscopicity: Data not available

Density (Crystal): Data not available

Vapour Pressure: $6 \times 10^{-6}$ mm Hg at $25^\circ$C (3)

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Reacts with strong oxidizers such as dichromates and chlorine (3).

Stability: Breaks down above $485^\circ$C and in sunlight (3).

Flammability: Non-flammable; used as a fire retardant (1).

II. USES

A. Army Unique Use

Fire retardant in tracer ammunitions.

B. Other Uses

Insecticide, fire retardant for plastics, rubber, paint, paper, electrical goods (1).
III. ANALYTICAL METHODS

A. Acceptable Methods

Gas chromatography (GC) is a well-established technique for analysis of Mirex. Electrolytic conductivity detector is especially well-suited for this poly-chlorinated compound (4). Recent work has resulted in development of a new electrochemical detector for GC that uses a pyrolysis furnace to decompose halogenated compounds with analysis via a potentiometric chloride electrode (5). Driscoll et al. claimed a 1-2 orders of magnitude increase in sensitivity to polychlorinated compounds such as Mirex.

Bush et al. (6) have developed a high performance liquid chromatography method using Ultra Violet (UV) photolysis with electric conductance to measure common pollutants including Mirex at sensitivity of less than 10 nanograms.

Methane chemical ionization (CI) selected ion monitoring (SIM) mass spectrometry is the most sensitive method reported. Hergesheimer reported ppt (parts per trillion) sensitivity for polychlorinated compounds in complex matrices including Mirex (7).

B. Limit of Detection

World Health Organization WHO (4) reported 0.2 pg general and 0.001 micrograms/liter for gas chromatography with electrolytic conductivity detector. Driscoll et al. reported a 1-2 order of magnitude increase over the ECD detector (5).

Bush et al. reported <10 ng for HPLC (6).

Hergesheimer reported parts per trillion for CI-SIM mass spectroscopy (7).
IV.  HEALTH EFFECTS

TABLE IV-1.  TOXICITY OF MIREX*

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>50-500 mg/kg</td>
<td>Estimated lethal dose</td>
<td>(8)</td>
</tr>
<tr>
<td>NS**</td>
<td>dermal</td>
<td>NS</td>
<td>Moderate skin irritant</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>235-3,000 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(10)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>50 mg/kg single dose; observed for 28 days</td>
<td>Liver hypertrophy</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1.0 mg/kg (corn oil) for 14 days</td>
<td>Liver hypertrophy; induction of mixed-function oxidase enzymes</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>5 or 30 ppm in diet for up to 36 mo</td>
<td>No effects on liver weight; proliferation of smooth endoplasmic reticulum after 12 mo</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>50 or 100 ppm in diet for 18 mo; observed until 24 mo</td>
<td>Increased incidence of neoplastic nodules in high-dose male rats; of 17 rats from all groups, 6 animals including 4 high-dose males had liver-cell carcinomas; no metastases were observed</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>NS</td>
<td>Acute</td>
<td>Muscle tremors, diarrhea, and depression followed by death</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>intraperitoneal</td>
<td>365 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(11)</td>
</tr>
<tr>
<td>Rat</td>
<td>dermal</td>
<td>2,000 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>(11)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
** Not specified
<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects (cont.)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>1-90 ppm in diet for up to 70 wk</td>
<td>Increased liver weights at 5 ppm and higher; increased mixed-function oxidase activity, total liver DNA and protein, and mitochondrial respiration at 1 ppm after 70 wk</td>
<td>(12)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>1-30 ppm in diet for up to 18 mo-</td>
<td>Increased liver weights at 1 ppm in females, at 5 ppm and higher in males; histological changes at 5 ppm and higher; proliferation of smooth endoplasmic reticulum observed ultrastructurally at 1 ppm and above</td>
<td>(12)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>dermal</td>
<td>3.33 or 6.7 g mirex bait/kg, 6-7 hr/d, 5 d/wk for 9 wk</td>
<td>No compound-related gross or histopathological changes</td>
<td>(13)</td>
</tr>
<tr>
<td>Dog (male)</td>
<td>oral</td>
<td>1,000 mg/kg (corn oil)</td>
<td>LD$_{50}$</td>
<td>(13)</td>
</tr>
<tr>
<td>Dog</td>
<td>oral</td>
<td>100 ppm in diet for 13 wk</td>
<td>Liver enlargement</td>
<td>(13)</td>
</tr>
<tr>
<td>Monkey</td>
<td>oral</td>
<td>0.25 or 1.0 mg/kg, 6d/wk for up to 26 mo</td>
<td>No effect on liver weights, liver histology, or liver ultrastructure</td>
<td>(14)</td>
</tr>
<tr>
<td>Hamster</td>
<td>oral</td>
<td>125-250 mg/kg</td>
<td>LD$_{50}$</td>
<td>(13)</td>
</tr>
<tr>
<td>Duck</td>
<td>oral</td>
<td>2,400 mg/kg</td>
<td>LD$_{50}$</td>
<td>(10)</td>
</tr>
<tr>
<td>Bird</td>
<td>inhalation 1,400 ppm</td>
<td></td>
<td>LC$_{50}$</td>
<td>- (10)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
** Not specified
TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF MIREX

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat (Wistar)</td>
<td>1.5-6 mg/kg/day</td>
<td>Negative</td>
<td>(15)</td>
</tr>
<tr>
<td>dominant lethal</td>
<td>by gavage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>assay</td>
<td>for 10 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'Standard Ames'</td>
<td>NS*</td>
<td>Negative; test included</td>
<td>(14)</td>
</tr>
<tr>
<td>bacterial assay</td>
<td>liver microsomal activation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

This substance has been listed as a carcinogen in the Second Annual Report on Carcinogens (16).

Mirex is covered in the "Preliminary Problem Definition Study on Munitions-Related Chemicals" (1). The ARC report states that Mirex has been used as a pesticide and flame retardant for plastics. The Army's principal current use is in tracer mixes. The material is persistent and mobile in the environment. Its high bioconcentration and biomagnification is noted in the literature. Mirex has been shown to be teratogenic and may also be carcinogenic. Based on the extensive environmental and toxicological studies, use of Mirex has been restricted by the US EPA and the chemical is no longer manufactured in the USA. The small amount used by the military as a tracer is imported.

Mirex is one of the most environmentally stable of the organochlorine insecticides. It degrades slowly and its breakdown products are as toxic and stable as Mirex itself. Mirex bioaccumulates at all trophic levels and biomagnifies in the food chains. Biomagnification in the food chain is enhanced by the delayed mortality typical of Mirex poisoning. Chronic toxicity is a better indicator of the true toxicity of Mirex and is uniformly high (17).

This report is an update; only information since 1978 is discussed below.

A. Environmental Fate

Al. Transport — Data not available

Ala. Adsorption — Data not available
MIREX (cont.)

Alb. Volatilization — Mirex has a very low vapor pressure under normal conditions. The World Health Organization reports that they assume that release of dust is the principal cause of observed airborne Mirex transport (18).

Alc. Leachability — Mirex has a very low water solubility. If concentrations exceed 1 µg/l, Mirex would be found in suspended particulate matter. Mirex applied to land has been found to be transported to adjacent water bodies (18).

Ald. Bioaccumulation — BCF: algae = 12,200; snails = 4,900; daphnids = 14,650; fish = 2,580; crayfish = 16,860–71,400 (20). as determined with fathead minnow (Pimephales promelas) in 32-day exposures: 18,100 (2).

A2. Transformation — Data not available

A2a. Biodegradation — Mirex is highly resistant to microbial degradation and thus can persist in soil for long periods. However, it has been reported that in sewage sludge under anaerobic conditions in the dark, about 80% of mirex was degraded into unknown metabolites (19).

A2b. Hydrolysis — Aquatic reactions: Exposure to sunlight and UV light have indicated slow degradation; resulting compounds included chlordecone hydrate, undecachloropentacyclodecane, and monochloropentacyclodecane–5-one hydrate (20).

A2c. Photolysis — Mirex undergoes photolytic dechlorination to photomirex (8-monoiodohxymirex) and lesser amounts of 5,8-dihydromirex when exposed to sunlight in organic solvent and in duck eggs. Studies examining aged Mirex residues recovered from soil showed fairly large concentrations of photomirex (21).

A2d. Other chemical reaction — Data not available

A2e. Half-life — The environmental half-life of Mirex can be many years (22).

B. Effects on Animals

B1. Avian species — Available data indicate low Mirex toxicity to birds (23).

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — Data not available
MIREX (cont.)

B7. Aquatic species fish and invertebrates — Mirex degradation products were found to be highly toxic for fresh and saltwater bacterial cultures and may be more soluble in water than Mirex itself. Exposure of phytoplankton and algae to Mirex result in reduced productivity and growth rate. Mirex is highly toxic for crustacea. Effects of Mirex on fish are variable (24).

C. Effects on Plants
C1. Phytotoxicity — What little work has been done on Mirex effects on terrestrial plants has shown reduction in germination and emergence of grass seeds.

C2. Uptake — Available data indicate uptake accumulation and translocation of Mirex in plants (23).

C3. Metabolism — Available data indicate no metabolic transformation (23).

VI. STANDARDS AND REGULATIONS
A. Health
Mirex meets criteria for proposed OSHA Medical Records Rule (25) and is included in the Michigan Critical Materials Register.

B. Environmental
Data updating ARC report not available

VII. DISPOSAL
A. Current Recommended Army Disposal Practices
Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for DDT, a pesticide of related structure, is to dilute or dissolve in a flammable substance, followed by burning in an incinerator equipped with an afterburner and an effluent scrubber. Incineration should be conducted at temperatures exceeding 1000°C with a minimum of 2 seconds swell time in the combustion zone. Scrubber overflow is to be neutralized prior to discharge. Incinerator ash should be buried in a hazardous or sanitary landfill (26).

While Mirex is known to be resistant to pyrolysis even at temperatures as high as 950°C, it is believed that incineration using the procedure above would destroy most Mirex feed.

B. Alternate Disposal Practices Under Consideration by the Army
Data updating ARC report not available

DAHD17-84-C-4133 37-8
C. Other Disposal Practices Employed

Data updating ARC report not available

VIII. REFERENCES


MIREX (cont.)

17. World Health Organization (WHO), p. 49.
24. World Health Organization (WHO), p. 34.
25. Federal Register, Vol. 47, No. 82, p. 30420.
N-NITROSODIPHENYLAMINE

Much of the available data on N-Nitrosodiphenylamine has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_{12}\text{H}_{10}\text{N}_2\text{O} \)
Molecular Weight: 198.22 (estimated)

Structural Formula:

\[ \text{N} \begin{array}{c} \quad \text{N} \end{array} \]

B. Alternate Names and Registry Numbers

CAS Registry Number: 86-30-6
CA Name (9CI): Benzenamine, N-nitroso-N-phenyl
CA Name (8CI): Diphenylamine, N-nitroso
RTECS Number: JJ9800000

Other Significant Synonyms: Retarder J, N-Nitroso-N-phenylaniline, Diphenylnitrosamine, N,N-Diphenylnitrosamine, N,N-Diphenyl-N-nitrosoamine

C. Chemical and Physical Properties

Physical State: Solid (1)
Color: Yellow to brown or orange powder or flakes (1)
Odor: Mildly amine (1)
Melting Point: 64-66°C (1)
N-NITROSODIPHENYLAMINE (cont.)

Solubilities:
Water: Practically insoluble (1)
Nonaqueous Solvents: Soluble in acetone, benzene, alcohol, and ethylene dichloride. Somewhat soluble in gasoline (1).

Octanol Water Partition Coefficient: Log P = 3.96 (2)

Hygroscopicity: Data not available

Density (Crystal): 1.23 g/cc (1)

Vapility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Comparable to benzene (1)

Stability: Data not available

Flammability: Data not available

II. USES
A. Army Unique Use
   A degradation product of diphenylamine, a propellant (1).

B. Other Uses
   Vulcanization retardant in the treatment of rubber. Currently being phased out of industry (1).

III. ANALYTICAL METHODS
A. Best Acceptable Method

The Environmental Protection Agency published an official method, number 607, for detection of nitrosamines in water. The method calls for an initial extraction, separation on an alumina column and injection into a gas chromatograph equipped with a nitrogen-phosphorus detector.
Difficulty has been reported in separating diphenylamine from N-nitrosodiphenylamine in Method 607 (3). One of the most recent reported methods is a tandem mass spectrometry method by Hunt et al. that eliminated all preparatory steps including chromatography (4).

B. Limit of Detection

EPA Method 607 has been reported to 8.22 ug/l (3). Hunt et al. reported a limit of 10 ppb for their mass spectrometry method (4).
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF N-NITROSODIPHENYLAMINE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>0, 1,000, or 4,000 ppm in feed for 100 wk</td>
<td>Significantly lower survival in high-dose females; significantly increased incidences of transitional-cell carcinomas of the urinary bladder in high-dose groups; males: controls 0/19, low-dose 0/46, high-dose 16/45; females: controls 0/18, low-dose 0/48, high-dose 40/49</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1,650 mg/kg</td>
<td>LD₅₀</td>
<td>(6)</td>
</tr>
<tr>
<td>Mouse (B₆C₃F₁)</td>
<td>oral</td>
<td>Males: 0, 10,000 or 20,000 ppm in feed for 101 wk; Females: 0, 2,315, or 5,741 ppm (time-weighted average) in feed for 98 wk</td>
<td>Chronic inflammatory lesions of the urinary bladder; no significant increases in tumor incidences compared with controls</td>
<td>(5)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>3,850 mg/kg</td>
<td>LD₅₀</td>
<td>(6)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>eye</td>
<td>500 mg/24 hr</td>
<td>Severe irritation</td>
<td>(6)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
TABLE IV-2. MUTAGENICITY OF N-NITROSODIPHENYLAMINE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>50 ug/plate</td>
<td>Mutagenic with microsomes</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat embryo cells</td>
<td>1,500 ug/L</td>
<td>Oncogenic transformation</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat liver</td>
<td>300 umol/L</td>
<td>DNA Damage</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat liver</td>
<td>500 nmol/L</td>
<td>Unscheduled DNA synthesis</td>
<td>(6)</td>
</tr>
<tr>
<td>Hamster embryo cells</td>
<td>5,300 ug/L</td>
<td>Oncogenic transformation</td>
<td>(6)</td>
</tr>
<tr>
<td>Hamster kidney cells</td>
<td>97 mg/L</td>
<td>Oncogenic transformation</td>
<td>(6)</td>
</tr>
<tr>
<td>Hamster fibroblasts</td>
<td>100 umol/L</td>
<td>Sister chromatid exchange</td>
<td>(6)</td>
</tr>
<tr>
<td>Various assays in pro-</td>
<td></td>
<td>Negative results</td>
<td>(7)</td>
</tr>
<tr>
<td>karyotes and eukaryotes</td>
<td></td>
<td>for mutagenicity and other chromosomal effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport — Data not available

A1a. Adsorption — Data not available

A1b. Volatilization — Data not available

A1c. Leachability — Data not available

A1d. Bioaccumulation — Log BCF = 2.34, bioconcentration in bluegill sunfish (Lepomis macrochirus), 14-day exposure (8).

A2. Transformation — Data not available

A2a. Biodegradation — N-Nitrosodiphenylamine was shown to biodegrade easily. Acclimitization to 5 mg/L in culture media was rapid; acclimitization to 10 mg/L, gradual. Biodegradation in tests ranged from 87% to 100% at 5 mg/L and from 47% to 98% at 10 mg/L dosage (9).

A2b. Hydrolysis — Data not available
N-NITROSODIPHENYLAMINE (cont.)

A2c. Photolysis -- Data not available
A2d. Other chemical reaction -- Data not available
A2e. Half-life -- Data not available

B. Effects on animals
B1. Avian species -- Data not available
B2. Mammalian wildlife species -- Data not available
B3. Terrestrial invertebrates -- Data not available
B4. Reptiles -- Data not available
B5. Amphibians -- Data not available
B6. Microorganisms, aquatic and soil -- N-nitrosodiphenylamine was found to be inactive in bacterial DNA repair and reversion tests and yeast mitotic recombination assays made to assess the qualitative nature of the compound's genotoxic potential (10).
B7. Aquatic species (fish and invertebrates) -- Data not available

C. Effects on plants
C1. Phytotoxicity -- Data not available
C2. Uptake -- Data not available
C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health
Data not available

B. Environmental

Reported in EPA TSCA Inventory 1983.

N-Nitrosodiphenylamine has a statutory reportable quantity (RQ) of 1 lb. under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (11).
VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or, occasionally, hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) which has the responsibility to review current disposal practices and to develop plans for future disposal practices (12).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRAECOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (13).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


N-NITROSODIPHENYLAMINE (cont.)


1-NITRO-2-PROANOL

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{C}_3\text{H}_7\text{NO}_3$
Molecular Weight: 105.09 (Estimated)

Structural Formula:

$\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{O} \\
\end{array}$

B. Alternate Names and Registry Numbers

CAS Registry Number: 3156-73-8
CA Name (BCI): 2-Propanol, 1-nitro
CA Name (BCI): Same
RTECS Number: Data not available
Other Significant Synonyms: NPL (1)

C. Chemical and Physical Properties

Physical State: Data not available
Color: Data not available
Odor: Data not available
Melting Point: Data not available

Solubilities:
- Water: Data not available
- Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Data not available
Hygroscopicity: Data not available
Density (Crystal): Data not available
I-NITRO-2-PROpanol (cont.)

Volutility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Flash point = 93°C; autoignition temperature = 420°C (1).

II. USES
A. Army Unique Use
   Explosive
B. Other Uses
   Data not available

III. ANALYTICAL METHODS
A. Best Acceptable Method
   No analytical methods were found in a computerized search of Chemical Abstracts dating back to 1967. Gas chromatography is the most promising technique for development of new methods.
B. Limit of Detection
   Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF 1-NITRO-2-PROPANOL

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Nitro-2-propanol</td>
<td></td>
<td></td>
<td>No toxicity data located; data on analogues appear below.</td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>Human</td>
<td>oral</td>
<td>Large amounts produce dizziness, abdominal cramps, vomiting,</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>bloody diarrhea, weakness, convulsions, and collapse; small repeated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>doses may lead to weakness, headache, and mental depression</td>
<td></td>
</tr>
<tr>
<td>2-Nitroethanol</td>
<td>Mouse</td>
<td>intra-</td>
<td>LD$_{50}$: 2,000 mg/kg</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>peritoneal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Nitro-1,3-propanediol</td>
<td>Mouse</td>
<td>intra-</td>
<td>LD$_{50}$: 765 mg/kg</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>peritoneal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,2-Dinitro-1-propanol</td>
<td>Mouse</td>
<td>intra-</td>
<td>LD$_{50}$: 280 mg/kg</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>peritoneal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopropyl nitrate</td>
<td>Mouse</td>
<td>inhalation</td>
<td>LC$_{50}$: 65 g/m$^3$/ 2hr</td>
<td>(3)</td>
</tr>
<tr>
<td>n-Propyl nitrate</td>
<td>Rabbit</td>
<td>intravenous</td>
<td>LD$_{50}$: 200 mg/kg</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td>intravenous</td>
<td>LD$_{50}$: 200 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td>intravenous</td>
<td>LD$_{50}$: 100 mg/kg</td>
<td>(4)</td>
</tr>
</tbody>
</table>
V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of 1-nitro-2-propanol.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or, occasionally, hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (5).

B. Alternate Disposal Practices Under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (6).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


DAMD17-84-C-4133 39-4


2-NITRODIPHENYLAMINE

Much of the available data on nitrodiphenylamine has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_{12}\text{H}_{8}\text{N}_{2}\text{O}_{2} \)

Molecular Weight: 214.24

Structural Formula:

\[
\begin{array}{c}
\text{N} \\
\text{H} \\
\text{NO}_2
\end{array}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 119-75-5

CA Name (9CI): Benzenamine, 2-nitro-N-phenyl

CA Name (8CI): Diphenylamine, 2-nitro

RTECS Number: Not available on RTECS

Other Significant Synonyms: o-Nitro-N-phenylaniline, o-Nitrodiphenylamine, 2-Nitro-N-phenyl benzenamine

C. Chemical and Physical Properties

Physical State: Crystalline powder (1)

Color: Red-brown (1)
2-NITRODIPHENYLAMINE (cont.)

Odor: Data not available

Boiling Point: 224°C (2)

Melting Point: 75-76°C (1)

Solubilities:
  Water: Data not available
  Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Log P = 4.60 (estimated)

Hygroscopicity: Data not available

Density (Crystal): Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Reactivity: Combustible

Heat of Combustion: Data not available

Reactivity: Data not available

Stability: Data not available

Flammability: Slight (2)

II. USES

A. Army Unique Use

Data not available

B. Other Uses

Stabilizer for nitroglycerin, chemical intermediate.
III. ANALYTICAL METHODS

A. Best Acceptable Method

Bender reported qualitative and quantitative determinations of 2-nitrodiphenylamine and other components of smokeless powders by high performance liquid chromatography with ultraviolet or thermal energy analyzer detectors.

Thin-layer chromatography and high performance thin-layer chromatography with liquid chromatography, have been reported by Ammann et al. to analyze the stabilizers in double-base propellants including 2-nitrodiphenylamine.

B. Limit of Detection

Reactive and oxidative electrochemical detection with liquid chromatography is applied to the determination of explosives—e.g. nitroglycerin, 2,4-dinitrotoluene and diphenylamine in military explosives and single- and double-base smokeless gunpowders (3).
IV. HEALTH EFFECTS

TABLE IV-1. MUTAGENICITY AND RELATED EFFECTS OF 2-NITRODIPHENYLAMINE*

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli W3110/polA+</td>
<td>100 ug</td>
<td>Not active with or without Aroclor</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>10 mg</td>
<td>1254-induced rat liver S9</td>
<td></td>
</tr>
<tr>
<td>p3478/polA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. typhimurium</td>
<td>NS**</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(4)</td>
</tr>
<tr>
<td>TA100, TA1535,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA1537, TA1538</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. cerevisiae D5</td>
<td>NS</td>
<td>Did not produce mitotic recombination</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with or without Aroclor 1254-induced rat liver S9</td>
<td></td>
</tr>
</tbody>
</table>

* Information not included in the ARC report
** Not specified

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available
A1a. Adsorption -- Data not available
A1b. Volatilization -- Data not available
A1c. Leachability -- Data not available
A1d. Bioaccumulation -- Data not available
A2. Transformation -- Data not available
A2a. Biodegradation -- Data not available
A2b. Hydrolysis -- Data not available
A2c. Photolysis -- Data not available
A2d. Other chemical reaction -- Data not available
A2e. Half-life -- Data not available

B. Effects on animals

DAMD17-84-C-4133  40-4
2-NITRODIPHENYLAMINE (cont.)

B1. Avian species — Data not available
B2. Mammalian wildlife species — Data not available
B3. Terrestrial invertebrates — Data not available
B4. Reptiles — Data not available
B5. Amphibians — Data not available
B6. Microorganisms, aquatic and soil — 2-Nitrodiphenylamine was found to be inactive in bacterial DNA repair and reversion tests and yeast mitotic recombination assays made to assess the qualitative nature of the compound's genotoxic potential (4).
B7. Aquatic species fish and invertebrates — Data not available

C. Effects on plants
C1. Phytotoxicity — Data not available
C2. Uptake — Data not available
C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS
A. Health
   Data not available
B. Environmental
   Data not available

VII. DISPOSAL
A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHANA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (5).
B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (6).

C. Other Disposal Practices Employed

For 4-nitrodiphenylamine, the following disposal method is given:
Dissolve or mix the material with a combustible solvent and burn in an incinerator equipped with an afterburner and scrubber (7). Also, Eastman Kodak Company recommends disposal in an approved incinerator equipped with an afterburner and a scrubber (8).

VIII. REFERENCES


CCTAC0%LOR

-4iRBANILE

CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_{13}H_4Cl_8N_2O \)

Molecular Weight: 487.8 (estimated)

Structural Formula:

B. Alternate Names and Registry Numbers

CAS Registry Number: 2899-02-7

Ca Name (9CI): Urea, \( N,N' \)-dichloro-\( N,N' \)-bis (2,4,6-trichlorophenyl)-

CA Name (8CI): Carbanilide, \((N,N',2,2',4,4',6,6') \) octachlor

RTECS Number: Not in RTECS

Other Significant Synonyms: CO2, Sym-dichlor-bis (2,4,6-trichlorophenyl) urea

C. Chemical and Physical Properties

Physical State: Solid (1)

Color: White, turns pink to red with decomposition (1)

Odor: Chlorine (1)

Melting Point: Decomposes on heating above 150\( ^\circ \)C (1)
OCTACHLOR CARBANILIDE (cont.)

Solubilities:
Water: Insoluble (1)
Nonaqueous Solvents: Not ethanol; glacial acetic acid (1)

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Not hygroscopic

Density (Crystal): Data not available

Volvility: Data not available

Vapor Pressure: 2mm Hg (1)

Specific Heat: 43 kcal/mole (1)

Heat of Combustion: Data not available

Reactivity: Explosive with compounds that react with chlorine (1).
Octachlor carbanilide reacts explosively with dimethylsulfoxide (DMSO) (2).

Stability: Unstable; decomposes photochemically and in the presence of oxygen. Must be kept in dark and under vacuum (1).

Flammability: Data not available

II. USES

A. Army Unique Use
Chlorinating Agent (1); ingredient in anti-chemical agent impregnation mixture, often used to impregnate clothing.

B. Other Uses
Potential use as fire retardant, bactericide, and anti-vesicant (3).

III. ANALYTICAL METHODS

A. Best Acceptable Method
No methods of analysis were found in a search of Chemical Abstracts from 1967 through the present.

B. Limit of Detection
Data not available

DAMD17-84-C-4133 41-2
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF OCTACHLOR CARBANILIDE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octachlor carbanilide (N,N',2,2',4,4',6,6'-Octachlorocarbanilide)</td>
<td>Rat</td>
<td>oral</td>
<td>No toxicity data located; data on structural analogues and chemical classes follow below</td>
<td></td>
</tr>
<tr>
<td>2,2',4,4',6,6'-Hexachlorocarbanilide</td>
<td></td>
<td></td>
<td>Mortality: 1/10 at 50 mg/kg, 0/10 at 100 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>2,3',4'-Trichlorocarbanilide</td>
<td>Mouse</td>
<td>intra-venous</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;: 63 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>3,4,4'-Trichlorocarbanilide</td>
<td>Mouse</td>
<td>intra-peritoneal</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;: 2,100 mg/kg</td>
<td>(4)</td>
</tr>
<tr>
<td>1,2,3-Trichlorobenzene, 1,3,5-Trichlorobenzene</td>
<td>NS*</td>
<td>NS</td>
<td>Moderate irritant to skin, eyes, and mucous membranes; causes hair loss; liver injury has been reported with 1,2,3-trichlorobenzene</td>
<td>(5)</td>
</tr>
<tr>
<td>Hypochlorous acid (available chlorine)</td>
<td>Human</td>
<td>local</td>
<td>Highly irritating to skin, eyes, and mucous membranes</td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>ingestion</td>
<td>Irritation and corrosion of mucous membranes with pain and vomiting; a fall in blood pressure, delirium, and coma may occur</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>inhalation</td>
<td>Coughing, choking; may cause severe respiratory tract irritation and pulmonary edema</td>
<td>(7)</td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 41-3
V. ENVIRONMENTAL EFFECTS

Little information was found regarding the environmental fate or effects of octachlor carbanilide.

Octachlor carbanilide decomposes at high temperature with the formation of Sym-2,4,6-trichlorophenyl urea (8).

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

The disposal practice recommended by the U.S. Navy in their Consolidated Hazardous Item List for Impregnite, a related compound used for a similar purpose, is burning in an incinerator equipped with an effluent scrubber. Scrubber overflow is to be neutralized prior to discharge. Incinerator ash should be buried in a hazardous or sanitary landfill (9).

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


p-NITROPHENOL

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_6H_5NO_3 \) (1)
Molecular Weight: 139.11 (1)
Structural Formula:

\[
\text{OH} \quad \text{NO}_2
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 100-02-7
CA Name (9CI): Phenol, 4-nitro
CA Name (8CI): Phenol, p-nitro
RTECS Number: SM2275000
Other Significant Synonyms: p-Hydroxynitrobenzene; 4-hydroxynitrobenzene

C. Chemical and Physical Properties

Physical State: Crystals (1)
Color: Colorless to slightly yellow (1)
Odor: Odorless (1)
Melting Point: 113-114°C; sublimes (1)
p-NITROPHENOL (cont.)

Boiling Point: 279°C; decomposes (2)

Solubilities:
Water: Slightly soluble in cold water; soluble in solutions of fixed alkali hydroxide and carbonates (1): 1.6% at 25°C; 2.7% at 90°C (3).
Nonaqueous Solvents: Soluble in alcohol, chloroform, ether (1).

Octanol Water Partition Coefficient: Log P = 1.91 (4)

Dissociation Constant: 7.0 x 10⁻8 (5)

Hygroscopicity: Data not available

Density (Crystal): 1.270 g/cc

Volutility: Sublimes (1)

Vapor Pressure: Less than 1 mm Hg at 38°C

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Data not available

Stability: Data not available

Flammability: Slightly flammable; combustable solid, may thermally decompose in absence of air (3).

II. USES

A. Army Unique Use

Explosive

B. Other Uses

Acid-base indicator (0.1% alcohol solution, pH: 5.6, colorless; pH: 7.6, yellow) (1). Intermediate in organic synthesis; production of parathion; fungicide for leather (3).
p-NITROPHENOL (cont.)

III. ANALYTICAL METHODS

A. Best Acceptable Method

Two high pressure liquid chromatographic methods for determining p-nitrophenol in complex wastewater matrices have been reported. Nielen et al. (6) reported that using precolumn separation and diode-array detection, 29 chemicals found in wastewater, including p-nitrophenol, can be separated and quantitized in a fully automated system. Kruempelman and Danielson (7) reported the use of Picolyt Kel-f to separate nitrophenols.

Eichelberger et al. (8) reported success using both packed column and fused silica capillary column GC/MS. Chudyk et al. (8) reported detecting p-nitrophenol in contaminated groundwater in situ at a depth of 25 m by laser-induced fluorescence at below parts-per-billion level.

B. Limit of Detection

Eichelberger et al. (8) reported 16.3 micrograms/liter for the packed column method and 20 micrograms/liter for the capillary column.
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF p-NITROPHENOL**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation, ingestion, skin</td>
<td>Headache, drowsiness, nausea, loss of consciousness; blue color in lips, ears, and fingernails (cyanosis)</td>
<td>(10)</td>
</tr>
<tr>
<td>Human</td>
<td>local</td>
<td>Dust is irritating to eyes, nose, and throat; solid is irritating to skin and eyes</td>
<td>(10)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>Estimated lethal dose: 50-500 mg/kg</td>
<td>(10)</td>
</tr>
<tr>
<td>Test animals</td>
<td>NS*</td>
<td>Central and peripheral vagus stimulation, central nervous system depression, methemoglobinemia, dyspnea, and hyper-thermia</td>
<td>(12,13)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>LD$_{50}$: 350 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Rat</td>
<td>subcutaneous</td>
<td>LD$_{50}$: 200 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>LD$_{50}$: 380 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intra-peritoneal</td>
<td>LD$_{50}$: 75 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>subcutaneous</td>
<td>LD$_{50}$: 200 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Dog</td>
<td>intravenous</td>
<td>LD$_{50}$: 10 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Cat</td>
<td>NS</td>
<td>LD$_{50}$: 150 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Pigeon</td>
<td>intramuscular</td>
<td>LD$_{50}$: 65 mg/kg</td>
<td>(14)</td>
</tr>
<tr>
<td>Frog</td>
<td>subcutaneous</td>
<td>LD$_{50}$: 60 mg/kg</td>
<td>(14)</td>
</tr>
</tbody>
</table>

* Not specified

**DAMD17-84-C-4133 42-4**
TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF p-NITROPHENOL

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>50 umol/L</td>
<td>Induction of DNA damage</td>
<td>(14)</td>
</tr>
<tr>
<td>Microorganism</td>
<td>10 mg/plate</td>
<td>Effects on DNA repair</td>
<td>(14)</td>
</tr>
<tr>
<td>(unspecified)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamster fibroblasts</td>
<td>1 mmol/L</td>
<td>Inhibition of DNA synthesis</td>
<td>(14)</td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport

A1a. Adsorption — Tests performed on four soil types reported that p-nitrophenol appears to follow a Freundlich Isotherm for soil adsorption. Freundlich parameters k and n appear to correlate with Hammet (G) and hydrophobic (pi) parameters (5).

A1b. Volatilization — Data not available

A1c. Leachability — Data not available

A1d. Bioaccumulation — The strongly hydrophobic nature of p-nitrophenol suggests that it could accumulate in cell lipids, particularly membrane lipid bilayers. The kinetics of killing of cultured mammalian cells revealed that the cells became more sensitized to the pollutant with time of exposure, and this may also reflect a time-dependent accumulation of the compound into the hydrophobic regions of the membranes (15).

A2. Transformation — Data not available

A2a. Biodegradation — Adapted culture: 2% removal after 48-hour incubation, feed: 200 mg/L. Decomposition by a soil microflora in 10 days. Adapted activated sludge at 20°C, with p-nitrophenol as sole carbon source: 95.0% COD removal at 17.5 mg COD/g dry inoculum/h.

Lag period for degradation of 16 mg/L by wastewater at pH 7.3, 30°C: 3-5 days; soil suspension at pH 7.3, 30°C: 7-14 days. P-Nitrophenol was found to biodegrade rapidly under both aerobic and anaerobic conditions in the presence of exogenous organic nutrients, but its persistence increased considerably in the absence of such nutrients (17).
p-NITROPHENOL (cont.)

A2b. Hydrolysis — Data not available
A2c. Photolysis — Data not available
A2d. Other chemical reaction — Data not available
A2e. Half-life — Data not available

B. Effects on Animals
B1. Avian species — Data not available
B2. Mammalian wildlife species — Data not available
B3. Terrestrial invertebrates — Data not available
B4. Reptiles — Data not available
B5. Amphibians — Data not available
B6. Microorganisms, aquatic and soil — The o-, m- and p-nitrophenols reduce the rate of algal photosynthetic oxygen production by as much as 70% at the relatively high exposure of 50-100 mg/L (18).

Toxicity threshold (cell multiplication inhibition test): bacteria (Pseudomonas putida), 4 mg/L; algae (Microcystis aeruginosa), 56.0 mg/L; green algae (Scenedesmus quadricauda), 7.4 mg/L; protozoa (Entosiphon sulcatum), 0.83 mg/L; protozoa (Uronema parduizi Chatton-Lwoff), 0.89 mg/L (16).

B7. Aquatic species, fish and invertebrates — Fish: Vairon (F): TLM 6 hr: distilled water: 4-6 mg/L; hard water: 30-33 mg/L (16).

Daphnia magna: 24-hour LC50: 24000 ug/L (19).
Lepomis macrochirus: 24-hour LC50: 12000 ug/L; 96-hour LC50: 8300 ug/L (21).
Shrimp (Crangon septemspinosus): 96-hour Lethal threshold: 26.4 mg/L;
Clam (Mya arenaria): 96-hour Lethal threshold: 29.4 mg/L; (22)

C. Effects on Plants
C1. Phytotoxicity — Data not available
C2. Uptake — Data not available
C3. Metabolism — Data not available
p-NITROPHENOL (cont.)

VI. STANDARDS AND REGULATIONS
A. Health
Data not available
B. Environmental
The compound p-nitrophenol has a statutory reportable quantity (RQ) of 1 lb. under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (23).

VII. DISPOSAL
A. Current Recommended Army Disposal Practices
Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (24).
B. Alternate Disposal Practices Under Consideration by the Army
Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARADCON and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (25).
C. Other Disposal Practices Employed
Wastewater treatment: ion exchange; adsorption on Amberlite XAD-2; 100% retention effective; influent 0.2ppm, effluent nil (19).

VIII. REFERENCES


Gosselin, Robert E., Dr., Dr. Roger P. Smith, Dr. Harold C. Hodge, and Jeanette E. Bradsock. 1984. Clinical Toxicology of Commercial Products, 5th ed. Williams & Wilkins, Baltimore, MD.


PENTAFRYTHRITOL TETRANITRATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \(\text{C}_{2}\text{H}_{8}\text{N}_{4}\text{O}_{12}\)

Molecular Weight: 316.17

Structural Formula:

\[
\begin{align*}
\text{H}_2\text{C} & - \text{O} - \text{NO}_2 \\
\text{O}_2\text{N} & - \text{O} - \text{CH}_2 - \text{C} - \text{CH}_2 - \text{O} - \text{NO}_2 \\
\text{H}_2\text{C} & - \text{O} - \text{NO}_2
\end{align*}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 78-11-5

CA Name (9CI): 1,3-propanediol, 2,2-bis (nitrooxy) methyl-dinitrate (ester)

CA Name (8CI): Pentaerythritol, tetranitrate

RTECS Number: EZ2623000

Other Significant Synonyms: 2,2-Bis(dihydroxymethyl)-1,3-propanediol, tetranitrate; Nitropentaerythritol; PETN

C. Chemical and Physical Properties

Physical State: Tetragonal crystals (1)

Color: White (2)

Odor: Odorless

Melting Point: 141°C (2)
PENTAERYTHRITOL TETRANITRATE (cont.)

Solubilities:
- Water: Practically insoluble (3); 0.01g/100 g at 50°C
- Nonaqueous Solvents (20°C): Acetone, 24.95% (very soluble); methyl acetate, 13%; beta-ethoxy ethyl acetate, 1.5% (2)

Octanol Water Partition Coefficient: Log P = 0.59 (4)

Hygroscopicity: 0 at 30°C, 90% relative humidity (2)

Density (Crystal): 1.77 g/cc (2)

Vapor Pressure (p): Below measurable limits.

Specific Heat: 0.26 cal/g°C (2)

Heat of Combustion: 1,960 cal/g (2)

Reactivity: The explosion hazard is severe when shocked or exposed to heat. One of the most powerful high explosives, it is particularly sensitive to shock. Explodes at 205-215°C. On decomposition, emits highly toxic fumes of NOx; can react vigorously with oxidizing materials (5).

Stability: Due to its symmetrical structure, PETN is highly resistant to many reagents. PETN differs from the majority of nitrate esters because it is not readily decomposed by sodium sulfide at 50°C. It is decomposed quickly, however, by boiling in a ferrous chloride solution. Boiling with a 2.5% solution of sodium hydroxide causes very slow decomposition. PETN is hydrolyzed by treatment with water at approximately 100°C. At 125°C under pressure, hydrolysis proceeds quickly and is considerably enhanced by the presence of 0.1% HNO3. A dilute sodium hydroxide solution causes PETN to hydrolyze more rapidly than acidified water. Hydrolysis produces mainly pentaerythritol dinitrate (6).

Flammability: Will not continue to burn (2)

II. USES

A. Army Unique Use

PETN is used in Class A-detonating fuse and boosters and Class B-priming compositions, as a base charge in anti-aircraft shells and mixed with TNT (70-30) in mines, explosive bombs and torpedoes. It is a very effective demolition explosive. It is also used in blasting caps combined with lead azide and dinitrodinitrophenol. PETN was known as an explosive in 1894; it was not used on a practical basis until after World War I (5,2).
B. Other uses

PETN is used therapeutically in the treatment of angina pectoris (7).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Several chromatographic methods were reported in recent literature. Lloyd reported an high performance liquid chromatography method that uses a pendant mercury drop electrode at the detector. This method compared favorably with electron capture detection in gas chromatography (8).

A Thermal Energy Analyzer (TEA) interfaced with a gas or liquid chromatograph was reported by Fine et al. (9) to detect explosives in debris without prior clean-up.

Yu et al. (10) reported a method to determine this compound with nitro/nitroso specific detector with either a gas or liquid chromatograph. This method can be used in the analysis of wastewater or biological fluids. The detector is a TEA and can also be applied to metabolites of nitrate esters.

Cantu et al. (11) reported success using a Fourier transform infrared spectrometer coupled with HPLC.

Yinon (12) described a custom built mass spectrometer interfaced with an HPLC that can successfully analyze PETN and other explosives. Cumming and Park (13) reported a gas chromatography/single ion monitoring mass spectroscopy method.

Malotky and Downes (14) reported a field kit for the analysis of 28 different explosives, including PETN, using thin-layer chromatography.

B. Limit of Detection

Lloyd (8) reported a detection limit of 2-20 picogram/10 microliters of injected sample.

Fine et al. (9) reported a detection limit of <10 picograms.
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF PENTAEYTHRITOL TETRANITRATE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>Therapeutic</td>
<td>Cutaneous vasodilation; rash; headache; increased intraocular pressure; dizziness, weakness, other signs of cerebral ischemia associated with postural hypotension</td>
<td>(7, 15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dose levels</td>
<td>Erythroderma</td>
<td>(16)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>10 mg, 4x/d, x8 yr; with glyceryl trinitrate, 1 or 2x/mo</td>
<td>Rosacia with strong flushing</td>
<td>(17)</td>
</tr>
<tr>
<td>(63-yr-old man)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>80 mg/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(74-yr-old man)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF PENTAEYTHRITOL TETRANITRATE**

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella typhimurium TA98, TA100, TA1535, TA1537, TA1538</em></td>
<td>NS*</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver fraction or treatment with ozone or chlorine</td>
<td>(16)</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em></td>
<td>0.625, 1.25 mg (spot test); up to 2.5 mg/plate (plate incorporation assay)</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(19)</td>
</tr>
<tr>
<td><em>Saccharomyces cerevisiae D3</em></td>
<td>NS</td>
<td>Did not produce mitotic inhibition with or without Aroclor 1254-induced rat liver fraction or treatment with ozone or chlorine</td>
<td>(18)</td>
</tr>
</tbody>
</table>

* Not specified

**DAMD17-84-C-4133** 43-4
PENTAERYTHRITOL TETRANITRATE (cont.)

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport

A1a. Adsorption — Data not available

A1b. Volatilization — Non-volatile (2)

A1c. Leachability — Insoluble in water (6)

A1d. Bioaccumulation — Data not available

A2. Transformation — Data not available

A2a. Biodegradation — Studies in rats have shown that PETN is degraded to the mono-, di-, and tri-nitrates by the bacterial flora of the intestine. Studies both in vivo and in vitro have indicated that nitrite rather than nitrate is the product of biodegradation of PETN (20).

A2b. Hydrolysis — The water solubility of PETN is so low (about 2 mg/L at 20°C), that almost all hydrolysis studies have been carried out in mixed solvents at reflux temperatures, and reactions were promoted by strong acid or base. Therefore, the experimental data are not directly applicable to the assessment of hydrolysis of PETN in natural waters and wastewaters (20).

A2c. Photolysis — Burrows and Dacre report that there have been studies of the decomposition of solid PETN exposed to ultraviolet light, but they state that it is not known whether this relates in any way to degradation of dissolved PETN or its metabolites in the environment (20).

A2d. Other chemical reaction — Data not available

A2e. Half-life — Data not available

B. Effects on animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — Data not available
PENTERYTHRITOL TETRANITRATE (cont.)

E7. Aquatic species, fish and invertebrates -- Water flea (Daphnia magna): 48-hour LC₅₀: 292 mg/L; Bluegill (Lepomis macrochirus): 96-hour LC₅₀: >2230 <3430 mg/L; Fathead minnow (Pimephales promelas): 96-hour LC₅₀: 926 mg/L (21).

C. Effects on plants
C1. Phytotoxicity -- Data not available
C2. Uptake -- Data not available
C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS
A. Health
Data not available

B. Environmental
Reported in EPA TSCA Inventory 1983.

VII. DISPOSAL METHODS
A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (22).

B. Alternate Disposal Practice under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (23).

C. Other Disposal Practices Employed

Data not available
VIII. REFERENCES


PENTAERYTHRITOL TETRANITRATE (cont.)

PHOSPHORUS TRICHLORIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: PCl₃
Molecular Weight: 137.35 (1)

Structural Formula:

\[ \text{Cl} \quad \text{P} \quad \text{Cl} \]

B. Alternate Names and Registry Numbers

CAS Registry Number: 7719-12-2
Deleted CAS Registry Number: 11082-95-4
CA Name (9CI): Phosphorus trichloride
CA Name (8CI): Phosphorus chloride
RTECS Number: TH3675000
Other Significant Synonyms: Phosphine, trichloro-, phosphorus chloride

C. Chemical and Physical Properties

Physical State: A fuming liquid (1)
Color: Colorless (1)
Odor: Data not available
Melting Point: -112°C (1)
Boiling Point: 76°C (1)

Solubilities:
Water: Decomposes (1)
Nonaqueous Solvents: Decomposes in alcohol (1); soluble in benzene, ether, chloroform, carbon disulfide (1); soluble in carbon tetrachloride (2)
PHOSPHORUS TRICHLORIDE (cont.)

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Decomposes on contact with water (1)

Specific Gravity: 1.574 (1)

Vapour Pressure: 100 mm at 21°C (1); 400 mm at 56.9°C (3); vapor density 4.75 g/L (3)

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Data not available

Stability: Data not available

Flammability: Nonflammable (3)

II. USES

A. Army Unique Use

Obscurants and chemical intermediates.

B. Other Uses

Same uses as phosphorus oxychloride (chlorinating agent); in the manufacture of phosphorus pentachloride and phosphorus oxychloride, producing iridescent metallic deposits (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Phosphorus can be detected in trace amounts by atomic emission spectrometry. Hee et al. recently reported a simultaneous inductively coupled plasma atomic emission spectrometric method for phosphorus and 33 other elements (4).

B. Limit of Detection

Hee et al. reported a lowest quantifiable limit (LQL) of less than 0.1 microgram per milliliter (4).
IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF PHOSPHORUS TRICHLORIDE**

<table>
<thead>
<tr>
<th>Species Reference</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human contact</td>
<td>NS*</td>
<td>Highly irritating to skin, eyes, throat, and respiratory tract</td>
<td>(5)</td>
</tr>
<tr>
<td>Human contact</td>
<td>NS</td>
<td>Severe burns of the eyes and skin</td>
<td>(5)</td>
</tr>
<tr>
<td>Human inhal-</td>
<td>Minor exposures</td>
<td>Acute pulmonary edema; may be delayed 2-6 hr</td>
<td>(6)</td>
</tr>
<tr>
<td>Human inhalation</td>
<td>Moderate to severe exposures</td>
<td>Acute pulmonary edema; may be delayed 12-24 hr</td>
<td>(6)</td>
</tr>
<tr>
<td>Human (27 patients) inhalation</td>
<td>Exposure following a railroad yard accident</td>
<td>Effects included burning eyes, shortness of breath, throat irritation, eye lacrimation, headache, nausea, burning skin, sputum production, generalized chest pain, pleuritic chest pain, rash with or without itch, wheezing, blurring vision, vomiting, abdominal pain, pulmonary changes, hypoxemia</td>
<td>(7)</td>
</tr>
<tr>
<td>Human (chemical workers) inhalation</td>
<td>Intermittent exposure to PCl₃ and POC₁₃ concentrations of PCl₃ exceeded 3 mg/m³ standard in 2 of 13 air samples in original study later in a follow-up study (respirators worn in these cases); no air sampling in follow-up study</td>
<td>Increased incidences of respiratory distress consisting of wheezing, breathlessness, and chest tightness in 37 exposed workers 2 years in 2 of 13 air samples vs. 22 unexposed workers in original study and in 11 unexposed workers 2 years later in a follow-up study</td>
<td>(8)</td>
</tr>
</tbody>
</table>

* Not specified
### TABLE IV-1. TOXICITY OF PHOSPHORUS TRICHLORIDE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>550 mg/kg</td>
<td>LD$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>104 ppm/4 hr</td>
<td>LC$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>inhalation</td>
<td>50 ppm/4 hr</td>
<td>LC$_{50}$</td>
<td>(9)</td>
</tr>
</tbody>
</table>

* Not specified

### TABLE IV-2. MUTAGENICITY OF PHOSPHORUS TRICHLORIDE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>0.1-1,000 ug/ml;</td>
<td>Nonmutagenic with or without Aroclor 1254- induced rat liver S9</td>
<td>(10)</td>
</tr>
<tr>
<td>E. coli (2 strains)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport — Data not available

A1a. Adsorption — Data not available

A1b. Volatilization — Data not available

A1c. Leachability — Data not available

A1d. Bioaccumulation — Data not available

A2. Transformation — Data not available

A2a. Biodegradation — Data not available

A2b. Hydrolysis — Decomposes in water to hydrochloric acid and H$_3$PO$_4$ (3).

A2c. Photolysis — Data not available
PHOSPHORUS TRICHLORIDE (cont.)

A2d. Other chemical reaction — Data not available

A2e. Half-life — Data not available

B. Effects on animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — Data not available

B7. Aquatic species, fish and invertebrates — Data not available

C. Effects on plants

C1. Phytotoxicity — Data not available

C2. Uptake — Data not available

C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Phosphorus trichloride has a statutory reportable quantity (RQ) of 5000 lb under the Comprehensive Response, Compensation and Liability Act. The National Response Center must be notified when there is a release of this compound in an amount equal to or greater than the RQ (11).

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

A recent programmatic life cycle environmental assessment indicates that incineration is the preferred method for disposal of smoke/obscuring munitions. Munitions containing phosphorus would be incinerated in a unit equipped with afterburner and a scrubber (12).
PHOSPHORUS TRICHLORIDE (cont.)

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Phosphorus trichloride can be syphoned into a running stream and neutralized. However, the danger of forming explosive or toxic fumes dictates the work be done in an isolated area with all personnel adequately protected (3). (Editor's note: The recommendation that the material be neutralized is very important when using this disposal method; the pre-disposal pH of the stream should be maintained. This method may contribute to algal growth downstream due to excessive phosphorus application.)

VII. REFERENCES


I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_6H_4N_4O_6K \) (1), \( C_6H_3N_4O_7K \) (2)

Molecular Weight: 225 (1), 282 (Estimated)

Structural Formula:

\[
\begin{array}{c}
\text{NO}_2 \\
\text{K}^+ \\
\text{O}_2N^- \\
\text{H} \quad \text{OH} \\
\text{N}^+ \\
\text{O}^-
\end{array}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 29267-75-2

CA Name (9CI): 4-Benzofurazanol, 1-4-dihydro-5,7-dinitro, 3-oxide, ion(-1) potassium

CA Name (8CI): Benzofurazan, 4,6-dinitro-1-oxide, potassium salt*

RTECS Number: Not applicable

Other Significant Synonyms: KDNBF

C. Chemical and Physical Properties

Physical State: Crystalline solid (1)

Color: Gold orange (1)

Odor: Data not available

Melting Point: 210°C (Kiplodes) (1)
POTASSIUM DINITROBENZFUROXAN (cont.)

Solubilities:
Water: 0.245 g/100 g at 30°C (1)
Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: At 30°C — 75% Relative humidity — 0.11%
90% Relative humidity — 0.27% (1)

Density (Crystal): 2.21 g/cc (1)

Vapour Pressure: Data not available

Specific Heat: 0.217 cal/g/°C (1)

Heat of Combustion: 2209 cal/g (1)

Reactivity: Data not available

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

Primary explosive (1)

B. Other Uses

Data not available

III. ANALYTICAL METHODS

A. Best Acceptable Method

None found under name or CAS registry number.

B. Limit of Detection

None found under name or CAS registry number.
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF POTASSIUM DINITROBENZFUROXAN

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium dinitro-</td>
<td>Moderately toxic by inhalation and ingestion</td>
<td>(3)</td>
</tr>
<tr>
<td>hydroxy hydro-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>benzofuroxan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,6-Dinitrobenzofuroxan</td>
<td>Inhibition of RNA synthesis in sheep lymphocytes in vitro:</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>5% inhibition at 20 uM, 95% inhibition at 100 uM;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reacts with nucleophiles</td>
<td></td>
</tr>
<tr>
<td>4-Nitrobenzofuroxan</td>
<td>Mutagenic in <em>Salmonella typhimurium</em> strains TA98, TA100,</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>TA1530R, TA1535R+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inhibition of DNA synthesis in mouse leukocytes</td>
<td>(6)</td>
</tr>
<tr>
<td>4-Nitrobenzofuroxan</td>
<td>Inhibition of nucleic acid and protein synthesis in animal</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>cells</td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>Large amounts taken by mouth produce dizziness, abdominal</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>cramps, vomiting, bloody diarrhea, weakness, convulsions,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and collapse; small, repeated doses may lead to weakness,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>general depression, headache, and mental impairment</td>
<td></td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of potassium dinitrobenzofuroxan.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

DAMD17-84-C-4133 45-3
VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (8).

B. Alternate Disposal Practices Under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (9).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


POTASSIUM PERCHLORATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: KClO₄
Molecular Weight: 138.55

Structural Formula:

\[
\begin{array}{c}
\text{K}^+ \\
\text{O} \\
\text{O} \\
\text{O} \\
\text{O} \\
\end{array}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 7778-74-7
CA Name (9CI): Perchloric acid, potassium salt
CA Name (8CI): Perchloric acid, potassium salt
TECS Number: SC9700000

Other Significant Synonyms: Potassium hyperchloride; Potassium hyperchlorate.

C. Chemical and Physical Properties

Physical State: Rhombic crystals or white crystalline powder (1)
Color: Colorless or white
Odor: Odorless (2)
Melting Point: 610-620°C (3)
Boiling Point: Data not available

Solubilities:
Water: Soluble in 65 parts cold and in 15 parts boiling water (1)
Nonaqueous Solvents: Very slightly soluble in alcohol and insoluble in ether (4). Insoluble in alcohol (1).
POTASSIUM PERCHLORATE (cont.)

Density: 2.52 g/cc (5)
Octanol Water Partition Coefficient: Not applicable
Hygroscopicity: Data not available
Volatile: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Decomposed by organic matter and agents subject to oxidation; strong oxidizing agent (5); violent reaction with aluminum and magnesium, fluorine, nickel and titanium (3).
Stability: Decomposed by concussion (1); decomposes at 400 °C (4); decomposes at 530 °C (6); moderate explosion hazard (6).
Flammability: Data not available

II. USES

A. Army Unique Use
Pyrotechnics, oxidizer for rocket propellant

B. Other Uses
Fireworks, pharmaceuticals, oxidizing agent, analytical reagent.

III. ANALYTICAL METHODS

There is an ion chromatography method for determining potassium perchlorate in Pyrodex, a commercial black powder substitute. This method was developed for trace forensic analysis of black powders and their combustion products and residues.

B. Limit of Detection
Data not available

DAMD17-84-C-4133 46-2
IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF POTASSIUM PERCHLORATE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>Therapeutic</td>
<td>Nausea, vomiting, and hypersensitivity reactions such as maculopapular rashes, fever, and lymphadenopathies may occur; fatal aplastic anemia has occurred in a small proportion of patients; agranulocytosis, thrombocytopenia, and leucopenia have been reported.</td>
<td>(2)</td>
</tr>
<tr>
<td>72-yr-old</td>
<td>oral</td>
<td>1g/d for 1 month then 200 mg/d for 22 yr</td>
<td>No toxic effects</td>
<td>(7)</td>
</tr>
<tr>
<td>female (treated for thyrotoxicosis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>inhalation with dust, oral</td>
<td>NS*</td>
<td>Irritation of skin, contact eyes, and mucous membranes; absorption can produce methemoglobinemia and kidney injury</td>
<td>(3)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>27,675 mg/kg gestation days 1-9</td>
<td>TD&lt;sub&gt;Lo&lt;/sub&gt; for developmental abnormalities</td>
<td>(8)</td>
</tr>
<tr>
<td>Rat</td>
<td>intraperitoneal</td>
<td>10 mg</td>
<td>Antithyroid activity</td>
<td>(9)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>oral</td>
<td>2,100 mg/kg, gestation days 1-21</td>
<td>TD&lt;sub&gt;Lo&lt;/sub&gt; for developmental abnormalities</td>
<td>(8)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>oral</td>
<td>35,700 mg/kg, gestation days 48-68</td>
<td>TD&lt;sub&gt;Lo&lt;/sub&gt; for developmental abnormalities</td>
<td>(8)</td>
</tr>
</tbody>
</table>
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- Data not available

A2. Transformation -- Data not available

A2a. Biodegradation -- A few microorganisms are able to metabolise perchlorate; most are not. It has been reported that perchlorate is reduced to chloride by several species of heterotrophic bacteria, including the very common E. coli and Pseudomonas aeruginosa. Some Streptococcus and Flavobacterium spp. were inactive (10).

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Data not available

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Newts maintained at a level of 36 mg/L of perchlorate exhibit significant histological changes in the thyroid and pituitary. Continuous exposure to 360 mg/L results in arrested metamorphosis in tadpoles and a grossly enlarged thyroid in guppies (10).

B6. Microorganisms, aquatic and soil -- Toxicity thresholds, by cell multiplication inhibition test: bacteria (Pseudomonas putida): 1870 mg/L; green algae (Scenedesmus quadricauda): 360 mg/L; protozoa (Entosiphon sulcatum): 23 mg/L (11).
Aquatic species (fish and invertebrates) — LC$_{50}$ for *Daphnia magna* in 24-hour exposure = 670000 ug/L (calc.) (12).

Although few definitive studies have been conducted, it appears that the acute toxicity of perchlorate ion to aquatic animals and microorganisms is very low, with toxic levels probably exceeding 1000 mg/L for periods of 24 hours and longer. Because perchlorate is an important antithyroid agent, chronic effects may appear at much lower levels. Guppies (*Lebistes reticulatus*) exposed to 500 mg/L of potassium perchlorate for a year and longer suffered gross enlargement of the thyroid, followed by inactivation of the thyroid and arrested sexual development (10).

**C. Effects on plants**

C1. Phytotoxicity — Soybeans grown in water culture exhibit toxic symptoms at perchlorate levels as low as 2.5 mg/L four days after application. Soybeans grown in sand were noticeably less susceptible (10).

C2. Uptake — Uptake of iodide by the seaweed *Fucus ceranoides* is competitively inhibited by perchlorate at the 0.1 mg/L level in seawater (10).

C3. Metabolism — Data not available

**VI. STANDARDS AND REGULATIONS**

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1983.

**VII. DISPOSAL**

A. Current Recommended Army Disposal Practices

Current methods of disposal of pyrotechnics involves open burning or open detonation.

B. Alternate Disposal Practices Under Consideration by the Army

Data not available
**C. Other Disposal Practices Employed**

Use vast volume of concentrated solution of reducing agent (bisulfites or ferrous salts with $3\text{M}-\text{H}_2\text{SO}_4$ or hypc). Neutralize with soda ash or dilute HCl. Drain into a sewer with abundant water (13).

For small quantities: Cautiously add to a large stirred excess of water. Adjust the pH to neutral, separate any insoluble solids or liquids and package them for hazardous waste disposal. Flush the aqueous solution down the drain with plenty of water. The hydrolysis and neutralization reactions may generate heat and fumes which can be controlled by the rate of addition (14).

**VIII. REFERENCES**


PROPYLENE GLYCOL 1,2-DINITRATE

Much of the available data on propylene glycol 1,2-dinitrate has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_3\text{H}_6\text{N}_2\text{O}_6 \)

Molecular Weight: 166 (1)

Structural Formula:

\[
\begin{align*}
\text{NO}_2 \\
\text{O} \\
\text{O}_2\text{N} - \text{O} - \text{CH}_2 - \text{CH} - \text{CH}_3
\end{align*}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 6423-43-4

CA Name (9CI): 1,2-Propanediol, dinitrate

CA Name (8CI): Same

RTECS Number: TY6300000

Other significant synonyms: Isopropylene nitrate

C. Chemical and Physical Properties

Physical State: Liquid (1)

Color: Colorless (1)

Odor: Disagreeable (1)

Boiling Point: 92°C at 10mm Hg (1)
PROPYLENE GLYCOL 1,2-DINITRATE (cont.)

Solubilities:
Water: Soluble in water (1)
Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (specific gravity): 1.3774 (1)

Vapour Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: The glycol dinitrates hydrolyze rapidly in base, somewhat more slowly in acid and only at elevated temperatures in water alone. The hydrolysis of alkyl nitrates can lead to a variety of products including the parent alcohol, alkenes, aldehydes and carboxylic acids. Thermal decomposition of alkyl nitrates initially yields alkoxy radicals which react further to give complex mixtures which include CO, CO₂, NOₓ. Photolysis also gives complex mixtures including NO (1).

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

Principal constituent of Otto Fuel II for the Otto II torpedo (1).

B. Other Uses

No civilian uses (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Fine and Miles have developed a portable voltammmeter to monitor nitrate esters, particularly PGDN in waste water using a silver wire electrode (2).
Erk et al. described a gas chromatography method using an electron capture detector to determine PGDN in blood (3).

B. Limit of Detection

Miles and Fine reported in their patent application that 0.5 mg/L is easily detectable (2).

Erk et al. claimed 10 ng/mL limit of detection by gas chromatograph (3).
### IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF 1,2-PROPYLENE GLYCOL DINITRATE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human (workers exposed to 1,2-PGDN)</td>
<td>Inhalation</td>
<td>Mean exposure duration: 47.4 or 91.8 mo</td>
<td>No significant differences in mean scores of oculomotor and ataxia tests between exposed workers and controls</td>
<td>(5)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>Intraperitoneal</td>
<td>402 mg/kg</td>
<td>LD$_{50}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>Eye</td>
<td>100 mg</td>
<td>Mild irritation</td>
<td>(6)</td>
</tr>
<tr>
<td>Cat</td>
<td>Subcutaneous</td>
<td>200 mg/kg</td>
<td>LD$_{LO}$</td>
<td>(6)</td>
</tr>
<tr>
<td>Dog (Beagle)</td>
<td>Intra-venous</td>
<td>4-100 mg/kg suspended in polyethylene glycol 400</td>
<td>Dose-related decreases in systolic, diastolic, and pulse blood pressure; dose-related increase in heart rate; whole red blood cells in urine; vasodilation; methemoglobinemia at high doses</td>
<td>(7)</td>
</tr>
<tr>
<td>Rhesus monkey</td>
<td>Inhalation</td>
<td>0.3 ppm increasing to 4.23 ppm over 125 days</td>
<td>No significant changes in behavior or necropsy and histopathologic results</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-33 ppm for 6 hr</td>
<td>No unequivocal changes in visual evoked response</td>
<td>(8)</td>
</tr>
</tbody>
</table>

*Information not included in the ARC report*
V. ENVIRONMENTAL EFFECTS

A. Environmental Fate
   A1. Transport — Data not available
   A1a. Adsorption — Data not available
   A1b. Volatilization — Data not available
   A1c. Leachability — Data not available
   A1d. Bioaccumulation — Data not available
   A2. Transformation — Data not available
   A2a. Biodegradation — Data not available
   A2b. Hydrolysis — Data not available
   A2c. Photolysis — Data not available
   A2d. Other chemical reaction — Data not available
   A2e. Half-life — Data not available

B. Effects on animals
   B1. Avian species — Data not available
   B2. Mammalian wildlife species — Data not available
   B3. Terrestrial invertebrates — Data not available
   B4. Reptiles — Data not available
   B5. Amphibians — Data not available
   B6. Microorganisms, aquatic and soil — Data not available
   B7. Aquatic species, fish and invertebrates — Data not available

C. Effects on plants
   C1. Phytotoxicity — Data not available
   C2. Uptake — Data not available
   C3. Metabolism — Data not available
VI. STANDARDS AND REGULATIONS

A. Health
Data not available

B. Environmental
Reported in EPA TSCA Inventory 1983

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (9).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (10).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


PROPYLENE GLYCOL 1,2-DINITRATE (cont.)


PROPYLENE GLYCOL 1,3-DINITRATE

Much of the available data on propylene glycol 1,3-dinitrate has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled *A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals*. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

   Chemical Formula: \( \text{C}_3\text{H}_6\text{N}_2\text{O}_6 \)

   Molecular Weight: 166 (1)

   Structural Formula: \( 3\text{N(CH}_2\text{)}_3\text{NO}_3 \)

B. Alternate Names and Registry Numbers

   CAS Registry Number: 3457-90-7

   CA Name (9CI): 1,3-Propanediol, dinitrate

   CA Name (8CI): Same

   RTECS Number: Data not available

   Other Significant Synonyms: Trimethylene dinitrate

C. Chemical and Physical Properties

   Physical State: Liquid (1)

   Color: Colorless (1)

   Odor: Data not available

   Boiling Point: \( 180^\circ\text{C at 10 mm Hg} \) (1)

   Solubilities:
   - Water: Data not available
   - Nonaqueous Solvents: Data not available

   Octanol Water Partition Coefficient: Data not available

   Hygroscopicity: Data not available

   Density (Specific Gravity): 1.3952 (1)
PROPYLENE GLYCOL 1,3-DINITRATE (cont.)

Volatility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available

Reactivity: The glycol dinitrates hydrolyze rapidly in base, somewhat more slowly in acid and only at elevated temperatures in water alone. The hydrolysis of alkyl nitrates can lead to a variety of products including the parent alcohol, alkenes, aldehydes and carboxylic acids. Thermal decomposition of alkyl nitrates initially yields alkoxy radicals which react further to give complex mixtures which include CO, CO₂, and NO. Photolysis also gives complex mixtures including NOₓ (1).

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

Explosive and plasticizer (1).

B. Other Uses

None found

III. ANALYTICAL METHODS

A. Best Acceptable Method

No analytical methods were found in a computerized search of Chemical Abstracts dating back to 1967. Several methods were found for the 1,2-ester, including voltammetric and gas chromatographic analyses. These methods could possibly be extended to this compound. See the report on propylene glycol 1,2-dinitrate.

B. Limit of Detection

Data not available
IV. HEALTH EFFECTS

No information other than that in the ARC report was located. See report on 1,2-propylene glycol dinitrate.

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of 1,3-propylene glycol dinitrate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation or, occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USTHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (2).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savannah Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (3).

C. Other Disposal Practices Employed

Data not available
VIII. REFERENCES


RED PHOSPHORUS

The Army's need for research on the toxicological and environmental hazardous of red phosphorus is defined in the Atlantic Research Corporation (ARC) report entitled, *A Preliminary Problem Definition Study of 48 Munitions Related Chemicals*. The report states that red phosphorus is considered relatively non-toxic to mammals unless it contains some of the white form, and that there is no evidence that the compound is toxic to aquatic life.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( P_4 \)

Molecular Weight: 123.92 (1) 124.08 (2)

Structural Formula:

![Structural formula of red phosphorus]

B. Alternate Names and Registry Numbers

CAS Registry Number: 7723-14-0

CA Name (9CI): Phosphorus

CA Name (8CI): Phosphorus

RECS Number: T.3495000

Other Significant Synonyms: Amorphous, red (2), phosphorus (3)

C. Chemical and Physical Properties

Physical State: Reddish-brown powder (2)

Color: Red to violet (4)

Odor: Data not available
RED PHOSPHORUS (cont.)

Melting Point: Sublimes at 416°C (5)
Boiling Point: 280°C (6)
Solubilities:
  Water: Insoluble
  Nonaqueous Solvents: Insoluble in caustic alkali, carbon bisulfide, ether and ammonia solution (1). Insoluble in organic solvents, soluble in phosphorous tribromide (4).
  Octanol Water Partition Coefficient: Not applicable
Hygroscopicity: Data not available
Density (Crystal): 2.34 g/cc
Volatility: Data not available
Vapor Pressure: 0.181 torr at 25°C (6)
Vapor Density: 4.77 g/L
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Reacts only at high temperature; less reactive than white phosphorus (4). Avoid contact with potassium chlorate, potassium permanganate, peroxides and other oxidizing agents (4).
Flammability: Catches fire when heated in air to about 260°C (autoignition temperature) and burns with formation of pentoxide. Burns when heated in an atmosphere of chlorine (4).
Ignition Point: 200°C (1)
Autoignition Temperature: 260°C in air (7)

II. USES
A. Army Unique Use
   Obscurant, pyrotechnic (5)
B. Other Uses
   Manufacture of phosphoric acid (q.v.) and other phosphorous compounds, phosphor bronzes, metallic phosphides, additive to semiconductors, electroluminescent coatings, incendiaries, safety matches, fertilizers (7).
III. ANALYTICAL METHODS

A. Brst Acceptable Method

Phosphorus can be detected in trace amounts by atomic emission spectrometry. Hee et al. have recently reported a simultaneous inductively coupled plasma atomic emission spectrometric method for phosphorus and 33 other elements (8).

A photometric detector for gas chromatography, designed to monitor cold chemiluminescence has been reported by Mielniczuk (9).

B. Limit of Detection

Hee et al. reported a lowest quantifiable limit (LQL) of less than 0.1 microgram per milliliter (8).
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF RED PHOSPHORUS

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>NS**</td>
<td>4,412 ug/kg</td>
<td>LD_{50}</td>
<td>(10)</td>
</tr>
<tr>
<td>Human</td>
<td>NS</td>
<td>NS</td>
<td>Relatively nontoxic unless it contains white phosphorus as an impurity</td>
<td>(4)</td>
</tr>
<tr>
<td>Human</td>
<td>NS</td>
<td>NS</td>
<td>Irritant to eyes</td>
<td>(11)</td>
</tr>
<tr>
<td>Human</td>
<td>Inhal-</td>
<td>40 mg/m^3</td>
<td>Acu. *typical pneumonia of sudden onset as observed in workers in plants producing red phosphorus by sublimation of white phosphorus</td>
<td>(12)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>Inhal-</td>
<td>100-700 mg/m^3</td>
<td>Phosphorus smoke formulations caused reversible pulmonary symptoms and mucous membrane irritation</td>
<td>(12)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>for less than 15 min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F344</td>
<td>Oral</td>
<td>&gt;10,000 mg/kg</td>
<td>LD_{50}</td>
<td>(13)</td>
</tr>
<tr>
<td>Rat</td>
<td>Inhal-</td>
<td>1,537 mg/m^3/1 hr</td>
<td>Smoke caused mortality of 1/10</td>
<td>(12)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>1,676 mg/m^3/2 hr</td>
<td>Smoke caused mortality of 4/10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,572 mg/m^3/3 hr</td>
<td>Smoke caused mortality of 8/10</td>
<td></td>
</tr>
</tbody>
</table>

* Information not included in the ARC Report.
** Not specified.
TABLE IV-1. TOXICITY OF RED PHOSPHORUS (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porton rat</td>
<td>Inhalation</td>
<td>6,700-6,800 ppm/30 min</td>
<td>Smoke of two pyrotechnic mixtures containing 95% red phosphorus plus 5% butyl rubber or 97% red phosphorus plus 3% butadiene styrene caused inflammation and epithelial necrosis of the larynx and trachea, alveolitis, and broncho-pneumonia. The effects were attributed to pyrolytic production of ortho phosphoric acid</td>
<td>(14)</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Eyes</td>
<td>100 mg dry material in one eye</td>
<td>No irritation</td>
<td>(13)</td>
</tr>
<tr>
<td>rabbit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>Intact</td>
<td>500 mg/L/in^2/ 24 h</td>
<td>No irritation</td>
<td>(13)</td>
</tr>
<tr>
<td>rabbit</td>
<td>and abraded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Hartley</td>
<td>Inhalation</td>
<td>352 ppm/10 min</td>
<td>Smoke caused mortality of 4/10</td>
<td>(12)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Hartley</td>
<td>Intradermal</td>
<td>0.1 mL of a 1 g/L solution 3 x w for 10 doses</td>
<td>Slight irritation but no sensitization</td>
<td>(13)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Skin</td>
<td>0.5 mL of a 100 g/L solution 6 h/3x w for 10 doses</td>
<td>No sensitization</td>
<td>(13)</td>
</tr>
<tr>
<td>Hartley Guinea pig</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Information not included in the ARC report.
TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF RED PHOSPHORUS

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. typhimurium</td>
<td>NS*</td>
<td>Not active with or without Aroclor 1254-induced rat liver S9</td>
<td>(15)</td>
</tr>
<tr>
<td>TA100, TA1535, TA1537, TA1538</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. cerevisiae</td>
<td>NS</td>
<td>Not active with or without Aroclor 1254-induced rat liver S9</td>
<td>(15)</td>
</tr>
<tr>
<td>E. Coli</td>
<td>100 ug- 10 mg</td>
<td>Not active with or without Aroclor 1254-induced rat liver S9</td>
<td>(15)</td>
</tr>
<tr>
<td>W3110/polA+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p3478/polA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of red phosphorus which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

Red phosphorus is excluded from designation as hazardous in that it is a nontoxic allotrope, although it is frequently contaminated with a small amount of the yellow (16).

B. Environmental

Reported in EPA TSCA Inventory 1983.

Phosphorus has a statutory reportable quantity (RQ) of 1 lb. under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (17).
VII. DISPOSAL

A. Current Recommended Army Disposal Practices

A recent programmatic life cycle environmental assessment indicates that incineration is the preferred method for disposal of smoke/obscurant munitions. Munitions containing phosphorous would be incinerated in a unit equipped with afterburner and a scrubber (18).

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Controlled incineration followed by alkaline scrubbing and particulate removal equipment (17).

Cautiously make a 5% solution of the product in water; vent because of possible vigorous evolution of flammable hydrogen gas. Acidify the solution to pH 1 by adding 1M sulfuric acid dropwise. Acidification will cause vigorous evolution of hydrogen gas. Allow the solution to stand overnight. Evaporate to dryness and bury the residue in a chemical landfill (19).

VIII. REFERENCES


RED PHOSPHORUS (cont.)


SODIUM AZIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: NaN₃
Molecular Weight: 65.02 (1)
Structural Formula: Na⁺(N=N-N)⁻¹

B. Alternate Names and Registry Numbers

CAS Registry Number: 26628-22-8
Deleted CAS Registry Numbers: 20828-18-6; 12136-89-9
CA Name (9CI): Sodium azide NaN₃
CA Name (8CI): Sodium azide
RTECS Number: VY8050000
Other Significant Synonyms: Smite

C. Chemical and Physical Properties

Physical State: Crystal (1) hexagonal (2)
Color: Colorless (2)
Odor: Data not available
Melting Point: Decomposes to nitrogen and sodium (1)

Solubilities:
Water: 40.16% at 10°C (1); 41.7% at 17°C (1)
Nonaqueous Solvents: 0.3% in alcohol at 25°C (1). Insoluble in ether; soluble in liquid ammonia (1).

Octanol Water Partition Coefficient: Not applicable

Hygroscopicity: Data not available
Density (Crystal): 1.846 g/cc (2)
Volatility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Moderate (3)

II. USES

A. Army Unique Use
Data not available

B. Other Uses

In the preparation of hydrazoic acid, lead azide, and pure sodium; as a propellant for inflating automotive safety bags; and in weed and fruit rot control (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

Misovets (4) reported a thin-layer chromatography system for the detection of sodium azide, using Silufol plates and 40:20:1 acetone:water:formic acid mobile phase and 0.2% ninhydrin solution in butyl alcohol as the visualizing agent. Asplund (5) reported a voltammetric determination of sodium azide in trace amounts from air using a dropping mercury electrode.

B. Limit of Detection

Misovets (4) reported 0.01-0.1 mg; Asplund (5) reported 0.05 mg per cubic meter.
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF SODIUM AZIDE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>NS*</td>
<td>Acute</td>
<td>Hypotension (unresponsive to pressor drugs), tachycardia, tachypnea, hypothermia, acidosis, convulsions, severe headache</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>NS</td>
<td>0.2-4.0 ug/kg</td>
<td>Extremely potent directly acting vasodilator</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>&quot;Several g&quot;</td>
<td>Collapse and death within 40 min; swelling of the brain and lungs; mild fatty degeneration of the liver</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>50-60 mg</td>
<td>Collapse within 5 minutes accompanied by hypotension and tachycardia lasting almost 1 hr</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>150 mg (in aqueous solution)</td>
<td>Breathlessness and tachycardia within 5 min; nausea, vomiting, headache, restlessness, and diarrhoea within 15 min; later polydipsia, ECG changes, and leukocytosis occurred</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>710 ug/kg</td>
<td>Behavioral and urogenital symptoms</td>
<td>(7)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>0.01-0.02 mg/kg</td>
<td>A drop in blood pressure for 10 to 15 min in hypertensive patients</td>
<td>(8)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>NS</td>
<td>Vapor and fumes are irritants of mucous membranes; heavy exposure has caused bronchitis and pulmonary edema</td>
<td>(6)</td>
</tr>
</tbody>
</table>

* Not specified

DAMD17-84-C-4133 50-3
### TABLE IV-1. TOXICITY OF SODIUM AZIDE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>42 mg/kg</td>
<td>$LD_{Lo}$</td>
<td>(7)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>2,730 mg/kg,</td>
<td>Equivocal evidence for tumors of the endocrine system and skin</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5,460 mg/kg,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>total dose,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>78 wk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>27 mg/kg</td>
<td>$LD_{50}$</td>
<td>(7)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-peri-</td>
<td>30 mg/kg</td>
<td>$LD_{Lo}$</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>toneal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>intra-peri-</td>
<td>5-10 mg/kg,</td>
<td>Severe intoxication; some survivors show injury and demyelination of</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td>toneal</td>
<td>2-4x/hr for</td>
<td>myelinated nerve fibers in the central nervous system and testicular-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9-6 hr</td>
<td>kidney lesions</td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>sc</td>
<td>35 mg/kg</td>
<td>$LD_{Lo}$</td>
<td>(7)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>27 mg/kg</td>
<td>$LD_{50}$</td>
<td>(7)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intra-peri-</td>
<td>18 mg/kg</td>
<td>$LD_{50}$</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>toneal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>intravenous</td>
<td>19 mg/kg</td>
<td>$LD_{50}$</td>
<td>(7)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>oral</td>
<td>3-10 mg/kg</td>
<td>40-60% reduction in blood pressure lasting over 1 hr</td>
<td>(8)</td>
</tr>
</tbody>
</table>

### TABLE IV-1. TOXICITY OF SODIUM AZIDE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monkey</td>
<td>NS*</td>
<td>Repeated doses</td>
<td>Central nervous system effects: blindness and attacks of rigidity with</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>abnormal motions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133  50-4
### SODIUM AZIDE (cont.)

#### TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF SODIUM AZIDE*

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>3 mmol/L/2 hr</td>
<td>Mutagenic</td>
</tr>
<tr>
<td>S. typhimurium</td>
<td>1 ug/plate</td>
<td>Mutagenic with metabolic plate activation</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>150 nmol/L</td>
<td>Mutagenic</td>
</tr>
<tr>
<td>E. coli</td>
<td>5 gm/L</td>
<td>Effects on DNA repair</td>
</tr>
<tr>
<td>Insect</td>
<td>100 mg/L oral</td>
<td>Dominant lethal mutation and heritable translocation</td>
</tr>
<tr>
<td>Human fibroblasts</td>
<td>50 mg/L</td>
<td>DNA synthesis inhibition</td>
</tr>
<tr>
<td>Rat liver cells</td>
<td>1 mmol/L</td>
<td>Mutagenic</td>
</tr>
<tr>
<td>Mouse lymphocytes</td>
<td>500 mg/L/2 hr</td>
<td>Mutagenic</td>
</tr>
<tr>
<td>Hamster lung cells</td>
<td>1 mmol/L</td>
<td>Effects on DNA repair</td>
</tr>
</tbody>
</table>

* Data from RTECS (1985)

#### V. ENVIRONMENTAL EFFECTS

##### A. Environmental Fate

- **Al.** Transport — Data not available
- **Ala.** Adsorption — Data not available
- **Alb.** Volatilization — Data not available
- **Alc.** Leachability — Data not available
- **Ald.** Bioaccumulation — Data not available
- **A2.** Transformation — Data not available

DAMD17-84-C-4133  50-5
A2a. Biodegradation — Data not available

A2b. Hydrolysis — In water, sodium azide will shift between the dissolved salt form and hydrazoic acid depending upon solution pH. Azides react with many organics to form amines. They can also be oxidized to nitrates or reduced to ammonia. The azide ion itself will not persist in solution (9).

A2c. Photolysis — Data not available

A2d. Other chemical reaction — Data not available

A2e. Half-life — Data not available

B. Effects on animals

B1. Avian species — Data not available

B2. Mammalian wildlife species — Data not available

B3. Terrestrial invertebrates — Data not available

B4. Reptiles — Data not available

B5. Amphibians — Data not available

B6. Microorganisms, aquatic and soil — Sodium azide impairs the phototaxis (light-orienting capability) of the photosynthetic flagellate alga, Euglena gracilis (10).

B7. Aquatic species, fish and invertebrates — Threshold toxicities in river water: Daphnia: 0.3 ppm; Microregma: 3.0 ppm; Scenedesmus: 4.0 ppm; Escherichia coli: 19.0 ppm (9).

Fish: 50% inhibition of carbonic anhydrase activity from the red blood cells of Ictalurus punctatus at 5900 ug/L sodium azide (11).

Crustacean: Gammarus lacustris: 24-hour LC$_{50}$: 14000 ug/L; 48-hour LC$_{50}$: 9000 ug/L; 96-hour LC$_{50}$: 5000 ug/L (12).

C. Effects on plants

C1. Phytotoxicity — Data not available

C2. Uptake — Data not available
C3. Metabolism — Sodium azide inhibits the two photosynthesis partial reactions of 3-phosphoglycerate photoreduction and oxaloacetate photoreduction, as demonstrated by study in permeabilized cell preparations from wild type and mutants of Chlamydomonas reinhardtii (13).

VI. STANDARDS AND REGULATIONS
A. Health
Data not available

B. Environmental
Reported in EPA TSCA Inventory 1980.

Sodium azide has a statutory reportable quantity (RQ) of 1 lb. under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the RQ (14).

VII. DISPOSAL METHODS
A. Current Recommended Army Disposal Practices
AEHA: NSN 6810-00-300-5423

a. Dispose of through a commercial contractor.

b. Dispose of using a special procedure.

Detonation of this item shall be accomplished by Explosive Ordnance Disposal (EOD) experts only at a remote uninhabited location. The U.S. Army Escort Unit, if requested, is available to assist in the disposal of this item. AR 740-32 outlines the procedure necessary to obtain their services. Liaison may be established with their Disposal Office, AUTOVON 584-4382. EOD personnel shall determine the amount to be disposed of at a given time in accordance with their Range Safety and Movement Regulation. Movement of this material from a storage location to a range for disposal shall be in accordance with existing Department of Transportation regulations as well State and local regulations (15).
SODIUM AZIDE (cont.)

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


SODIUM PERCHLORATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: NaClO₄
Molecular Weight: 122.44

Structural Formula:

\[ \text{Na}^+ \left( \overset{\text{O}}{\overset{\text{O}}{\text{O-Cl-O}}} \right)^- \]

B. Alternate Names and Registry Numbers

CAS Registry Number: 7601-89-0
CA Name (9CI): Perchlorate acid, sodium salt
CA Name (8CI): Perchlorate acid, sodium sal.
RTECS Number: SC 9800000
Other Significant Synonyms: Irenat (1)

C. Chemical and Physical Properties

Physical State: Deliquescent crystals (2)
Color: White
Odor: Odorless (3)

Melting Point: Decomposes at 482°C (4).

Solubilities:
Water: Very soluble (2)
Nonaqueous Solvents: 51.4 g/100g methyl alcohol; 51.7 g/100g acetone; 14.7 g/100g ethyl alcohol; 4.89 g/100g propyl alcohol; 1.86 g/100g butyl alcohol; 9.65 g/100g ethyl acetate; 0.786 g/100g iso-butyl alcohol; insoluble in ether (5).
SODIUM PERCHLORATE

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Deliquescent

Density (Crystal): Specific Gravity: 2.02 (2)

Volutility: Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: A powerful oxidizing agent, readily combustible if mixed with organic material (6). Pure NaClO₄ is insensitive to impact (5). Strong oxidant when heated, particularly under acidic conditions. Forms an explosive with ammonium nitrate, calcium hydride, charcoal, magnesium, strontium hydride and with reducing agents (1).

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

Explosives, pyrotechnics

B. Other Uses

Jet fuel, analytical reagent (2)

III. ANALYTICAL METHODS

A. Best Acceptable Method

Sodium can be determined by atomic absorption or by atomic emission spectrometry as described by Hee (7).

A perchlorate membrane selective electrode has been developed, but it may not be sensitive for trace analysis. Khokhlova et al. have used this electrode to study activity coefficients of perchlorate ions (8).

B. Limit of Detection

Hee reports a lower determination range of 0.01-0.1 ug/ml for sodium (7).
### TABLE IV-1. TOXICITY OF SODIUM PERCHLORATE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>Therapeutic dose levels</td>
<td>Nausea, vomiting, and hypersensitivity reactions such as maculopapular rashes, fever, and lymphadenopathies may occur; fatal aplastic anemia has occurred in a small proportion of patients; agranulocytosis, thrombocytopenia, and leucopenia have been reported; antithyroid activity</td>
<td>(3)</td>
</tr>
<tr>
<td>Human</td>
<td>contact with dust</td>
<td>NS*</td>
<td>Irritation of skin, throat, eyes, and nose</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>2,100 mg/kg</td>
<td>LD$_{50}$; effects on behavior, pulmonary system, metabolism</td>
<td>(9)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-peritoneal</td>
<td>20 mg</td>
<td>Antithyroid activity</td>
<td>(10)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intra-peritoneal</td>
<td>551 mg/kg</td>
<td>LD$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>injection aqueous solution; conc. and duration NS</td>
<td></td>
<td>No long term toxic effects; &quot;behaved as a mild muscular poison&quot;; large doses produced diarrhea and liver damage</td>
<td>(5)</td>
</tr>
</tbody>
</table>

*Not specified*
SODIUM PERCHLORATE

TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF SODIUM PERCHLORATE

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli DNA repair plate</td>
<td>1500 pmol/plate</td>
<td>Active</td>
<td>(9)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

A. Environmental Fate

A1. Transport -- Data not available

A1a. Adsorption -- Data not available

A1b. Volatilization -- Data not available

A1c. Leachability -- Data not available

A1d. Bioaccumulation -- Data not available

A2. Transformation -- Data not available

A2a. Biodegradation -- A few microorganisms are able to metabolize perchlorate; most are not. It has been reported that perchlorate is reduced to chloride by several species of heterotrophic bacteria, including the very common E. coli and Pseudomonas aeruginosa. Some Streptococcus and Flavobacterium spp. were inactive (11).

A2b. Hydrolysis -- Data not available

A2c. Photolysis -- Data not available

A2d. Other chemical reaction -- Data not available

A2e. Half-life -- Data not available

B. Effects on animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

DAMD17-84-C-4133 51-4
SODIUM PERCHLORATE

B5. Amphibians -- The acute toxic level of sodium perchlorate to tadpoles is reported to be 2000 mg/L. Chronic effects appear at much lower levels. Newts maintained at a level of 36 mg/L of perchlorate exhibit significant histological changes in the thyroid and pituitary. Continuous exposure to 360 mg/L results in arrested metamorphosis in tadpoles and a grossly enlarged thyroid in guppies (11).

B6. Microorganisms, aquatic and soil -- A 2% solution of sodium perchlorate will check the growth of E. coli; about 10% is required to check the growth of Staphylococcus aureus and Sterigmatocystic nigr (11). Sodium perchlorate added to incubated soil caused inhibition of the respiration activity and a decrease in the number of ammonifying, nitrifying and denitrifying bacteria. In pure cultures of soil bacteria, the reduction of NO\textsubscript{3} to NH\textsubscript{4}, the reduction NO\textsubscript{2} to NO\textsubscript{2}, and NO\textsubscript{3} utilization were inhibited. The ClO\textsubscript{4} ions act in two ways: by liberating metabolites (Cl-) toxic to the cells and by competing with NO\textsubscript{3} for the nitrate reductase A enzyme (12).

B7. Aquatic species, fish and invertebrates -- Although few definitive studies have been conducted, it appears that the acute toxicity of perchlorate ion to aquatic animals and microorganisms is very low, with toxic levels probably exceeding 1000 mg/L for periods of 24 hours and longer. Because perchlorate is an important antithyroid agent, chronic effects may appear at much lower levels (11).

C. Effects on plants

C1. Phytotoxicity -- Soybeans grown in water culture exhibit toxic symptoms at perchlorate levels as low as 2.5 mg/L four days after application. Soybeans grown in sand were noticeably less susceptible (11).

C2. Uptake -- Uptake of iodide by the seaweed Fucus ceranoides is competitively inhibited by perchlorate at the 0.1 mg/L level in seawater (11).

C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory-1983.
VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (13).

B. Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARCADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (14).

C. Other Disposal Practices Employed

Use vast volume of concentrated solution of reducing agent (bisulfites or ferrous salts with 3M-HSO₄ or hypo). Neutralize with soda ash or dilute with HCl. Drain into a sewer with abundant water (6).

Bury in a landfill site approved for the disposal of chemical and hazardous waste (15).

VIII. REFERENCES


DAMD17-84-C-4133 51-6
SODIUM PERCHLORATE


STRONTIUM OXALATE

Much of the available data on strontium oxalate has been reported in a previous study by the Atlantic Research Corporation (ARC), entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: SrC$_2$O$_4$ • H$_2$O (1)

Molecular weight: 193.64 (1)

Structural formula:

\[ \text{Sr}^{+2} \quad \text{C}\equiv\text{O} \]

\[ \quad \text{C}\equiv\text{O} \quad \text{O} \]

B. Alternate Names and Registry Numbers

CAS Registry Number: 814-95-9

Deleted CAS Registry Number: 14529-93-2

CA Name (9CI): Ethanedioic acid, strontium salt (1:1)

CA Name (8CI): Oxalic acid, strontium salt (1:1)

RTECS Number: Data not available

Other significant synonyms: Data not available

C. Chemical and Physical Properties

Physical State: Crystalline powder (1)

Color: Colorless (1)

Odor: Odorless (1)

Melting Point: 150 °C with loss of H$_2$O (1)
Solubilities:
Water: Slightly soluble (1), 1 in 20,000 parts water; 1 in 1900 parts of 3.5% acetic acid; 1 in 1115 parts of 23% acetic acid, but less soluble in 35% acetic acid; readily soluble in dilute HCl or HNO₃ (2).
Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): Data not available

Vapour Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Hydrolyzes to form oxalic acid and strontium hydroxide. Thermal decomposition proceeds with an initial loss of water, formation of strontium carbonate and finally formation of strontium oxide (1).

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

Constituent of R-256 tracer mix used in the M-17, .50 caliber tracer rounds (1).

B. Other Uses

Radiator cleaner (1)
III. ANALYTICAL METHODS

A. Best Acceptable Method

No methods have been developed to analyze strontium oxalate as a complete entity since the publication of the ARC report. Newer methods have been developed for the analysis of strontium such as simultaneous inductively coupled plasma atomic emission spectrometry as reported by Hee et al. (3).

B. Limit of Detection

Hee et al. reported a lower determination limit range for strontium as <0.001 ug/mL (3).
IV. HEALTH EFFECTS

TOXICITY OF STRONTIUM OXALATE*

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Route</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strontium oxalate</td>
<td>oral, inhal-</td>
<td>No toxicity data located; data on chemical classes</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>follow below</td>
<td></td>
</tr>
<tr>
<td>Strontium Salts</td>
<td>oral, inhal-</td>
<td>Moderately irritating; the strontium ion has a low</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>order of toxicity</td>
<td></td>
</tr>
<tr>
<td>Oxalates</td>
<td>oral, inhal-</td>
<td>High acute toxicity</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>ation</td>
<td>local Powerful irritant; corrosive to tissue; when</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>taken by mouth, oxalates produce a caustic effect</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>on the mouth, esophagus, and stomach</td>
<td></td>
</tr>
</tbody>
</table>

* Information not included in the ARC report

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of strontium oxalate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory.
VII. DISPOSAL

A. Current Recommended Army Disposal Practices

A recent programmatic life cycle environmental assessment indicates that incineration is the preferred method for disposal of smoke/obscurant munitions. Munitions containing strontium oxalate should be incinerated in a unit equipped with afterburner and a scrubber; scrubber overflow should be neutralized prior to discharge (5).

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


TETRANITROCARBAZOLE

Much of the available data on tetranitrocarbazole has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{C}_{12}\text{H}_{5}\text{N}_5\text{O}_8 \)
Molecular Weight: 347.2 (1)

Structural Formula:

![Structural Formula Image]

B. Alternate Names and Registry Numbers

CAS Registry Number: 4543-33-3
CA Name (9CI): 9H-Carbazole, 1,3,6,8-tetranitro
CA Name (8CI): Carbazole, 1,3,6,8-tetranitro
Alternate CAS Registry Number: 28453-24-9
Alternate CA Name (9CI): 9H-Carbazole, tetranitro
Alternate CA Name (8CI): Carbazole, tetranitro
RTECS Number: Not listed in RTECS
Other Significant Synonyms: TNC

C. Chemical and Physical Properties

Physical State: Powder (1)
TETRANITROCARBAZOLE (cont.)

Color: Yellow (1)

Odor: Data not available

Melting Point: 285°C (1)

Solubilities:
Water: Insoluble (1)
Nonaqueous Solvents: Soluble in hot acetone (1). Soluble in benzene; insoluble in ether, alcohol and chloroform (2).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Not hygroscopic (2)

Density (Crystal): Data not available

Vapor Pressure: Data not available

Specific Heat: Data not available

Heat of Combustion: 3773 cal/g (1)

Reactivity: Data not available

Stability: Data not available

Flammability: Data not available

II. USES

A. Army Unique Use

TNC is a constituent in a yellow first-fire mixture that is used to ignite the primary explosive charge (1).

B. Other Uses

Less than 25 pounds per year consumed for civilian purposes. Formerly used in fireworks (1). Compound has been cited in a Japanese patent and 1,3,6,7-TNC specifically for use in electrophotographic photosensitive plates (3).

III. ANALYTICAL METHODS

No analytical methods were reported in Chemical Abstracts in a computerized search of both registry numbers, dating back to 1967.

DAMD17-84-C-4133 53-2
IV. HEALTH EFFECTS

TABLE IV-1. HEALTH EFFECTS RELATED TO TETRANITROCARBAZOLE*

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetranitrocarbazole</td>
<td>Unknown, probably toxic</td>
<td>(4)</td>
</tr>
<tr>
<td>Organic nitrates and nitrites</td>
<td>Vasodilation, headache, dizziness, weakness, and other signs of cerebral ischemia associated with postural hypotension; large amounts may produce coma, convulsions, and collapse</td>
<td>(5)</td>
</tr>
</tbody>
</table>

Data On Analog as

- 2,4,7-Trinitro-9-fluorenone** Carcinogenic and mutagenic (6)
- 2,7-Dinitrofluorenone** Carcinogenic and mutagenic (6)

* Information not included in the ARC report
** Structurally related to tetranitrocarbazole

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of tetranitrocarbazole that updates the ARC report.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available
TETRANITROCARBAZOLE (cont.)

VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Review of past Installation Assessment Reports indicates that current methods of disposal of waste explosives and propellants involve open burning, open detonation, or occasionally, hauling by a licensed contractor and landfilling. Current use of methods discussed above has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices and to develop plans for future disposal practices (7).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (8).

C. Other Disposal Practices Employed

Small Spill: Absorb or sweep on paper. Burn in iron pan in fume hood.

Large Spill: Mix with sand. Package in paper carton. Transfer to sanitary landfill. Wash spill site with strong soap and water (4).

VIII. REFERENCES


TETRYL

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( C_7H_5N_5O_8 \)

Molecular Weight: 287.17

Structural formula:

B. Alternate Names and Registry Numbers

CAS Registry Number: 479-45-8

CA Name (9CI): Benzenamine, N-methyl-N,2,4,6-tetranitro-

CA Name (8CI): Aniline, N-Methyl-N,2,4,6-tetranitro-

RTECS Number: BY6300000

Other Significant Synonyms: Nitramine; Tetralite; Tetril; 2,4,6-Tetral; Trinitrophenylmethylnitramine; 2,4,6,Trinitrophenylmethylnitramine

C. Chemical and Physical Properties

Physical State: Monoclinic crystals

Color: Yellow
TETRYL (cont.)

Odor: Data not available

Melting Point: 130-132 °C

Boiling Point: 180-190 °C

Solubilities:
- Water: Insoluble
- Nonaqueous Solvents: Soluble in alcohol, ether, benzene, glacial acetic acid

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): 1.57 g/cc

Volatility: Data not available

Vapor Pressure: Data not available

Specific Heat: \(0.0523 + 6.62 \times 10^{-4} T\) cal/g/°C

Heat of Combustion: 2,925 kcal/kg

Reactivity: Severe explosive hazard when shocked or exposed to heat or flame. Sensitive to percussion. Dangerous fire risk. Highly resistant to attack by dilute mineral acids. Does not react with aluminum, tin, copper, nickel lead or Cu-plated steel, bronze and stainless steel.

Vapor Density: 9.92 g/cc

Stability: Fairly resistant to gamma radiation.

Heat of Combustion: 2,925 cal/g

Flammability: Autoignition temp = 166°C; explosive temperature = 257°C. Explodes at 180 to 190 °C.

II. USES

A. Army Unique Use
   High explosive

B. Other Uses
   Acid-base indicator; pH 10.8 colorless; pH 13.0 reddish brown.
TETRYL (cont.)

III. ANALYTICAL METHODS

A. Best Acceptable Method

Several chromatographic methods are reported in the recent literature. Lloyd reported a high performance liquid chromatography method that used a pendant mercury drop electrode at the detector. This method compares favorably with electron capture detection in gas chromatography (8).

A thermal energy analyzer (TEA) interfaced with a gas or liquid chromatograph was reported by Fine (9) to detect explosive in debris without prior clean-up.

Cantu et al (10) reported success using a Fourier transform infrared spectrometer coupled with HPLC.

Yinon (11) described a custom built mass spectrometer interfaced with an HPLC that can successfully analyze tetryl and other explosives.

Malotky and Downes (12) reported a field kit for the analysis of 28 different explosives including tetryl using thin-layer chromatography.

B. Limit of Detection

Lloyd (8) reported a detection limit of 2-20 picogram/10 microliters of injected sample.

Fine (9) reported a detection limit of <10 picograms.
## IV. HEALTH EFFECTS

### TABLE IV-1. TOXICITY OF TETRYL

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>NS*</td>
<td>Potent sensitizer causing allergic dermatitis. Severe cases show massive generalized edema with partial obstruction of the trachea. Acutely irritating to the mucous membranes of the respiratory tract and eyes causing coughing, sneezing, epistaxis, conjunctivitis, and palpebral edema. Systemic effects include irritability, easy fatigability, malaise, headache, lassitude, insomnia, nausea, and vomiting. Anemia of both the marrow depression or deficiency type.</td>
<td>(13)</td>
</tr>
<tr>
<td></td>
<td>skin and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>eye</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>occupatio-</td>
<td>NS</td>
<td>Powerful sensitizer causing dermatitis. Local irritation of the conjunctiva, nose, throat and bronchial tubes, producing common cold-like symptoms, nose bleed, cough, and occasionally asthma-like symptoms. No reports of systemic or internal poisoning.</td>
<td>(14)</td>
</tr>
<tr>
<td></td>
<td>nal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>exposure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>NS</td>
<td>Gastrointestinal symptoms and anemia may develop. May cause tracheitis and asthma.</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>skin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>1 g/kg</td>
<td>Necrosis of the liver and degeneration of the kidney</td>
<td>(16)</td>
</tr>
<tr>
<td></td>
<td>(route</td>
<td>daily up</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>implied</td>
<td>to 3 mo</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TETRYL (cont.)

TABLE IV-1. TOXICITY OF TETRYL (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>sc</td>
<td>5,000 mg/kg</td>
<td>LD&lt;sub&gt;Lo&lt;/sub&gt;</td>
<td>(17)</td>
</tr>
</tbody>
</table>

* Not specified

TABLE IV-2. CARCINOGENICITY OF TETRYL

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>oral</td>
<td>10 doses of 40 mg/rat at 3-d intervals; observed for 9 mo</td>
<td>No effect, but study is inadequate</td>
<td>(18)</td>
</tr>
</tbody>
</table>

Sprague-Dawley rat
TABLE IV-3. MUTAGENICITY AND RELATED EFFECTS OF TETRYL

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>33.3 or 100 ug/plate</td>
<td>Mutagenic with and without Aroclor 1254-induced rat liver S9.</td>
<td>(19)</td>
</tr>
<tr>
<td>TA98, TA100, TA1537, TA1538</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccharomyces cerevisiae D5</td>
<td>62.5 and 125 ug/ml</td>
<td>Increased frequency of mitotic recombination in the absence of Aroclor 1254-induced rat liver S9. Not active with S9.</td>
<td>(19)</td>
</tr>
<tr>
<td>S. typhimurium TA100, TA1535</td>
<td>5 ug/plate</td>
<td>Analytical-grade: mutagenic in TA100 and TA1535. Military-grade: mutagenic in TA100 but less so than analytical-grade</td>
<td>(20)</td>
</tr>
<tr>
<td>S. cerevisiae D4</td>
<td>5 ug/plate</td>
<td>Mutagenic causing mitotic gene conversions at ade³ and trp.</td>
<td>(20)</td>
</tr>
<tr>
<td>Neurospora crassa</td>
<td>10 ug/plate</td>
<td>Mutagenic inducing ad-3* reversions.</td>
<td>(20)</td>
</tr>
</tbody>
</table>

V. ENVIRONMENTAL EFFECTS

A. ENVIRONMENTAL FATE

A1. Transport — Data not available

A1a. Adsorption — A six-month study showed very little detectable movement of tetryl or its transformation products through soil columns in that time frame. This may be combined result of soil fixation and limited water solubilities of the compounds (21).

A1b. Volatilization — Data not available

A1c. Infiltration — Data not available

A1d. Bioaccumulation — Data not available

A2. Transformation — Data not available

DAMD17-84-C-4133 54-6
TETRYL (cont.)

A2a. Biodegradation -- Biodegradation in 7 day tests: nil % degradation in original culture, neither in 1st, 2nd or 3rd subculture (22).

A2b. Hydrolysis -- In natural waters tetryl is slowly degraded to picric acid. Authors recovered no information indicating that wastewater effluents containing picric acid or its metabolite, picramic acid, in concentrations anticipated from the degradation of tetryl, would present an environmental hazard, either directly or indirectly (23). The principal detectable product of the hydrolysis of tetryl in the dark, in borax buffer, is methylnitramine. Other identified products include: picrate ion, nitrite ion, N-methylpicramide, and nitrate ion. In a 110-day test, no degradation of the methylnitramine was noted (24).

A2c. Photolysis -- Tetryl photolyzes under ambient lighting conditions at least an order of magnitude faster than it hydrolyzes. The major photoproduct is N-methylpicramide (trinitromethylaniline) (24).

A2d. Other chemical reaction -- Tetryl reacts in concentrated sulfuric acid to form N-methylpicramide (24).

A2e. Half-life -- The hydrolysis half-life of tetryl was estimated for a range of activation energies, for environmental conditions of 20°C and pH 6.8, to be approximately equal to 302 days (plus or minus 76 days). The author notes that some soils might have a strong accelerating effect on tetryl's hydrolysis rate which could drastically alter its environmental hydrolysis half-life (24).

B. Effects on Animals

B1. Avian species -- Data not available

B2. Mammalian wildlife species -- Data not available

B3. Terrestrial invertebrates -- Data not available

B4. Reptiles -- Data not available

B5. Amphibians -- Data not available

B6. Microorganisms, aquatic and soil -- Data not available

B7. Aquatic species, fish and invertebrates -- Data not available

C. Effects on Plants

C1. Phytotoxicity -- Data not available

C2. Uptake -- Data not available
C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS

A. Health

TLV: TWA 1.5 mg/cu m (skin) (25)
STEL 3.0 mg/m³ (skin) (25)
PSHA-air: TWA 1500 ug/m³ (Skin) (26)
DOT-class A explosive (27)
Tentative STEL value: 3.0 mg/m³ (28)

B. Environmental — Data not available

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (31).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (32).

C. Other Disposal Practices Employed

Pour into sodium bicarbonate or a mixture of sand-soda ash (9:1). After mixing, transfer into a paper carton filled with packing paper. Burn in an open furnace, or more efficiently, in a furnace with afterburner and scrubber (4).

Tetryl can be decomposed by heating it with an aqueous sodium sulfide solution. (Reference provides specific procedure). Supernatant liquid is discharged to a sump and any precipitate is burned in a burning ground (29). Activated carbon with regeneration capacity was recommended system for removal of tetryl among other compounds from munitions wastewater, in a study which compared carbon and polymeric resin adsorbents for this purpose (30).
VIII. REFERENCES


25. American Conference of Governmental Industrial Hygienists (ACGIH). 1984. TLV's Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices with Intended Changes. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.


TITANIUM TETRACHLORIDE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: TiCl₄ (1)
Molecular Weight: 189.73 (1)
Structural Formula:

\[
\begin{array}{c}
\text{Cl}^{-} \\
\vdots \\
\text{Cl}^{-} \quad \text{Ti}^{+4} \quad \text{Cl}^{-} \\
\vdots \\
\text{Cl}^{-}
\end{array}
\]

B. Alternate Names and Registry Numbers

CAS Registry Number: 7550-45-0
Deleted CAS Registry Numbers: 44246-22-2, 15612-71-2
CA Name (9CI): Titanium chloride (TiCl₄)
CA Name (8CI): Titanium chloride (TiCl₄)
RTECS Number: XR1925000
Other Significant Synonyms: Tetrachlorotitanium

C. Chemical and Physical Properties

Physical State: Liquid (1)
Color: Colorless (1); light yellow (2)
Odor: Penetrating acid odor (1)
Melting Point: -24.1°C (1)
TITANIUM TETRACHLORIDE (cont.)

Boiling Point: 136.4°C (1)

Solubilities:
Water: Soluble in cold water, decomposed by hot water (1), soluble in dilute HCl (2).
Nonaqueous Solvents: Soluble in alcohol

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Hygroscopic (1)

Specific Gravity: 1.726

Vapor Pressure: 100 mm at 91°C (3), 11.7 mm at 25°C

Vapor Pressure: Volatile, adsorbs moisture through the air and evolves dense white fumes (1).

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Reactive only under extreme conditions (3).

Stability: Data not available

Flammability: Nonflammable (3)

II. USES

A. Army Unique Use

Smoke agent "FM" (4)

B. Other Uses

Formerly used with potassium bitartrate as a mordant in textile industry, and with dyewoods in dyeing leather; also as smoke-producing screen with ammonia and in the manufacture of iridescent glass and artificial pearls (1).

Laundering; chemical production; and in chemical laboratories (3).
III. ANALYTICAL METHODS

A. Best Acceptable Method

Titanium can be determined through atomic absorption or atomic emission spectrometry (AES). Hee reported a simultaneous inductively coupled plasma AES method for determining titanium and 33 other elements.

B. Limit of Detection

Hee reported a lower determination limit range for titanium as <0.001 microgram/milliliter.
**TITANIUM TETRACHLORIDE (cont.)**

**IV. HEALTH EFFECTS**

**TABLE IV-1. TOXICITY OF TITANIUM TETRACHLORIDE**

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>ingestion</td>
<td>NS*</td>
<td>Nausea, vomiting, cramps, diarrhea, and possible tissue ulceration</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>contact with liquid</td>
<td>NS</td>
<td>Thermal and acid burns of eyes, skin, throat, and stomach; lasting deep brown pigment about the periphery of the scars and in areas of healed burns</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>contact with vapor</td>
<td>NS</td>
<td>Severe irritation and damage to eyes, coughing, headache, dizziness, lung damage, and bronchial pneumonia</td>
<td>(7)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>Approx. 2 min after industrial accident</td>
<td>Pulmonary burns followed by diffuse endobronchial polyp formation</td>
<td>(8)</td>
</tr>
<tr>
<td>Human</td>
<td>NS</td>
<td>NS</td>
<td>Late development of upper respiratory and nervous system disturbances</td>
<td>(6)</td>
</tr>
<tr>
<td>Rat</td>
<td>inhalation</td>
<td>460 mg/m$^3$/4 hr</td>
<td>LC$_{50}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Mouse</td>
<td>inhalation</td>
<td>10 mg/m$^3$/2 hr</td>
<td>LC$_{LO}$</td>
<td>(9)</td>
</tr>
<tr>
<td>Guinea pig (albino)</td>
<td>skin</td>
<td>2x/d for 3d (liquid)</td>
<td>Destruction of the outer layers of the skin comparable to a second-degree thermal burn</td>
<td>(7)</td>
</tr>
</tbody>
</table>
## TITANIUM TETRACHLORIDE (cont.)

### TABLE IV-1. TOXICITY OF TITANIUM TETRACHLORIDE (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>inhalation</td>
<td>intermit-</td>
<td>Respiratory distress with vomiting; decreased blood pressure, increased pulse and respiration rate; focal congestion and hemorrhage of the lungs with particulate deposits of Ti in the alveoli; mortality due to intense bronchitis and some edema interpreted as HCL effects</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tent exposure of 1-2 h-; conc. not measured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>inhalation</td>
<td>6 hr/d, 5 d/wk, 9 wk; conc.: 8.4 ppm Ti, 6.8 ppm volatile chloride</td>
<td>No weight loss; increased leukocyte count; lung foci consisting of monocytes with brown Ti granules grouped around the bronchi and necrotic cells associated with proliferation of connective tissue</td>
<td>(7)</td>
</tr>
</tbody>
</table>

* Not specified

### V. ENVIRONMENTAL EFFECTS

#### A. Environmental Fate

##### Al.
- Transport — Data not available

##### Ala.
- Adsorption — Data not available

##### Alb.
- Volatilization — Data not available

##### Alc.
- Leachability — Data not available

##### ld.
- Bioaccumulation — Concentration factors of 200 to 10,000 for 6 species of brown algae are reported; invertebrates, 2000; fish, 1000 (3).

#### A2.
- Transformation — Data not available

##### A2a.
- Biodegradation — Data not available

##### A2b.
- Hydrolysis — Reacts vigorously with water to evolve HCl gas and Ti(OH)₄ (3).

DAMD17-84-C-4133 55-5
TITANIUM TETRACHLORIDE (cont.)

A2c. Photolysis -- Data not available
A2d. Other chemical reaction -- Data not available
A2e. Half-life -- Data not available

B. Effects on animals
B1. Avian species -- Data not available
B2. Mammalian wildlife species -- Data not available
B3. Terrestrial invertebrates -- Data not available
B4. Reptiles -- Data not available
B5. Amphibians -- Data not available
B6. Microorganisms, aquatic and soil -- Data not available
B7. Aquatic species, fish and invertebrates -- Median threshold effect:
   Scenedesmus: 96-hour test, 2 ppm as titanium; Daphnia: 48-hour test, 4.6 ppm as titanium; Microregma: 48-hour test, 4 ppm as titanium (3).

C. Effects on plants
C1. Phytotoxicity -- Toxic to sugar beets at 12 ppm as titanium (3).
C2. Uptake -- Data not available
C3. Metabolism -- Data not available

VI. STANDARDS AND REGULATIONS
A. Health
   Data not available

B. Environmental
   Data not available
TITANIUM TETRACHLORIDE (cont.)

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

A recent programmatic life cycle environmental assessment indicates that incineration is the preferred method for disposal of smoke/obscurant munitions (10). Munitions containing titanium tetrachloride should be incinerated in a unit equipped with afterburner and a scrubber; scrubber overflow should be neutralized prior to discharge.

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Sift or pour onto a dry layer of sodium bicarbonate in a large evaporating dish. After mixing thoroughly, spray with 6M NH₄OH while stirring. Cover with a layer of crushed ice and stir. When the smoke of NH₄Cl has partly subsided, add iced water and stir. Dump this slurry into a large container. Repeat until all has been treated. Neutralize and slowly siphon the suspension into the drain with excess running water. Notify local sewage authority (3).

VIII. REFERENCES


TITANIUM TETRACHLORIDE (cont.)


TRIAMINOTRINITROBENZENE

Much of the available data on triaminotrinitrobenzene has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: C₆H₆N₆O₆

Molecular Weight: 258.15 (Estimated)

B. Alternate Names and Registry Numbers

CAS Registry Number: 3058-38-6

CA Name (9CI): 1,3,5-Benzenetramine, 2,4,6-trinitro-

CA Name (8CI): Same

Alternate CAS Registry Number: 67539-61-1

Alternate CA Name (9CI): Benzenetramine, ar, ar, ar-trinitro-

Other significant synonyms: 1,3,5-Triamino-2,4,6-Trinitrobenzene
s-Triaminotrinitrobenzene, sym-Triaminotrinitrobenzene, 2,4,6-
Trinitro-1,3,5-benzenetramine

DAMD17-84-C-4133 56-1
TRIAMINOTRINITROBENZENE (cont.)

C. Chemical and Physical Properties

Physical State: Triclinic crystals (1)

Color: Light yellow (1)

Odor: Data not available

Melting Point: Decomposes at 450–451°C (1); 350°C (2)

Solubilities:

Water: Soluble in acids, 20% wt/vol in concentrated sulfuric acid, fluorosulfonic, chlorosulfonic and trifluoromethane sulfonic acids (1).

Nonaqueous Solvents: Soluble in approximately 1% wt/vol in aniline, dimethylformamide, ethylenediamine. Insoluble in benzene, chloroform, ethanol, ether, and glacial acetic acid (1).

Density (Crystal): 1.93 g/cc (1)

Vapor Pressure: \(10^{-5}\) torr at 171.3°C \(10^{-7}\) torr at 131.4°C (1)

Heat of Combustion: 735.0 kcal/mol (1)

Stability: Relatively insensitive high explosive (3); excellent thermal stability up to 260–290°C (2).

Flammability: Low; autoignition temperature = 368°C (3)

II. USES

A. Army Unique Use

Currently being processed at Holston AAP for DOE use (4). It is coated with a binder and granulated, then shipped to the Amarillo, Texas DOE facility.

Used in nuclear weapons systems (1).

B. Other Uses

DOE unique (5).

DAND17-84-C-4133 56-2
III. ANALYTICAL METHODS

A. Best Acceptable Method

An assay method of analysis for TATB using high pressure liquid chromatography was developed by Schaffer. This is primarily designed for production quality control, but could possibly be adapted for trace analysis.

B. Limit of Detection

Data not available

IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF TRIAMINOTRINITROBENZENE*

<table>
<thead>
<tr>
<th>EFFECTS</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Although specific data are not available, the material should be treated as highly toxic by ingestion, inhalation, and skin absorption</td>
<td>(1)</td>
</tr>
</tbody>
</table>

* Information not included in the ARC report.

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of triaminotrinitrobenzene.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Data not available

DAMD17-84-C-4133 56-3
VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (6).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (7).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $\text{C}_6\text{H}_{15}\text{N}_3\text{O}_7 \cdot \text{HNO}_3$

Molecular Weight: 212.2

Structural Formula: $(\text{HOCH}_2\text{CH}_2)_3\text{NH}^+\text{NO}_3^-$

B. Alternate Names and Registry Numbers

CAS Registry Number: 27096-29-3

Deleted CAS Registry Number: 29868-09-5

CA Name (9CI): Ethanol, 2,2',2''-nitrilotris-, nitrate (salt)

CA Name (8CI): Ethanol, 2,2',2''-nitrilotri-, nitrate (salt)

RTECS Number: Data not available

Other Significant Synonyms: Triethanolamine-nitric acid salt; Triethanolamine nitrate; Triethanolamine mononitrate; TEAN

C. Chemical and Physical Properties

Physical State: Data not available

Color: Data not available

Odor: Data not available

Melting Point: Data not available

Solubilities:
Water: Data not available
Nonaqueous Solvents: Data not available

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): Data not available

Volatility: Data not available
Vapor Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Data not available

II. USES

A. Army Unique Use
   Propellant

B. Other Uses
   Data not available

III. ANALYTICAL METHODS

A. Best Acceptable Method
   Kaplan et al. (1) used gas chromatography to monitor soil degradation of TEAN. The free amine was determined with a flame ionization detector (FID) eluted from a Tenax-GC packed column at 260°C. Kaplan et al. also performed GC analysis for the presence of TEAN in the headspace gas in the biodegradation studies. Carbosieve columns with a thermal conductivity detector and temperature programming were used.

B. Limit of Detection
   Kaplan et al. reported 175.8 ng as the limit of detection for TEAN as the free amine using the FID.
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF TRIETHANOL AMMONIUM NITRATE

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triethanol ammonium nitrate</td>
<td>Human</td>
<td>oral</td>
<td>Large amounts</td>
<td>No toxicity data located; data on structural analogues and chemical classes follow below</td>
<td>(2)</td>
</tr>
<tr>
<td>Nitrates</td>
<td>Human</td>
<td>oral</td>
<td>Small repeated doses</td>
<td>Dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, and collapse</td>
<td>(2)</td>
</tr>
<tr>
<td>Triethanol amine</td>
<td>Human</td>
<td>skin</td>
<td>15 mg, 3 days</td>
<td>Mild irritation</td>
<td>(3)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>8,680 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td></td>
<td>(3)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>9,110 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td></td>
<td>(4)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>0.73 g/kg</td>
<td>0.73 g/kg</td>
<td>Microscopic lesions and deaths</td>
<td>(4)</td>
</tr>
<tr>
<td>Mouse</td>
<td>intraperitoneal</td>
<td>1,450 mg/kg</td>
<td>LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td></td>
<td>(3)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>0.03 or 0.3% diet</td>
<td>Significant increases in incidences of females</td>
<td></td>
<td>(4)</td>
</tr>
</tbody>
</table>
### TABLE IV-1. TOXICITY OF TRIETHANOL AMMONIUM NITRATE (Cont.)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triethanol amine</td>
<td>Guinea pig</td>
<td>oral</td>
<td>8,000 mg/kg</td>
<td>LD$_{50}$</td>
<td>(3)</td>
</tr>
<tr>
<td>cont.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabbit skin</td>
<td>Rabbit</td>
<td>skin</td>
<td>560 mg, 24 hr</td>
<td>Mild irritation</td>
<td>(3)</td>
</tr>
<tr>
<td>Rabbit eye</td>
<td></td>
<td>eye</td>
<td>5,620 ug</td>
<td>Severe irritation</td>
<td>(3)</td>
</tr>
<tr>
<td>Rabbit skin or rat</td>
<td></td>
<td>solution</td>
<td>5 or 10%</td>
<td>Not irritating</td>
<td>(4)</td>
</tr>
<tr>
<td>N-Nitroso diethanol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>amine (NDELA)</td>
<td></td>
<td></td>
<td></td>
<td>Triethanolamine may produce, or contain as an impurity, diethanolamine, which in the presence of nitrite, nitrate, or nitrogen oxides may lead to the formation of the carcinogen NDELA</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat drinking water</td>
<td>Rat</td>
<td>drinking</td>
<td>600 - 1,000 mg/kg</td>
<td>Hepatocellular carcinomas</td>
<td>(3)</td>
</tr>
<tr>
<td>Hamster subcutaneous</td>
<td>Hamster</td>
<td>subcutaneous</td>
<td>565 mg/kg 2x/wk for over 45 wk; killed at wk 78</td>
<td>Nasal cavity adeno- carcinomas and tracheal tumors</td>
<td>(3)</td>
</tr>
</tbody>
</table>

* Not specified

### V. ENVIRONMENTAL EFFECTS

No data available

### VI. STANDARDS AND REGULATIONS

No data available

DAMD17-84-C-4133  57-4
VII. DISPOSAL METHODS

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (5).

B. Alternate Disposal Methods Under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (6).

Disposal practices recommended by the U.S. Navy in their Consolidated hazardous item list for hydroxylamine, the parent compound of hydroxylammonium nitrate, is to return to the supplier (7).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


TRIETHYLENE GLYCOL DINITRATE

Much of the available data on triethylene glycol dinitrate has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled, A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_{6}H_{12}N_{2}O_{8}$

Molecular Weight: 240.20 (1)

Structural Formula: $O_{2}NO(CH_{2}CH_{2}O)_{3}ONO_{2}$

B. Alternate Names and Registry Numbers

CAS Registry Number: 111-22-8

CA Name (9CI): Ethanol, 2,2'-[1,2-ethanediylbis(oxy)]bis-, dinitrate

CA Name (8CI): Triethylene glycol, dinitrate

RTECS Number: YE5500000

Other Significant Synonyms: TEGDN

C. Chemical and Physical Properties

Physical State: Oily liquid (1)

Color: Light yellow (1)

Odor: Data not available

Melting Point: $-19^\circ C$ (1)

Solubilities:
- Water: Slightly soluble (1).
- Nonaqueous Solvents: Very soluble in acetone, ether, and 2:1 ether-ethanol; soluble in carbon disulfide (1).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available
TRIETHYLENE GLYCOL DINITRATE (cont.)

Specific Gravity (Liquid): 1.335 (1)

Volatility: 40 mg/cc/hr at 60°C (1)

Vapor Pressure: 0.001 mm at 25°C (1)

Specific Heat: Data not available

Heat of Combustion: 3428 cal/g or 819 kcal/mole (1)

Reactivity: Data not available

Stability: Do not expose to shock, heat, flame or electrostatic discharge (2).

Flammability: Moderate hazard (2); explosive temperature is 223°C.

II. USES

A. Army Unique Use

High explosive (2).

B. Other Uses

Data not available

III. ANALYTICAL METHODS

A. Best Acceptable Method

Malotky and Downes reported a field kit for the analysis of 28 different explosives including TEGDN using thin-layer chromatography.

B. Limit of Detection

Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF TRIETHYLENE GLYCOL DINITRATE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>NS**</td>
<td>NS</td>
<td>Organic nitrates produce vasodilation, headache, dizziness, weakness, and other signs of cerebral ischemia associated with postural hypotension; may progress to loss of consciousness; drug rash is occasionally produced</td>
<td>(3)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-796 mg/kg</td>
<td>NS</td>
<td>Increased plasma activities of alkaline phosphatase, creatine kinase, aspartate aminotransferase, and lactic dehydrogenase</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat</td>
<td>intra-acute,</td>
<td>13.0 mmol/kg</td>
<td>Convulsions, hyperactivity to auditory and tactile stimuli</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>sc13.0 mmol/kg</td>
<td>13.0 mmol/kg</td>
<td>Methemoglobin formation, ataxia, lethargy, respiratory depression, violent tremors, hyperactivity to auditory and tactile stimuli</td>
<td>(4)</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>intra-100, 200,</td>
<td>100, 200,</td>
<td>Decreased food intake and retarded weight gain</td>
<td>(4)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>dermal21 mmol/kg</td>
<td>21 mmol/kg</td>
<td>Death in 2-3 wk, 20% loss in body weight, emaciated appearance</td>
<td>(4)</td>
</tr>
<tr>
<td>Rhesus monkey</td>
<td>inhalation2.4 ppm</td>
<td>2.4 ppm aerosol for 2 or 4 hr</td>
<td>No significant changes in electroencephalograph or visual evoked response; significant increase in Sidman avoidance response rate</td>
<td>(6)</td>
</tr>
</tbody>
</table>

DAMD17-84-C-4133 58-3
TRIETHYLENE GLYCOL DINITRATE (cont.)

V. ENVIRONMENTAL EFFECTS

No information was found regarding the fate or effects of triethylene glycol dinitrate which would update the Atlantic Research Corporation document.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in the EPA TSCA Inventory 1980.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Past Installation Assessment Reports indicate that current methods of disposal of waste explosives and propellants involve open burning, open detonation or hauling by a licensed contractor and landfilling. This has also been confirmed by private communications from the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), which has the responsibility to review current disposal practices, and to develop plans for future disposal practices (7).

B. Alternate Disposal Practices under Consideration by the Army

Future plans for disposal of waste explosives and propellants are projected to emphasize fluid-bed incineration. This method has been tested successfully by ARRADCOM and is planned for use at installations such as Savanna Army Depot, Tooele Army Depot, and Hawthorne Naval Ammunition Depot (8).

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


VAT YELLOW 4

Much of the data on Vat Yellow 4 has been reported in a previous study by the Atlantic Research Corporation (ARC) entitled A Preliminary Problem Definition Study of 48 Munitions-Related Chemicals (1). Data reported herein reflects information more recent than that reported by ARC in 1978.

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: $C_{24}H_{12}O_2$
Molecular Weight: 332.25 (1)

Structural Formula:

![Structural Formula Image]

B. Alternate Names and Registry Numbers

CAS Registry Number: 128-66-5
Deleted CAS Registry Numbers: 39280-74-5, 12772-52-0

CA Name (9CI): Dibenzo[b,def]chrysene-7,14-dione
CA Name (8CI): Same

RTECS Number: H07030000

Other Significant Synonyms: Numerous (1), 3,8,8,9-Dibenzopyrene-5,10-dione

C. Chemical and Physical Properties

Physical State: Solid (1)
Color: Yellow
Odor: Data not available
Melting Point: Data not available
Solubilities:
Water: Data not available
Nonaqueous Solvents: Soluble in nitrobenzene, xylene, tetrahydronaphthalene (1); slightly soluble in acetone, alcohol, benzene, chloroform, o-chlorophenol, pyridine, toluene (1).

Octanol Water Partition Coefficient: Data not available

Hygroscopic: Data not available
Density (Crystal): Data not available
Vapour Pressure: Data not available
Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Data not available
Stability: Data not available
Flammability: Data not available

II. USES
A. Army Unique Use
Coloring agent to produce yellow smoke (1)

B. Other Uses
Dye

III. ANALYTICAL METHODS
A. Best Acceptable Method
Vat Yellow 4 can be analyzed by column and thin-layer chromatography and ultra violet, visible and fluorescence spectrophotometry. These methods have been used by Pierce and Katz (2) for air pollution analysis.

B. Limit of Detection
Data not available

DAMD17-84-C-4133 59-2
IV. HEALTH EFFECTS

**TABLE IV-1. TOXICITY OF VAT YELLOW 4***

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>oral</td>
<td>0, 3,500, or 7,000 ppm in feed for 104 wk</td>
<td>Decreased body weight gain; no significant increases in tumor incidences compared with controls</td>
<td>(3)</td>
</tr>
<tr>
<td>(Fischer 344)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>Males: 0, 25,000 or 50,000 ppm; Females: 0, 12,500, or 25,000 ppm in feed for 106 wk</td>
<td>Increased incidence of lymphoma in high-dose males: controls 3/20 (15%), low-dose 7/47 (15%), high-dose 22/50 (44%, P=0.019). Females showed no significant increases in tumor incidences compared with controls</td>
<td>(3)</td>
</tr>
<tr>
<td>(B6C3F1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Information not included in the ARC report

**TABLE IV-2. MUTAGENICITY AND RELATED EFFECTS OF VAT YELLOW 4***

<table>
<thead>
<tr>
<th>Test System</th>
<th>Dose</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium</td>
<td>0.1-1,000 µg/plate</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat liver S9</td>
<td>(4)</td>
</tr>
<tr>
<td>TA98, TA100, TA1535, TA1537, TA1538</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonella typhimurium</td>
<td>NS*</td>
<td>Nonmutagenic with or without Aroclor 1254-induced rat or Syrian hamster liver S9</td>
<td>(5)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of Vat Yellow 4 which would update the Atlantic Research Corporation document.

DAMD17-84-C-4133 59-3
VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1980.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for Dye Solution, a related compound used for a related purpose are to dilute with a flammable solvent and to burn in an incinerator equipped with an afterburner (6).

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


VAT YELLOW 4 (cont.)

WHITE PHOSPHORUS

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( P_4 \)

Atomic Weight: 30.97

Molecular Weight: 123.89

Structural Formula:

```
\[
\begin{array}{c}
P \\
\vdots \\
P
\end{array}
\]
```

B. Alternate Names and Registry Numbers

CAS Registry Number: 7723-14-0*

Deleted CAS Registry Number: 29879-37-6

CA Name (9CI): Phosphorus

CA Name (8CI): Same

RTECS Number: TH3495000, TH3505000, TH3500000

Other Significant Synonyms: Yellow phosphorus

B. Alternate Names and Registry Numbers

CAS Registry Number: 12185-10-3

Deleted CAS Registry Number: 51273-58-6

CA Name (9CI): Phosphorus, mol. (\( P_4 \))

CA Name (8CI): Same

RTECS Number: Data not available
Other significant synonyms: Tetraphosphorus, Phosphorus tetraatomic molecule, Tetrameric phosphorus, molecular phosphorus, Tetraphosphatricyclo-[1.1.0.02,4]butane

*Chemical Abstracts Service assigns the same Registry Number, 7723-14-0 for two forms of elemental phosphorus, white and red.

C. Chemical and Physical Properties

Physical State: Crystalline solid with two allotropic modifications: \( \alpha \) form exists at room temperature as cubic crystals; \( \beta \) form is formed at \(-79.6^\circ C\) as hexagonal crystals (1).

Color: Colorless or white, transparent, waxy appearance; darkens on exposure to light (1).

Odor: Data not available

Melting Point: 44.1\(^\circ C\) (1)

Boiling Point: 280\(^\circ C\) (1)

Solubilities:
- Water: One part in 300,000 (1).
- Nonaqueous Solvents: 1 g/400 mL absolute alcohol, 1 g/102 mL absolute ether, 1 g/40 mL in chloroform, 1 g/35 mL in benzene, 1 g/80 mL in olive oil, 1 g/60 mL turpentine, 1 g/100 mL almond oil (1); Soluble in anhydrous ammonia and toluene (2).

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density (Crystal): 1.88 g/cc (1); 1.82 g/cc at 20\(^\circ\)C (2); 1.83 g/cc (3)

Vapor Pressure: 0.181 mm Hg (1)

Specific Heat: Data not available

Heat of Combustion: Data not available

Reactivity: Very reactive, combines directly with halogens and metals, must be kept under water (1).

Stability: Very unstable, will ignite at 30\(^\circ\)C in moist air (1).
WHITE PHOSPHORUS (cont.)

Flammability: Very (1), autoignition point: 45°C (3).

II. USES
A. Army Unique Use
   Obscurant
B. Other Uses
   Rat poison (1)

III. ANALYTICAL METHODS
A. Best Acceptable Method
   White phosphorus can be detected by some of the same methods as red phosphorus. For detection of white phosphorus, a photometric detector designed to monitor cold chemiluminescence has been reported by Mielniczuk (4).

B. Limit of Detection
   Data not available
### IV. HEALTH EFFECTS

#### TABLE IV-1. TOXICITY OF WHITE PHOSPHOROUS

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>1,400 ug/kg</td>
<td>LD₅₀</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>Acute</td>
<td>Gastrointestinal effects including nausea, vomiting, belching may occur within 30 min; death from cardiovascular collapse can occur within 12 hr; a period of apparent recovery lasting about 2 days may occur followed by the return of gastrointestinal distress with hepatic, renal, and cardiovascular effects including jaundice, pitting edema, oliguria, high pulse rate, and low blood pressure; liver and kidney effects observed at death</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>Chronic</td>
<td>Gastrointestinal distress; phosphorus odor of the breath; slight jaundice; necrosis of bone, particularly the jaw; leukopenia, anemia</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>0.2 mg/kg</td>
<td>Minimum toxic dose</td>
<td>(6)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>16 mg/kg</td>
<td>Effects on the gastrointestinal tract; coma</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>oral</td>
<td>2,600 ug/kg</td>
<td>Effects on the gastrointestinal tract and behavior</td>
<td>(5)</td>
</tr>
<tr>
<td>Human</td>
<td>local</td>
<td>NS*</td>
<td>Severe burns of the skin; ocular damage</td>
<td>(6)</td>
</tr>
</tbody>
</table>

* Not specified
### TABLE IV-1. TOXICITY OF WHITE PHOSPHORUS (Cont.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>inhalation</td>
<td>100-700 mg/m³ for less than 15 min</td>
<td>Phosphorus smoke formulations caused reversible pulmonary symptoms and mucous membrane irritation</td>
<td>(7)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>11 ug/kg, days 1-22 of gestation</td>
<td>Effects on fertility</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>3,030 ug/kg</td>
<td>LD_{50}; effects on behavior and the pulmonary system</td>
<td>(5)</td>
</tr>
<tr>
<td>Mouse</td>
<td>oral</td>
<td>4,820 ug/kg</td>
<td>LD_{50}; effects on behavior and the pulmonary system</td>
<td>(5)</td>
</tr>
<tr>
<td>Rabbit</td>
<td>subcutaneous</td>
<td>10 mg/kg</td>
<td>LD_{Lo}</td>
<td>(5)</td>
</tr>
<tr>
<td>Dog</td>
<td>oral</td>
<td>50 mg/kg</td>
<td>LD_{Lo}</td>
<td>(5)</td>
</tr>
<tr>
<td>Dog</td>
<td>subcutaneous</td>
<td>2 mg/kg</td>
<td>LD_{Lo}</td>
<td>(5)</td>
</tr>
<tr>
<td>Pig</td>
<td>oral</td>
<td>160 mg/kg</td>
<td>LD_{Lo}</td>
<td>(5)</td>
</tr>
<tr>
<td>Duck</td>
<td>oral</td>
<td>3 mg/kg</td>
<td>LD_{Lo}; convulsions</td>
<td>(5)</td>
</tr>
</tbody>
</table>

* Not specified
WHITE PHOSPHORUS (cont.)

V. ENVIRONMENTAL EFFECTS

Summary of Programmatic Life Cycle Assessment

White phosphorous is reported to be transformed into phosphate salts in the environment by the action of water, air and sunlight. Unburned white phosphorous was observed to burn exposed vegetation in the immediate area of release. White phosphorous transformed into phosphates is rapidly complexed by soil constituents and absorbed by soil particles or biota.

Aquatic toxicity of white phosphorous has been difficult to measure because of its reactivity, rapidly disproportionating to phosphorous and phosphoric acids. White phosphorous dissolved in water is toxic to fresh water aquatic invertebrates and fish. White phosphorous is also toxic to saltwater species, with the Atlantic salmon observed to be the most sensitive. One author cited recommended a water quality criterion of 0.6 ug/L for white phosphorous. Prolonged exposure to elevated phosphorus levels in aquatic system can have adverse affects. Water pH may be lowered in some water systems causing algae blooms and lowering of dissolved oxygen resulting in fish kills.

Toxicity was also reported in black ducks and mallards. Sublethal effects of white phosphorous were reported for white phosphorous levels in smokes above 1000 milligrams per cubic meter and animals could receive lethal doses of elemental phosphorus if they ingested unreacted materials containing white phosphorous (8).

A. Environmental Fate

A1. Transport

A1a. Adsorption — Data not available
A1b. Volatilization — Data not available
A1c. Leachability — Data not available

A1d. Bioaccumulation — Radioactive phosphorus has been concentrated by waterfowl up to 75,000 times and by aquatic life by factors up to 850,000. Cod and other marine fish concentrate up to 1,000 times (3).

A2. Transformation — Data not available

A2a. Biodegradation — Data not available
A2b. Hydrolysis — See A2e.
A2c. Photolysis — Data not available
A2d. Other chemical reaction — Burns spontaneously in air (see Stability).

DAMD17-84-C-4133 60-6
A2e. Half-life — Although there are no definitive published reports on the kinetics of oxidation of elemental phosphorus in water, it appears that the rate is highly dependent on the degree of dispersion. At concentration (about 10 ug/L) well below the accepted solubility limit of 3 mg/L (dissolved oxygen concentration unspecified), elemental phosphorus disappears by a first order process, with a half-life of 2 hours at about 10°C, 0.85 hour at 30°C. At concentrations (50 to 100 mg/L) well above the solubility limit, with a dissolved oxygen concentration of 6 to 7 mg/L, the same reaction has a half-life of 80 hours at 30°C and 240 hours at 0°C. The relatively small temperature effect combined with the large inverse concentration effect is consistent with a diffusion-controlled process. The oxidation of colloidal phosphorus in sea water is reported to be measurably slower than in fresh water, suggesting that the high salt content brings about agglomeration of the phosphorus particles (3).

B. Effects on animals
B1. Avian species — Data not available
B2. Mammalian wildlife species — Data not available
B3. Terrestrial invertebrates — Data not available
B4. Reptiles — Data not available
B5. Amphibians — Data not available
B6. Microorganisms, aquatic and soil — Data not available
B7. Aquatic species, fish and invertebrates — Data not available

C. Effects on plants
C1. Phytotoxicity — Data not available
C2. Uptake — Data not available
C3. Metabolism — Data not available

VI. STANDARDS AND REGULATIONS
A. Health
TLV: TWA 0.1 mg/m³; STEL 0.3 mg/m³ for 15 minute exposure (3).
B. **Environmental**

Reported in EPA TSCA Inventory 1980.

Phosphorus has a statutory reportable quantity (RQ) of 1 lb. under the Comprehensive Environmental Response, Compensation and Liability Act. The National Response Center must be notified immediately when there is a release of this compound in an amount equal to or greater than the reportable quantity (9).

VII. **DISPOSAL**

A. **Current Recommended Army Disposal Practices**

A recent programmatic life cycle environmental assessment indicates that incineration is the preferred method for disposal of smoke/obscurant munitions. Munitions containing phosphorous would be incinerated in a unit equipped with afterburner and a scrubber (8).

B. **Alternate Disposal Practices Under Consideration by the Army**

AMCOM anticipates future waste smoke munitions will be demilitarized and white phosphorous recovered as phosphoric acid (8).

C. **Other Disposal Practices Employed**

Data not available

VIII. **REFERENCES**


ZINC NAPHTHENATE

I. CHEMICAL AND PHYSICAL DATA

A. Structural and Chemical Formulas and Molecular Weight

Chemical Formula: \( \text{Zn(C}_6\text{H}_5\text{COO})_2 \)

Molecular Weight: 319.7

Structural Formula: Napthene is a term used in the petroleum industry to denote five- and six-carbon cycloparaffins and their alkyl derivatives, found in crude petroleum. Sometimes used to include polycyclic members found in higher boiling fractions (1). This is not a unique chemical substance (CAS), but represents the Zinc (+2) salts of mixed napthene carboxylic acids.

B. Alternate Names and Registry Numbers

CAS Registry Number: 12001-85-3

CA Name (9CI): Napthenic acids, zinc salts

RTECS Number: QK9275000

Other Significant Synonyms: Zinc uversol

C. Chemical and Physical Properties

Physical State: Mixture, Viscous, basic liquid (with 8-10% Zn) or basic solid (with 16% Zn) (1)

Color: Amber (1)

Odor: Data not available

Melting Point: Not defined for a mixture

Solubilities:

Water: Data not available

Nonaqueous Solvents: Very soluble in acetone. (1)

Octanol Water Partition Coefficient: Data not available

Hygroscopicity: Data not available

Density: Data not available

Volatility: Data not available

Vapor Pressure: Data not available
ZINC NAPTHENATE (cont.)

Specific Heat: Data not available
Heat of Combustion: Data not available
Reactivity: Combustible (1)
Stability: Data not available
Flammability: Data not available

II. USES

A. Army Unique Use

Military anti-mildew agent

B. Other Uses

Drier and wetting agent in paints, varnishes and resins; insecticide, fungicide, and mildew preventive; wood preservative; waterproofing textiles; insulating materials (1).

III. ANALYTICAL METHODS

A. Best Acceptable Method

No methods were found for either zinc napthenate or napthenic acid in searching the Chemical Abstracts System back to 1967. Zinc can be analyzed by either atomic absorption spectroscopy or atomic emission spectrometry. Recently, a method was reported to enhance the detection of zinc by simultaneous inductively coupled plasma atomic emission spectrometry by Hee et al. (2).

B. Limit of Detection

The lower determination range for zinc reported by Hee et al. is 0.01-1.0 microgram/milliliter. The apparent linear range is 2.0 to 250 microgram/milliliter (2).

C. High Performance Liquid Chromatography

Data not available
IV. HEALTH EFFECTS

TABLE IV-1. TOXICITY OF ZINC NAPTHENATE

<table>
<thead>
<tr>
<th>Species</th>
<th>Route</th>
<th>Dose/Duration</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>oral</td>
<td>NS*</td>
<td>Some soluble zinc salts cause nausea and vomiting</td>
<td>(3)</td>
</tr>
<tr>
<td>Human</td>
<td>eyes, skin</td>
<td>NS</td>
<td>Naphthenic acids are irritants</td>
<td>(4)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>4,920 mg/kg (in lard)</td>
<td>LD50</td>
<td>(5)</td>
</tr>
<tr>
<td>Rat</td>
<td>oral</td>
<td>6,000 mg/kg once</td>
<td>Practically nontoxic</td>
<td>(6)</td>
</tr>
<tr>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>Low toxicity</td>
<td>(1)</td>
</tr>
</tbody>
</table>

* Not specified

V. ENVIRONMENTAL EFFECTS

No information was found regarding the environmental fate or effects of zinc naphthenate.

VI. STANDARDS AND REGULATIONS

A. Health

Data not available

B. Environmental

Reported in EPA TSCA Inventory 1980.

VII. DISPOSAL

A. Current Recommended Army Disposal Practices

Disposal practices recommended by the U.S. Navy in their Consolidated Hazardous Item List for Copper Naphthenate, a related compound used for a related purpose, are to turn in to a pesticide collection center, to the original supplier or to a commercial waste disposal service (7).

DAMD17-84-C-4133 61-3
ZINC NAPTHENATE (cont.)

B. Alternate Disposal Practices Under Consideration by the Army

Data not available

C. Other Disposal Practices Employed

Data not available

VIII. REFERENCES


DISTRIBUTION LIST

24 copies
Commander
ATTN: SGRD-UBG
US Army Medical Bioengineering Research and Development Laboratory
Fort Detrick, Frederick MD 21701-5010

2 copies
Commander
US Army Medical Research and Development Command
ATTN: SGRD-RMS
Fort Detrick, Frederick, Maryland 21701-5012

12 copies
Defense Technical Information Center (DTIC)
ATTN: DTIC-DDAC
Cameron Station
Alexandria, VA 22304-6145

1 copy
Dean
School of Medicine
Uniformed Services University of the Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20814-4799

1 copy
Commandant
Academy of Health Sciences, US Army
ATTN: AHS-CDM
Fort Sam Houston, TX 78234-6100