Description of document:	Defense Intelligence Agency report, Reference Book on Chemical Warfare Information (Worldwide), 31 January 1983
Requested date:	23-October-2008
Released date:	10-June-2013
Posted date:	13-August-2013
Source of document:	Commander US Army Intelligence & Security Command Freedom of Information/Privacy Office ATTN: IAMG-C-FOI 4552 Pike Road Fort George G. Meade, MD 20755-5995 Fax: (301) 677-2956 Email: FOIA/Privacy Office Online FOIA Request Form
Note:	This report is one of 16 reports released under Mandatory Declassification Review by the US Army Intelligence & Security Command. All of these reports may be accessed here: http://www/governmentattic.org/inscomBWCW.html

DEPARTMENT OF THE ARMY
UNITED STATES ARMY INTELLIGENCE AND SECURITY COMMAND
FREEDOM OF INFORMATION/PRIVACY OFFICE
FORT GEORGE G. MEADE, MARYLAND 20755-5995

REPLY TO
ATTENTION OF:

Freedom of Information/
Privacy Office

10 JUN 2013

This is in further response to your Freedom of Information Act (FOIA) request of October 23, 2008, and supplements our electronic message of May 12, 2010.

Coordination has been completed with another element of our command and other government agencies and records returned to this office for our review and direct response to you. We have reviewed the records and determined the records are partially releaseable to you. A copy of the records are enclosed for your use.

We have completed a mandatory declassification review in accordance with Executive Order (EO) 13526. As a result of our review information has been sanitized and 4 pages have been withheld in their entirety as the information is currently and properly classified TOP SECRET, SECRET and CONFIDENTIAL according to Sections 1.2(a)(1), 1.2(a)(2), 1.2(a)(3) and 1.4(c) of EO 13526. This information is exempt from the public disclosure provisions of the FOIA pursuant to Title 5 U.S. Code 552 (b)(1). It is not possible to reasonably segregate meaningful portions of the withheld pages for release. The records are enclosed for your use. A brief explanation of the applicable sections follows:

Section 1.2(a)(1) of EO 13526, provides that information shall be classified TOP SECRET if its unauthorized disclosure reasonably could be expected to cause exceptionally grave damage to the national security.

Section 1.2(a)(2) of EO 13526, provides that information shall be classified SECRET if its unauthorized disclosure reasonably could be expected to cause serious damage to the national security.

Section 1.2(a)(3) of EO 13526, provides that information shall be classified CONFIDENTIAL if its unauthorized disclosure reasonably could be expected to cause serious damage to the national security.

Section 1.4(c) of EO 13526, provides that information pertaining to intelligence activities, intelligence sources or methods, and cryptologic information shall be considered for classification protection.

In addition, information has been sanitized from the records and 4 pages have been withheld in their entirety as the release of the information would reveal sensitive intelligence methods. This information is exempt from public disclosure pursuant to Title 5 U.S. Code 552 (b)(7)(E) of the FOIA. The significant and legitimate governmental purpose to be served by withholding is that a viable and effective intelligence investigative capability is dependent upon protection of sensitive investigative methodologies. It is not possible to reasonably segregate meaningful portions of the withheld pages for release.

The withholding of the information described above is a partial denial of your request. This denial is made on behalf of Major General Stephen G. Fogarty, the Commanding General, U.S. Army Intelligence and Security Command, who is the Initial Denial Authority for Army intelligence investigative and security records under the FOIA. You have the right to appeal this decision to the Secretary of the Army. Your appeal must be postmarked no later than 60 calendar days from the date of this letter. After the 60-day period, the case may be considered closed; however, such closure does not preclude you from filing litigation in the courts. You should state the basis of your disagreement with the response and provide justification for a reconsideration of the denial. An appeal may not serve as a request for additional or new information. An appeal may only address information denied in this response. Your appeal is to be made to this office, for forwarding, as appropriate to the Secretary of the Army, Office of the General Counsel.

Coordination has been completed and we have been informed by the Central Intelligence Agency (CIA) that information is exempt from public disclosure pursuant to Title 5 U.S. Code 552 (b)(1) and (b)(3) of the FOIA.

The withholding of the information by the CIA constitutes a denial of your request and you have the right to appeal this decision to the Agency Release Panel within 45 days from the date of this letter. If you decide to file an appeal, it should be forwarded to this office and we will coordinate with the CIA on your behalf. Please cite CIA #F-2010-01292/Army #57F-09 assigned to your request so that it may be easily identified.

Coordination has been completed and we have been informed by the Defense Intelligence Agency (DIA) that their information is exempt from public disclosure pursuant to Title 5 U.S. Code § 552 (b)(1), (b)(2) (b)(3) and (b)(4) of the Freedom of Information Act and Executive Order (EO) 13,526 § 1.4 (c) (d) and (h). The statute invoked under Title 5 U.S. Code 552 (b)(3) is 10 U.S.C. §424, which allows for the protection of organizational and personnel information for DIA.

The withholding of the information by the DIA constitutes a partial denial of your request and you have the right to appeal this decision directly to the DIA. If you decide to file an appeal, it should be forwarded to the Director, Defense Intelligence Agency, ATTN: DAN-1A-FOIA, Washington, DC 20340-5100. Please cite MDR #0155-2010 assigned to your request so that it may be easily identified.

You have received all Army intelligence investigative records pertaining to this request.

There are no assessable FOIA fees.

If you have any questions regarding this action, feel free to contact this office at 1-866-548-5651, or email the INSCOM FOIA office at: INSCOM_FOIA_ServiceCenter@mi.army.mil and refer to case #57F-09.

Sincerely,

Brad S. Dorris
Director
Freedom of Information/Privacy Office
Investigative Records Repository

Enclosure

CONFIDENTIAL

DST-1620H-018-77

REFERENCE SET

DEFENSE
INTELLIGENCE
AGENCY

REFERENCE BOOK ON CHEMICAL WARFARE INFORMATION (WORLDWIDE) (U)

DST-77-C-008252

MAY 1974

CONFIDENTIAL

~~CONFIDENTIAL~~

Posted: 13 Dec

DST-1620H-018-77-CHG 4
31 January 1983

Publication No.
DST-1620H-018-77
Change 4

US ARMY MATERIEL
DEVELOPMENT AND READINESS COMMAND
FOREIGN SCIENCE AND TECHNOLOGY CENTER
Charlottesville, VA 22901

REFERENCE BOOK ON CHEMICAL WARFARE INFORMATION (WORLDWIDE) (U)

Publication No. DST-1620H-018-77 (formerly ST-HB-03-18-74), published May 1974, is amended as follows: The pages listed below are to be removed and destroyed in accordance with existing security regulations, and new pages are substituted therefor, or are added.

Remove pages:	Insert new pages:
Front and back covers	Front and back covers
Title page	Title page
v and vi	v thru vi.1 (Reverse Blank)
xi thru xiv	xi thru xiv
---	268.1 and 268.2
353 and 354	353 thru 354.2
356.9 thru 356.12	356.9 thru 356.12
A-1 thru A-4	A-1 thru A-4

NOT RELEASABLE TO FOREIGN NATIONALS

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~~CONFIDENTIAL~~

(This page is UNCLASSIFIED)

1709

~~CONFIDENTIAL~~

DST-1620H-018-77-CHG 3
4 March 1981

Publication No.
DST-1620H-018-77
Change 3

US ARMY MATERIEL
DEVELOPMENT AND READINESS COMMAND
FOREIGN SCIENCE AND TECHNOLOGY CENTER
Charlottesville, VA 22901

REFERENCE BOOK ON CHEMICAL WARFARE INFORMATION (WORLDWIDE) (U)

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Remove pages:	Insert new pages:
Front and back covers	Front and back covers
Title page	Title page
iii thru vi.1 (Reverse Blank)	iii thru vi
xiii thru xiv.2	xiii thru xiv.2
1 and 2	1 thru 2.2
17 and 18	17 and 18
51 thru 54	51 thru 54
329 thru 332.1 (Reverse Blank)	329 thru 332.3 (Reverse Blank)
341 thru 344.4 also had to remove Pages 344.5 ⇨ 344.6	341 thru 344.12
355 thru 356.2	355 thru 356.2b
356.7 thru 356.13 (Reverse Blank)	356.7 thru 356.15 (Reverse Blank)
361 and 362	361 thru 366
I-1 and I-2	I-1 and I-2
A-1 thru A-4	A-1 thru A-4

~~Confidential~~ Change 3 incorporated into Basic Document STS 3-11612 cy 3 of 28 cy. Which resulted in all SECRET pages being removed and destroyed. Basic Document now becomes Confidential. Secret pages were removed and destroyed on 6 Apr 1981. Posted 27 Mar 81 ERA

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~~CONFIDENTIAL~~

(This page is UNCLASSIFIED)

Posted: 23 May 79 S Copy

~~SECRET~~

6 June 1979

DST-1620H-018-77-CHG 2

Publication No.
DST-1620H-018-77
Change 2

US ARMY MATERIEL
DEVELOPMENT AND READINESS COMMAND
FOREIGN SCIENCE AND TECHNOLOGY CENTER
Charlottesville, VA 22901

REFERENCE BOOK ON CHEMICAL WARFARE INFORMATION
(WORLDWIDE) (U)

Publication No. DST-1620H-018-77 (formerly ST-HB-03-18-74), published May 1974, is amended as follows: The pages listed below are to be removed and destroyed in accordance with existing security regulations, and new pages are substituted therefor, or are added.

Remove pages:	Insert new pages:
Front cover	Front cover
Title page	Title page
v thru vi.1 (Reverse Blank)	v thru vi.1 (Reverse Blank)
xiii thru xiv.2	xiii thru xiv.2
329 and 330	329 and 330
335 thru 338	335 thru 338
344.1 and 344.2	344.1 and 344.2
356.7 thru 356.12 removed 1 (S) page	356.7 thru 356.13 (Reverse Blank)
A-1 and A-2	A-1 thru A-4
Back cover	Back cover

NATIONAL SECURITY INFORMATION
Unauthorized disclosure subject to
criminal sanctions

NOT RELEASABLE TO FOREIGN NATIONALS

Posted: Secret page removed and destroyed 24 May 79. (DDL)

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~~SECRET~~

(This page is UNCLASSIFIED)

~~SECRET~~

Posted 27 June 77 HHB

June 1977

DST-1620H-018-77-CHG 1

Publication No.
DST-1620H-018-77
Change 1

US ARMY MATERIEL
DEVELOPMENT AND READINESS COMMAND
FOREIGN SCIENCE AND TECHNOLOGY CENTER
Charlottesville, VA 22901

REFERENCE BOOK ON CHEMICAL WARFARE INFORMATION (WORLDWIDE) (U)

Publication No. ST-HB-03-18-74, published May 1974, is amended as follows: The pages listed below are to be removed and destroyed in accordance with existing security regulations, and new pages are substituted therefor, or are added.

Remove pages:	Insert new pages:	Remove pages:	Insert new pages:
Front and back covers	Front and back covers	103 and 104	103 and 104
Title page	Title page	151 and 152	151 and 152
iii thru vi	iii thru vi.1 (Reverse Blank)	191 and 192	191 and 192
ix thru xiv	ix thru xiv.2	197 and 198	197 and 198
1 and 2	1 and 2	329 thru 332	329 thru 332.1 (Reverse Blank)
11 and 12	11 and 12	335 thru 356	335 thru 356.12
15 thru 18	15 thru 18	359 and 360	359 thru 362
21 and 22	21 and 22	I-1 and I-2	I-1 thru I-2.2
29 and 30	29 and 30	IV-5 and IV-6	IV-5 and IV-6
47 thru 58	47 thru 58	IV-9 and IV-10	IV-9 and IV-10
69 and 70	69 and 70	IV-15 and IV-16	IV-15 and IV-16
73 thru 76	73 thru 76	IV-21 and IV-22	IV-21 and IV-22
		A-1 thru B-2	A-1 and A-2

Note: Effective 1 October 1975, after publication of this product, the caveat NO FOREIGN DISSEM (abbreviated NFD) was changed to NOT RELEASABLE TO FOREIGN NATIONALS (abbreviated NOFORN). Appropriate changes should be made throughout the body of this publication to reflect the new policy. In addition, the caveat REL TO (Specific Country) should be changed to NOFORN wherever it appears throughout this document, in accordance with current DIA policy.

~~STS3 11612 cy 3 of 28~~

NATIONAL SECURITY INFORMATION
Unauthorized disclosure subject to criminal sanctions

~~Cy 15 of 15~~
~~STS7 1895~~

NOT RELEASABLE TO FOREIGN NATIONALS

Change 1, STS7 1895 cy 15 of 15 cys incorporated into STS3 11612 cy 3 of 28 cys.
Posted: Superseded pages were destroyed on 27 June 77 HHB

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~~SECRET~~

(This page is UNCLASSIFIED)

1711A

~~SECRET~~

30 May 1974

CONFIDENTIAL

ST-HB-03-18-74

posted
E. Lindsey
6/12/74

ERRATA

(b)(1)

NATIONAL SECURITY INFORMATION
Unauthorized disclosure subject to
criminal sanctions

~~NO FOREIGN DISSEM~~

NOT RELEASABLE TO
FOREIGN NATIONALS

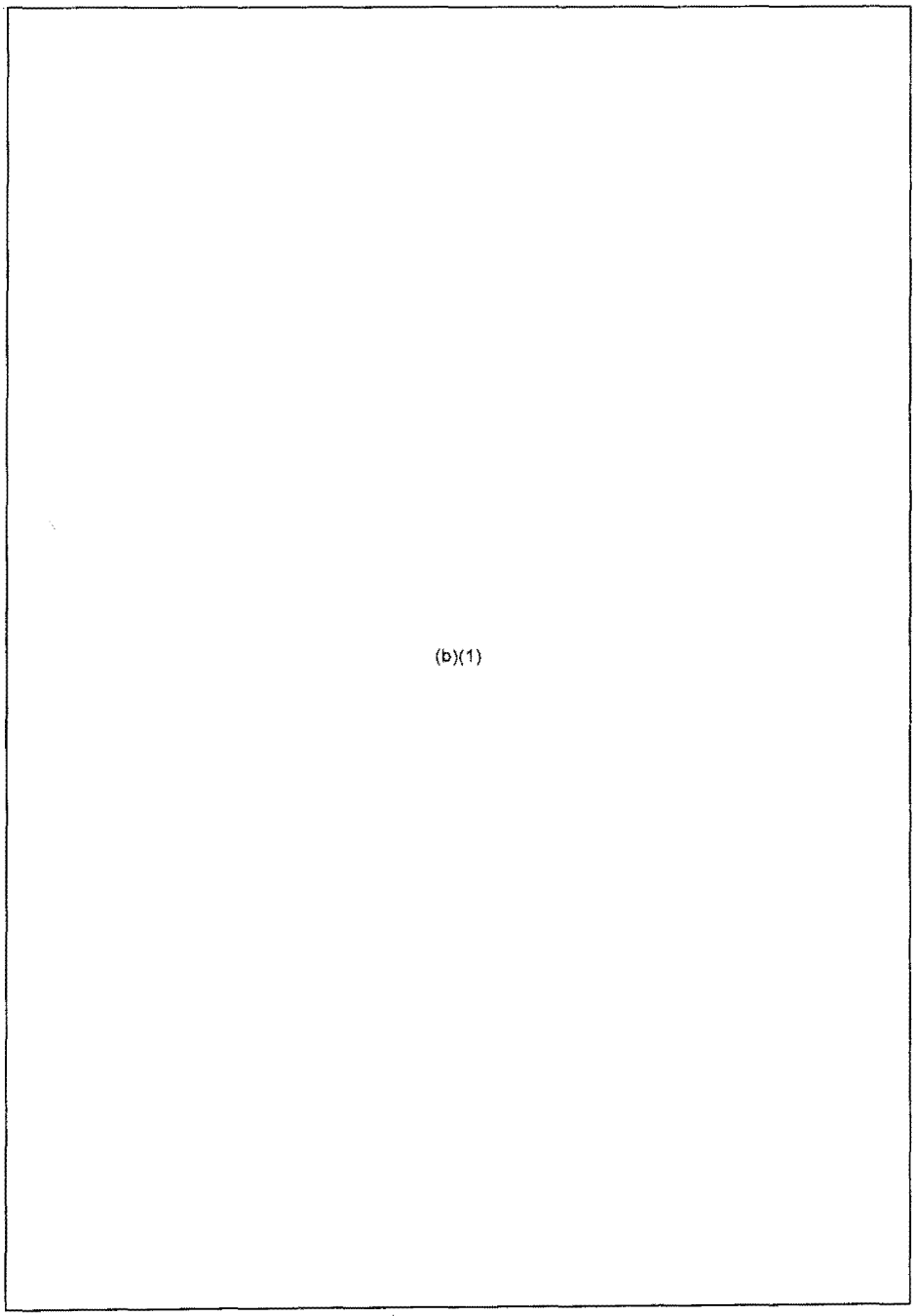
Classified by Cdr, USAFSTC
Exempt from GDS of EO 11652
Exemption Category: 3
Declassify on: IMPDET

~~SECRET~~

(This page is CONFIDENTIAL)

Misnumbered Page

1713



(b)(1)

(b)(1)

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NOTICE

Looseleaf binders have been ordered for this publication and will be furnished to the recipients in the near future.

~~CONFIDENTIAL~~

REFERENCE BOOK ON CHEMICAL WARFARE INFORMATION (WORLDWIDE) (U)

AUTHORS

(b)(6)

DST-1620H-018-77-CHG 4

DIA TASK UNIT PT-1620-01-02L

DATE OF PUBLICATION
31 January 1983

Information Cutoff Date
November 1982

Supersedes ST-HB-03-18-72, dated 29 September 1972.

This is a Department of Defense Intelligence Document prepared by the Foreign Science and Technology Center, US Army Materiel Development and Readiness Command, with contributions from the US Army Medical Intelligence and Information Agency and approved by the Assistant Vice Directorate for Scientific and Technical Intelligence of the Defense Intelligence Agency.

NOT RELEASABLE TO FOREIGN NATIONALS

CLASSIFIED BY: MULTIPLE SOURCES
DECLASSIFY ON: 1 SEPTEMBER 2011

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(This page is UNCLASSIFIED)

PREFACE

(b)(1)

(U) This publication is intended for use by planners on the various Department of Defense and Department of the Army staffs, arms-control negotiators, and other military and civilian chemical warfare experts in the Federal Government.

(b)(1)

(U) Appropriate material was derived from both foreign and domestic sources, classified as well as unclassified. Available sources included handbooks, manuals, textbooks, periodicals, scientific reports from US and foreign research installations, as well as reports from and studies by the intelligence community.

(b)(1)

(U) This handbook is being disseminated devoid of bibliographic material to facilitate wider distribution. A compiled bibliography has been prepared separately and can be made available to authorized recipients upon request to the Commander, US Army Foreign Science and Technology Center, 220 Seventh Street NE., Charlottesville, VA 22901 (ATTN: DRXST-PO). Unannotated material in the text generally was obtained from the original document, Handbook of Chemical Warfare Information (S-NOFORN), dated June 1970, prepared by the US Navy.

(U) The Foreign Intelligence Officer and scientific personnel of the US Army research laboratories and technical directorates at Edgewood Arsenal have contributed substantially to the accuracy of this study as the result of their review of the subject matter and their subsequent recommendations.

★ (U) A star in the left margin indicates that the adjacent paragraph contains significant new or revised information since the last edition of this study. A star preceding a table or figure caption indicates either that the table or figure is new or that it has been changed in some respect.

(U) Constructive criticisms, comments, or suggested changes are encouraged and should be forwarded to the Defense Intelligence Agency, Washington, DC 20301 (ATTN: DT).

The original pages of this product were published before the international system of units (Le Systeme International d'Unites) (SI) was adopted for use throughout the Department of Defense. The SI system (as described in the American Society for Testing and Materials Standard Metric Practice Guide, E 380-74) has been used, however, in recent amendments to the basic product and will be used in all future amendments to facilitate conversion to metric units of measure.

LIST OF EFFECTIVE PAGES

SUBJECT MATTER	PAGE NUMBERS	DATE
Title Page	None	31 January 1983
Preface	iii and iv	4 March 1981
List of Effective Pages ...	v thru vi.1 (Reverse Blank)	31 January 1983
Record of Changes	vii (Reverse Blank)	Original
Table of Contents	ix thru xiv.2	--------
	ix and x	June 1977
	xi thru xiv	31 January 1983
	xiv.1 and xiv.2	4 March 1981
Summary	xv and xvi	Original
Section I	1 thru 64	--------
	1 thru 2.2	4 March 1981
	3 thru 10	Original
	11 and 12	June 1977
	13 and 14	Original
	15 and 16	June 1977
	17 and 18	4 March 1981
	19 and 20	Original
	21 and 22	June 1977
	23 thru 28	Original
	29 and 30	June 1977
	31 thru 46	Original
	47 thru 50	June 1977
	51 thru 54	4 March 1981
	55 thru 58	June 1977
	59 thru 64	Original
Section II	65 thru 106	--------
	65 thru 68	Original
	69	June 1977
	70 thru 72	Original
	73	June 1977
	74	Original
	75	June 1977
	76 thru 102	Original
	103	June 1977
	104 thru 106	Original
Section III	107 thru 122	Original
Section IV	123 thru 146	Original
Section V	147 thru 171 (Reverse Blank)	--------
	147 thru 150	Original
	151	June 1977
	152 thru 171 (Reverse Blank)	Original
Section VI	173 thru 189 (Reverse Blank)	Original

Original

ST-HB-03-18-74

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	SIGNATURE, RANK/RATE AND ORGANIZATION OF INDIVIDUAL ENTERING CHANGE
1	June 77	27 Jun 77	(b)(6) FSTC, GS-04
2	6 Jun 79	23 May 79	
3	4 Mar. 81	26 Mar. 81	

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Original

SUMMARY

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SECTION I

NERVE AGENTS (U)

A. INTRODUCTION (U)

1. Cholinesterase Inhibitors (U)

(U) The most important nerve agents constitute a series of organophosphorus compounds that are more toxic and insidious than any of the other standard chemical warfare (CW) agents. The organophosphorus nerve agents include the well-known conventional G-agents that were developed during World War II; the thiocholine derivatives of the G-agents are termed V-agents (they are noted for their lower volatility and their higher skin-penetrating power); and the fluorophosphorylcholines, in which an oxygen atom replaces the sulfur in the thiocholine moiety of the V-agents and a fluorine atom is attached to the phosphorus. The nerve agents may gain entry into the body through the skin and eyes, by inhalation, or by ingestion of contaminated food or water. Nerve agents inhibit the enzyme acetylcholinesterase (AChE), which hydrolyzes the neurotransmitter acetylcholine. When this enzyme is inhibited, acetylcholine accumulates at the junctions of various nerve endings (cholinergic sites). The effect of this excessive acetylcholine is overstimulation of the smooth and skeletal muscles, the ganglia, and the glands, which can lead to convulsions, paralysis, and death. The most effective known nerve agents are organophosphorus compounds. Carbamate esters are another class of compounds that inhibit AChE. The following illustration shows the mechanisms for the natural breakdown of acetylcholine, organophosphorus inhibition, and carbamate inhibition. Under normal conditions, acetylcholine binds to the active site of the enzyme and is then rapidly hydrolyzed to choline and acetic acid, freeing the enzyme to hydrolyze more acetylcholine. Organophosphorus compounds bind to the active site of the enzyme and block the hydrolysis of acetylcholine. If an oxime such as pralidoxime is added quickly enough, it can reactivate the enzyme through a nucleophilic displacement reaction; if not, the phosphorylated enzyme dealkylates, or "ages," and the enzyme is permanently blocked. Carbamate esters bind to the active site in the same manner as acetylcholine, but the reaction proceeds at less than a millionth of the rate. The enzyme is blocked during this time and acetylcholine accumulates. Unlike organophosphate inhibition, the carbamylated enzyme will readily self-reactivate.

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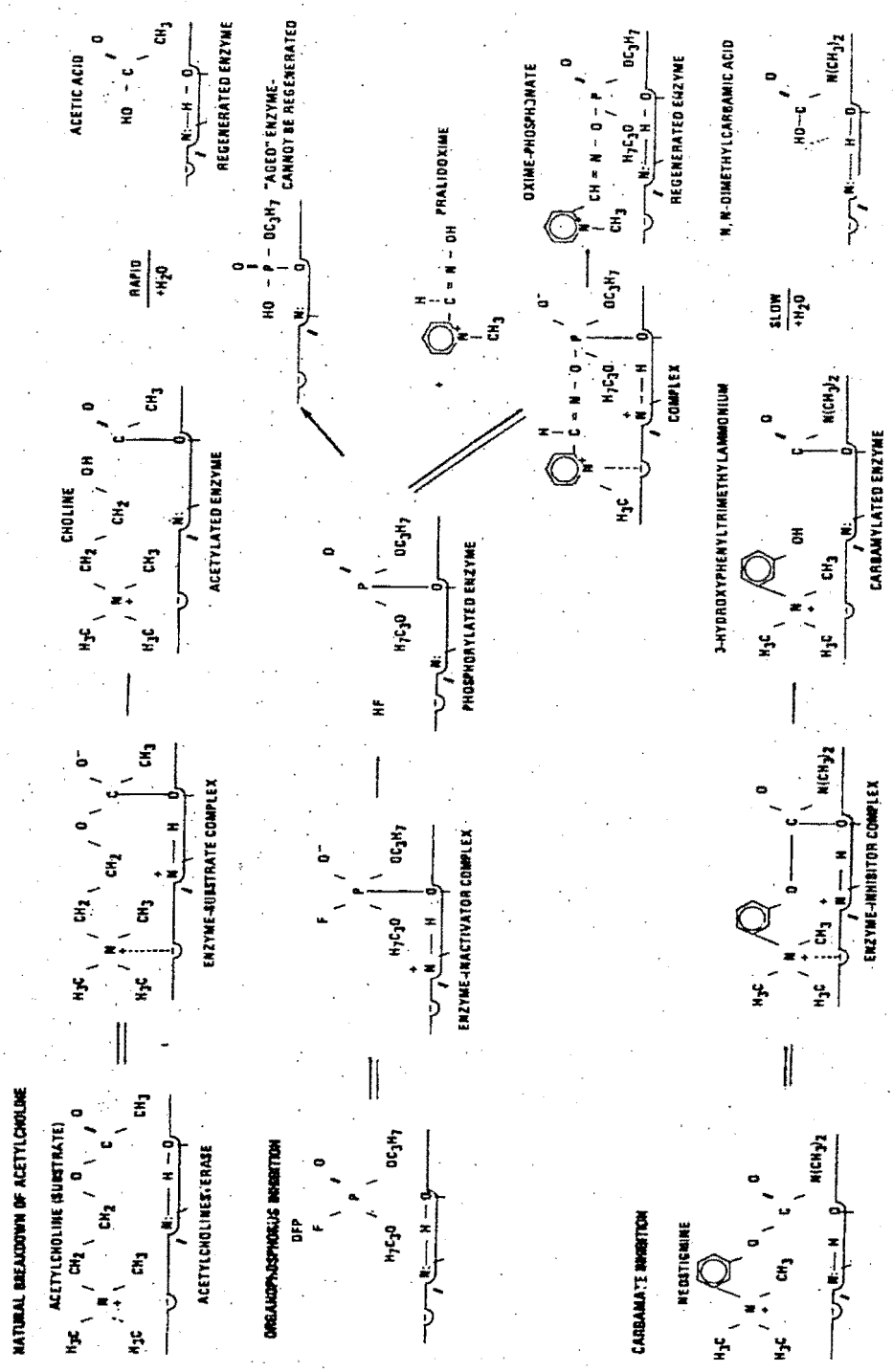
DST-1620H-018-77-CHG 3
4 March 1981



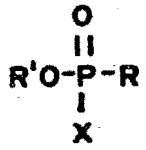
2. Symptoms of Nerve Agent Poisoning (U)

(U) In the parasympathetic system, the symptoms of nerve agent poisoning have been differentiated as muscarinic or nicotinic effects; some symptoms are also derived from central nervous system effects. Muscarinic effects are the result of the stimulation of autonomic effector cells of glands and smooth muscles and include such signs as contraction of the pupil of the eye, vomiting, salivation, loss of appetite, bronchial constriction, and bronchial spasms. Nicotinic effects result from stimulation and then blockage of the autonomic ganglia and end plates of skeletal muscles; these effects become evident by symptoms of fatigue, muscular weakness, involuntary twitching, convulsions, and paralysis of respiratory muscles. The toxic effects on the central nervous system cause dizziness, speech and equilibrium disturbances, depression of the respiratory center, and unconsciousness. The muscarinic, nicotinic, and central actions all contribute to the respiratory failure that finally results in death.

B. G-AGENTS (U)

3. General (U)

(U) The G-agents are organophosphorus nerve agents that were discovered and developed during World War II by German scientists as they searched for new insecticides. The G-agents have the basic structural configuration where R is an alkyl or amino group, R' is an alkyl group, and X is a halogen atom or cyano group. This class of compounds, typified by tabun, sarin, and soman, is considered by Western countries, and apparently also by the Soviets, to contain chemical agents suitable for military use. In the immediate post World War II period, the effects of substituting different chemical groupings in the R and R' positions on a compound's toxicity as well as its physical and chemical properties were extensively investigated.



Neg. 513054

4. Sarin (U)

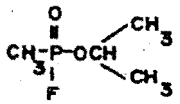
a. (C) Code or Alternate Designations (U).

- United States--GB, EA 1208, MFI, TL-1618 (U)
- (b)(1)
- Germany--Trilon 46, T-144, Gelan III (U)
- USSR--Zarin (U), (b)(1)
- (b)(1)

b. (U) Class (U). Nerve agent.

c. (U) Chemical name (U). O-isopropyl methylphosphonofluoridate.

d. (U) Formula. $C_4H_{10}FO_2P$



e. (U) Molecular Weight. 140.10.

f. (U) Alternate Chemical Names.

- Isopropyl ester of methylphosphonofluoridic acid.
- Methylisopropoxyfluorophosphine oxide.
- Isopropoxymethylphosphoryl fluoride.

g. (U) Raw Materials.

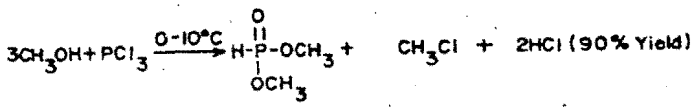
- Phosphorus (P).
- Chlorine (Cl_2).
- Methyl alcohol, 99% water-free (CH_3OH).
- Methyl chloride (CH_3Cl).
- Sodium fluoride, 97% to 98% pure (NaF).
- Hydrogen fluoride, 98% pure (HF).
- Metallic sodium (Na).
- Isopropyl alcohol, 99% pure, water-free (C_3H_7OH).

h. (U) Method of Manufacture.[2]

(1) (U) Method A. (Salt Process).

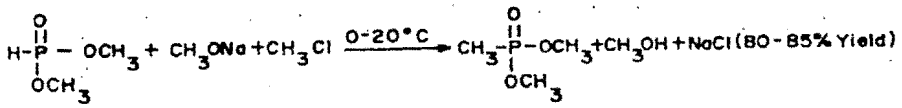
$$2P + 3Cl_2 \longrightarrow 2PCl_3$$

Phosphorus trichloride

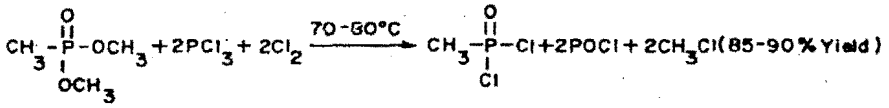


Dimethyl phosphonate

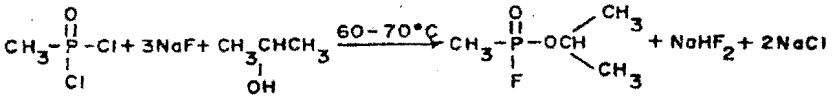
Sodium methylate



Dimethyl methyl-phosphonate

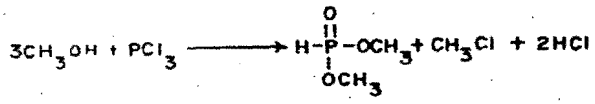


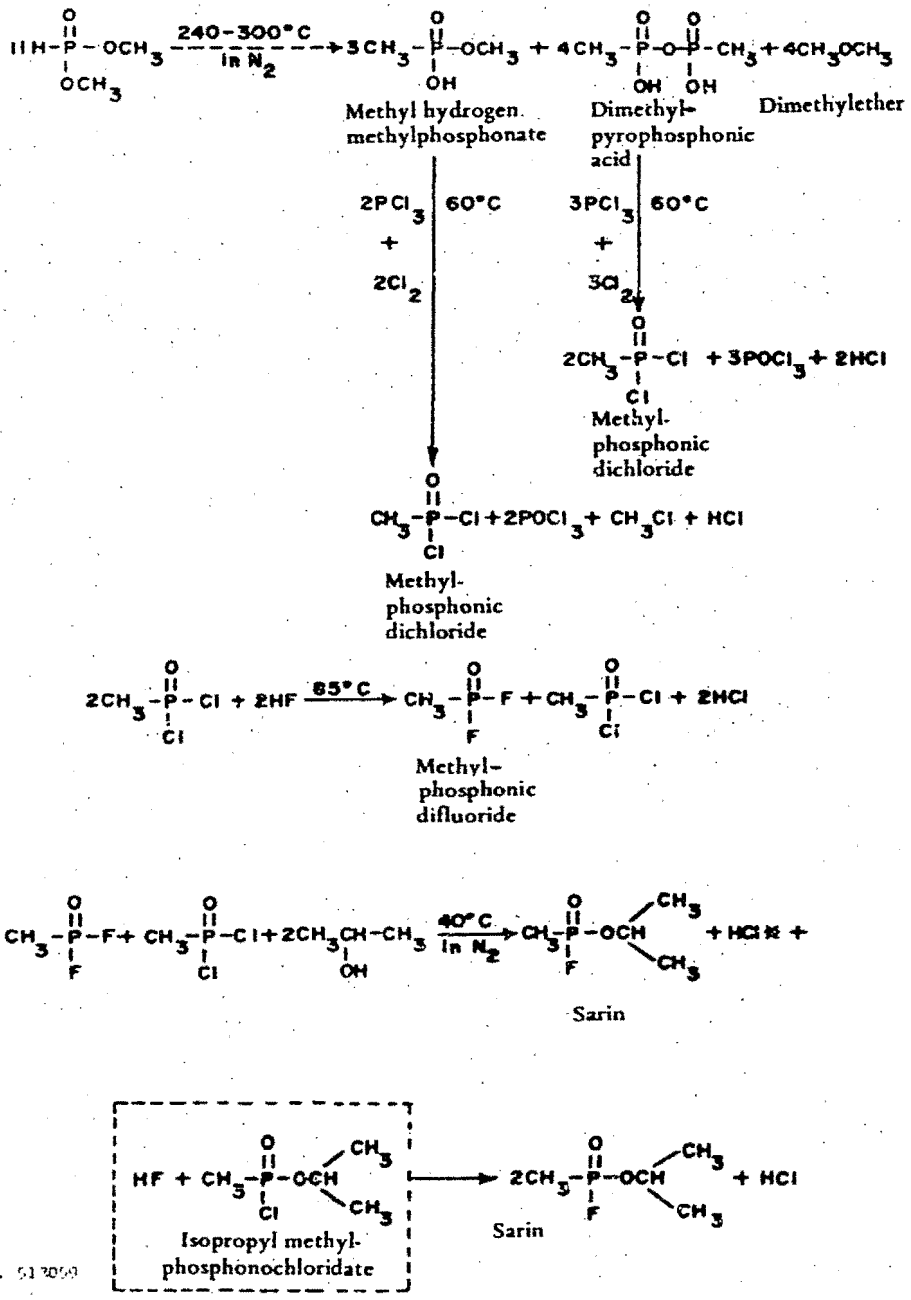
Methyl-phosphonic dichloride



Sarin

(2) (U) Method B. (Rearrangement Process).





*HCl is removed immediately; intermediate in box reacts to give the second mole of product.

i. (U) Equipment. Hastelloy "B" or silver-lined reaction vessels, pipes, and connections.

j. (U) Physical and Chemical Properties.

- Odor: Almost none when pure.[5]
- Physical state and color: Liquid and vapor both colorless.[4]
- Boiling point: 147° C at 760 mm Hg, 56° C at 16 mm Hg.[3,5]
- Melting point: -56° C.[5]
- Solubility: Miscible with water; soluble in gasoline, alcohols, fats, and oils.
- Vapor density (relative to air): 4.86.[5]
- Specific gravity (liq): 1.0887 at 25° C.[5]
- Volatility: 4300 mg/m^3 at 0° C; 21,900 mg/m^3 at 25° C; 38,500 mg/m^3 at 35° C.[4]
- Vapor pressure: 2.2 mm Hg at 25° C.[5]
- Heat of vaporization: 84.93 cal/g (average 25° and 50° C).[5]
- Flash point: Nonflammable.[5]
- Hydrolysis: In dilute acid solution, GB hydrolyzes to HF and isopropyl methylphosphonic acid. If the products are allowed to remain in the acid solution, the isopropyl methylphosphonic acid forms isopropyl alcohol and methylphosphonic acid. In more strongly acid solutions, GB hydrolyzes to isopropyl alcohol, and methylphosphonofluoridic acid. In alkaline solution, GB produces only the salts of hydrofluoric acid and isopropyl methylphosphonic acid. The rate of hydrolysis varies with pH. At pH between 4 and 6.5, the rate is at a minimum. The half-life of GB at 25° C in this pH range is about 175 hr. Rapid hydrolysis occurs under both acid and alkaline

conditions. In 0.1N acid, the half-life is approximately 15 min; in 0.1N alkali, the half-life is less than 1 sec. In unbuffered aqueous solution, the rate changes as the hydrolysis proceeds since the pH changes during the process.[5,12]

(b)(1)

l. (U) Use. High concentrations of GB cause death by inhalation of vapor and airborne droplets or by absorption of liquid through the skin or eyes. At low concentrations, it is effective for troop harassment and as a psychological weapon. Inhalation of even very low concentrations from ground contamination may result in blurring of vision; because eye effects may or may not indicate absorption of lethal concentrations, the morale of troops will be reduced as fears arise that a lethal dose could have been inhaled.

m. (U) Physiological Effects.

(1) (U) Typical signs and symptoms of nerve agent poisoning are tightness of the chest, nasal discharge and salivation, miosis with blurring of vision, difficulty in accommodation with frontal headache, muscular weakness and lack of coordination, profuse and uncontrollable vomiting, nausea, diarrhea, and incontinence of urine and feces. In addition to the signs and symptoms above, severe and fatal doses will lead to respiratory distress with collapse, convulsions, paralysis, and finally death due to heart muscle failure and asphyxia. Death generally occurs within an hour of exposure to a lethal concentration. Sarin, like the other nerve agents, does not give any immediate warning of its presence because it has no sensory irritation effect.

(2) (U) Poisoning may result from inhalation of the Sarin; absorption through the eyes, skin, or mucous membrane; ingestion of contaminated food and water; or from contaminated wounds.

(3) (U) Sarin is essentially a cumulative poison since it has a low rate of detoxification.

n. (U) Therapy. Administration of atropine, oximes, and artificial respiration.

o. (U) Decontamination.[6,8] Alcoholic solution of sodium or potassium hydroxide; scrubbing with hot soapy water; solutions (10%) or pastes of washing soda or baking soda; DS-2; bleach slurry. Liquid

agent on the skin may be decontaminated with fuller's earth pad in US M13 Individual Decontaminating and Reimpregnating Kit. Large supplies of GB may be destroyed by incineration at high temperatures in the presence of air.

(b)(1)

q. (U) Storage.[10,11] The stability of GB improves with purity. Pure GB is reasonably stable in steel containers at normal temperatures. A stabilizing effect is exerted by amines (triethylamine or tributylamine) and by solvents such as methanol and the halogen alkanes.

(b)(1)

*See Appendix III.

(2) ~~(C)~~ Percutaneously—

(b)(1)

s. (U) Persistence. Non-persistent (US); Soviets claim that Sarin can persist and remain a hazard in the summer for several hours and in the winter for several days.

t. (U) Historical.

- 1938: Discovered by Schrader in Germany. Production never passed the pilot plant stage.
- 1945: The plant was dismantled by the Soviets and removed from Dyhernfurth to the USSR.

u. ~~(C)~~ Detection.

(1) ~~(C)~~ Detectors.

(a) ~~(C)~~ USSR.

(b)(1)

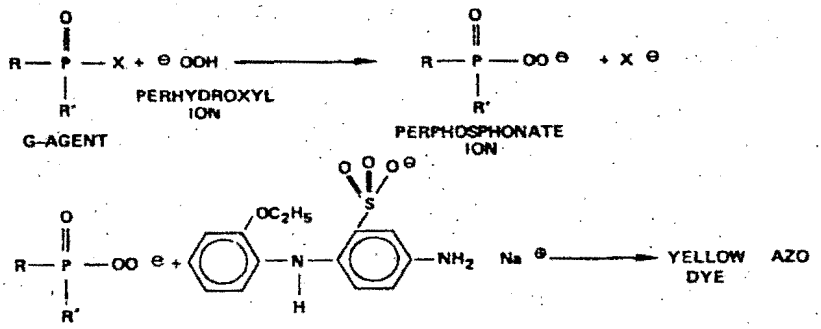
(b)

(c)

(b)(1)

(2) ~~(C)~~ (U) Chemical reactions.[21]

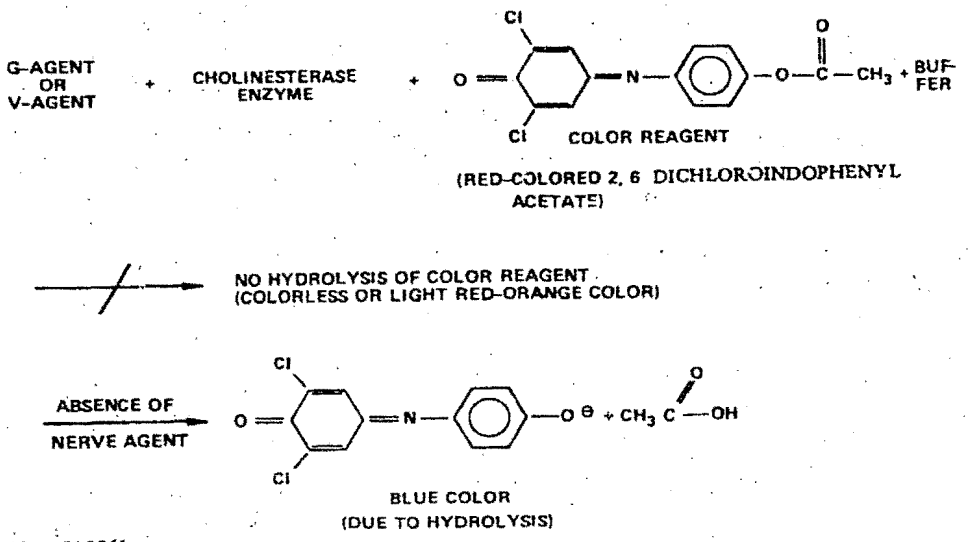
(a) (U) Schoenemann reaction.



Neg. 513060

Note - *o*-Tolidine or *o*-dianisadine also may be used as color reagent. These reagents produce a yellow-orange color and a yellow color, respectively.

(b) (U) Enzyme reaction.



Neg. 513061

Note 1. A strong base will hydrolyze the color reagent to give a false negative response.

Note 2. Enzyme reaction is being adapted to an electrochemical automatic alarm.

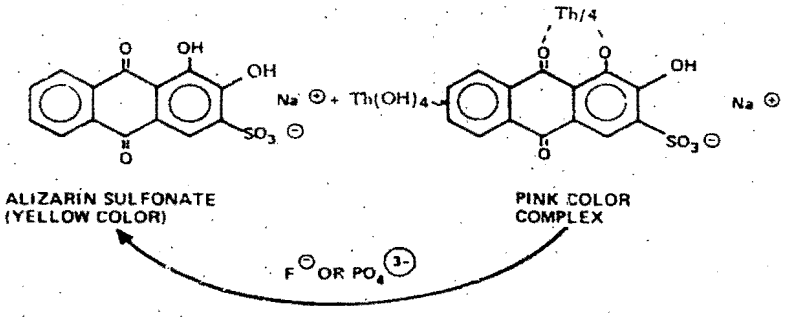
(c) (C) Oxime reaction (M8 Point Alarm).[23]

(b)(1)

*CN$^{\ominus}$ is detected electrochemically, using a silver electrode.

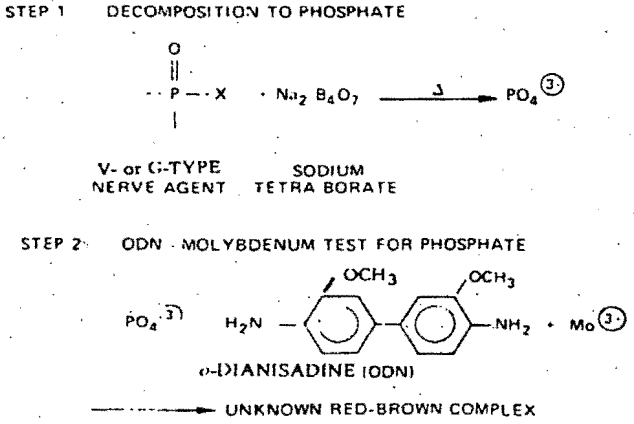
(b)(1)

(d) (U) Alizarin Lake test (for hydrolyzable fluoride and phosphate).



Note - This test is run in conjunction with step 2 of the ODN-Molybdenum Peroxide test and the Schoenemann Reaction to determine presence of Sarin, Soman, or GF. A fluoride-containing G-agent is indicated if the ODN-Molybdenum reaction is negative and if the Alizarin Lake test and Schoenemann Reaction are positive.

(e) (U) ODN-Molybdenum Peroxide test (for organophosphorus compounds).



Note - Step 2 alone must be performed on a control sample to determine if $PO_4^{\ominus}$ was present in test sample before decomposition by combustion and oxidation in Step 1.

(b)(1)

5. Soman.

a. Code or Alternate Designations.

- United States--GD, Soman. (U)

(b)(1)

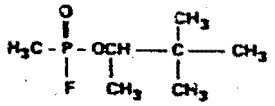
- Germany--Soman. (U)
- USSR--Zoman. (U)

(b)(1)

b. (U) Class. Nerve agent.

c. (U) Chemical Name. 3,3-Dimethyl-2-butyl methylphosphonofluoridate.

d. (U) Formula. $C_7H_{16}FO_2P$



Reg. 513063

e. (U) Molecular Weight. 182.18.

f. (U) Alternate Chemical Names.

- Pinacolyl methylphosphonofluoridate.
- 1,2,2-Trimethylpropyl methylphosphonofluoridate.
- Methylpinacolyloxyfluorophosphine oxide.
- Pinacoloxymethylphosphoryl fluoride.
- Pinacolyl methane fluorophosphonate.
- Methylfluoropinacolylphosphonite.
- Fluoromethylpinacoloxyphosphine oxide.

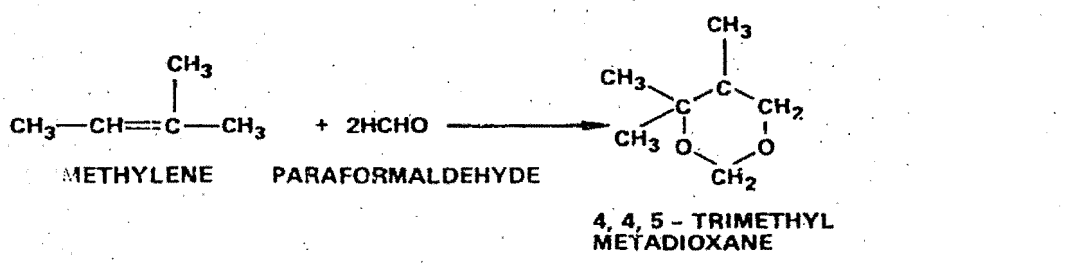
g. (U) Raw Materials.

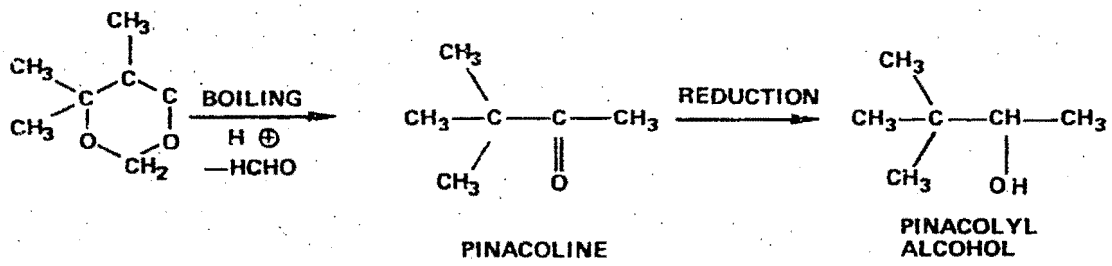
- Methyl alcohol, 99.9% pure (CH_3OH).
- Hydrogen fluoride (HF).
- Pinacolyl alcohol [$(CH_3)_3CCHOHCH_3$].
- Sodium fluoride (NaF).
- Phosphorus (P).
- Chlorine (Cl_2).

h. (U) Method of Manufacture.

(1) (U) Same as for GB, except that pinacolyl alcohol is substituted for isopropyl alcohol with a temperature of 60° C for the final step of the "Rearrangement" process and 100° C for the "Salt" process. Pinacolyl alcohol may be synthesized from acetone (CH_3COCH_3), hydrogen (H_2), metallic magnesium (Mg), and sulfuric acid (H_2SO_4).

(2) (U) A Soviet method involves the preparation of 4,4,5-trimethyl metadioxane and its subsequent conversion to pinacolyl alcohol according to the following reactions.[24]





Neg. 513064

i. (U) Equipment. Hastelloy "B" or silver-lined reaction vessels, pipes, and connections.

j. (U) Physical and Chemical Properties.

- Odor: Essentially odorless; impurities give a camphor odor.[5]
- Physical state and color: Liquid and vapor both colorless.[5]
- Boiling point: 198°C.[159]

- Melting point: -42°C. Does not crystallize at this temperature but becomes glassy.[159]
- Solubility: Soluble in water, sulfur mustard,[11] gasoline, alcohols, fats, and oils.
- Vapor density (relative to air): 6.33.[5] Specific gravity (liq): 1.022 at 25°C.[5]
- Volatility: 5880 mg/m^3 at 30°C; 4020 mg/m^3 at 25°C; 450 mg/m^3 at 0°C.[10]
- Vapor pressure: 54.7 Pa at 25°C.[5]
- Heat of vaporization: 55.35 kJ/mol.[159]
- Thermal stability: Soman decomposes noticeably above 150°C.[11]
- Hydrolysis: Hydrolysis products include HF. Rate varies with pH. Complete in 5 min in 5% NaOH solution.[4]

k. ~~(C)~~ Method of Dissemination (U).[6 7 16] (b)(1)

(b)(1)

l. (U) Use (U). Same as for sarin.

m. (U) Physiological Effects (U). Same as for sarin, except that GD is less volatile, acts faster in lower concentrations, is more readily absorbed through the skin, and GD-poisoning is less responsive to standard nerve agent therapy.

n. ~~(C-NOFORN)~~ Therapy (U). (b)(1)

(b)(1)

o. (U) Decontamination (U).[6] Same as for sarin.

NOT RELEASABLE TO FOREIGN NATIONALS

p. (U) Protection Required (U).[8 9] A well-fitting protective mask with activated charcoal in canister. Protective clothing made of nylon laminated over butyl rubber is said to afford protection against liquid GD. Absorbed by ordinary clothing, GD may be given off for about 30 min after contact with vapor.

q. (U) Storage (U). GD is stable in the pure state, but less stable than tabun (GA) or GB. GD is slightly corrosive to metals.

r. Toxicity (U).[10 12]

(1) (C) By inhalation (U). (b)(1)

(b)(1)

(2) (C) Percutaneously (U).

(b)(1)

s. (U) Persistence (U). Semipersistent. Heavily splashed liquid may persist for 1 to 2 days under average weather conditions.

t. (U) Historical (U). 1944: Discovered by Kuhn at Heidelberg, Germany. The agent was still in laboratory stage at end of World War II.

u. (U) Detection (U).

- US--Same as for sarin. Sensitivity of M8 Point Alarm is 0.4 mg/m^3.[22]
- USSR--Same as for sarin.

6. Tabun (U)

a. (U) Code or Alternate Designations (U).

(b)(1)

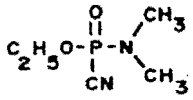
NOT RELEASABLE TO FOREIGN NATIONALS

- North Korea (USSR?) -- R-18. (C)[1]
- USSR -- Tabun. (U)
- North Vietnam -- Ta Bun. (C)

b. (U) Class. Nerve Agent.

c. (U) Chemical Name. Ethyl dimethylphosphoramidocyanidate.

d. (U) Formula. $C_5H_{11}N_2O_2P$



513069

e. (U) Molecular Weight. 162.13.

f. (U) Alternate Chemical Names.

- Ethyl N, N-dimethylphosphoramidocyanidate.
- Dimethylaminoethoxy-cyanophosphine oxide.
- Dimethylamidoethoxyphosphoryl cyanide.
- Ethyldimethylaminocyanophosphonate
- Ethyl ester of dimethylphosphoroamidocyanidic acid.
- Ethylphosphorodimethylamidocyanidate.

g. (U) Raw Materials.

- Methyl alcohol (CH_3OH).
- Ammonia (NH_3).
- Aluminum oxide (Al_2O_3).

- Phosphorus (P).
- Chlorine (Cl_2).
- Oxygen (O_2).
- Sodium cyanide (NaCN).
- Ethyl alcohol (C_2H_5OH).

h. (U) Method of Manufacture.

$$2CH_3OH + NH_3 \xrightarrow[350\text{-}380^\circ C]{Al_2O_3} (CH_3)_2NH + 2H_2O \quad (90\text{-}95\%\ Yield)$$

Dimethylamine

$$2P + 3Cl_2 \longrightarrow 2PCl_3 \xrightarrow{O_2} 2POCl_3$$

Phosphorus-trichloride — Phosphorus oxychloride

$$(CH_3)_2NH + POCl_3 \xrightarrow{85\text{-}135^\circ C} \begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!N\!-\!\overset{\overset{O}{\|}}{\underset{\underset{Cl}{|}}{P}}\!-\!Cl + HCl$$

N,N-dimethylphosphoramidic dichloride

$$\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!N\!-\!\overset{\overset{O}{\|}}{\underset{\underset{Cl}{|}}{P}}\!-\!Cl + 2NaCN + C_2H_5OH \xrightarrow{30^\circ C} \begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!N\!-\!\overset{\overset{O}{\|}}{\underset{\underset{CN}{|}}{P}}\!-\!OC_2H_5 + 2NaCl + HCN$$

Tabun

i. (U) Equipment.

- Jacketed enameled container with reflux condenser.
- Lead-lined steam-heated boilers.
- Lead-lined columns with Raschig rings.
- Stainless steel reaction vessels, steam jacketed and fitted with internal cooling coils.

j. (U) Physical and Chemical Properties.

- Odor: Faintly fruity; none when pure.[5]
- Physical state and color: Crude agent is dark brown; pure material is colorless liquid.[5]
- Boiling point: 240° C at $10x10^4$ Pa, 120° C at $1.3x10^3$ Pa.[3]
- Melting point: -50° C.[5]
- Solubility: Soluble in water, alcohol, gasoline, oils and fats.
- Vapor density (relative to air): 5.63.[5]
- Specific gravity: 1.073 at 25° C.[5]
- Volatility: 90 mg/m^3 at 0° C; 610 mg/m^3 at 25° C; 858 mg/m^3 at 30° C.[5]
- Vapor pressure: 9.3 Pa at 25° C (about the same as mustard).[5]
- Heat of vaporization: $33.3x10^4$ J/kg (average between 25° and 50° C).[5]
- Flash point: 78° C.[5]
- Decomposition temperature: 130° C (unstable when exposed to heat and thus likely to decompose upon explosion of munition).
- Hydrolysis: Gives off HCN as one product of hydrolysis. Reacts slowly with water but fairly rapidly with strong acids or alkalies; self-buffering at pH 4 to 5. Autocatalytic below pH 4 due to presence of HCN. Half-life of 7 hours at pH 4 to 5. Hydrolysis catalyzed by phosphate.[5]

k. (U) Method of Dissemination.[6 7] Mortar shells, artillery shells, bombs, bomblets, rockets, and land mines.

l. (U) Use. Same as for Sarin.

m. (U) Physiological Effects. Same as for Sarin.

n. (U) Therapy. Same as for Sarin, except that it is more oxime-resistant.

o. (U) Decontamination.[6] Same as for Sarin. In confined areas, however, GA reacts with chlorinating compounds to produce toxic cyanogen.

p. ~~(U)~~ Protection Required.[8,9,26] (b)(1)

(b)(1)

q. (U) Storage. Crude product is stable in steel and varnished containers at reasonably low temperatures; decomposes within 6 months at 60° C. Distilled product is more stable even under tropical storage conditions.

r. (U) Toxicity.[5]

- By Inhalation—LCt_{50} is 400 mg-min/m^3 for resting men. ICt_{50} is 300 mg-min/m^3 for resting men.
- Percutaneously—LD_{50} (liquid on skin) is 1000 to 1500 mg/man and LCt_{50} (vapor on skin) is 20 000 to 40 000 mg-min/m^3.

s. (U) Persistence. As an aerosol Tabun may persist for several minutes, depending on weather conditions. As a liquid on the ground, vapors generally evolve for more than 2 hours, depending on type of terrain as well as weather conditions.

t. (U) Historical.

- 1936: Discovered by Schrader at Elberfeld, Germany. Produced in considerable quantities by the Germans at Dyhernfurth.
- 1945: Dyhernfurth plant dismantled and removed to USSR.

u. ~~(C)~~ Detection.

(1) ~~(C)~~ Detectors.

(a) (U) USSR -- Same as Sarin.

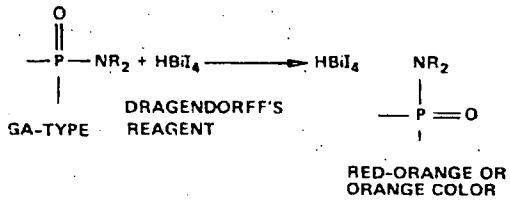
(b) ~~(C)~~ US.[21]

(b)(1)

(2) (U) Chemical reactions.[21]

(a) (U) Schoenemann, Enzyme, Oxime, ABC-M8 Detector, and ODN-Molybdenum peroxide reactions -- see Sarin.

(b) (U) Dragendorff's test (for tertiary amines and quaternary ammonium salts).



Positive reaction occurs in presence of GA as well as V-agents and HN-mustards.

(c) (U) Pyrazolane test (for hydrolyzable cyanide). See Hydrogen cyanide.

(d) (U) Prussian Blue test (for hydrolyzable cyanide). GA produces a blue color. See Hydrogen cyanide for chemical reaction.

7. ~~(U)~~ GE

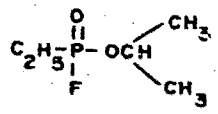
a. ~~(C)~~ Code or Alternate Designations.

- United States -- GE, T1-1620. (U)
- (b)(1) ~~(C)~~
- Germany -- Ethyl Sarin. (U)

b. (U) Class. Nerve Agent.

c. (U) Chemical Name. Isopropyl ethylphosphonofluoridate.

d. (U) Formula. $C_5H_{12}FO_2P$



Ser. 513067

e. (U) Molecular Weight. 154.12.

f. (U) Alternate Chemical Names.

- Isopropyl ethylfluorophosphonate.
- Ethylfluoroisopropylphosphonite.
- Ethylfluoroisopropoxyphosphine oxide.
- Isopropyl ester of ethylphosphonofluoridic acid.

g. (U) Raw Materials.

- Chlorine (Cl_2).
- Phosphorus trichloride (PCl_3).
- Hydrogen fluoride (HF).
- Ethyl alcohol (C_2H_5OH).
- Isopropyl alcohol (C_3H_7OH).

h. (U) Method of Manufacture. Same as for Sarin, Rearrangement Process, except using ethanol instead of methanol.

i. (U) Equipment. Hastelloy "B" or silver-lined reaction vessels, pipes, and connections.

j. (U) Physical and Chemical Properties.

- Odor: Fruity.
- Physical state and color: Colorless liquid.

- Boiling point: 162° C.
- Melting point: Below -10° C (does not crystallize readily).
- Solubility: Soluble in water, gasoline, alcohols, fats and oils.
- Volatility: 1,210 mg/m^3 at 25° C.
- Vapor pressure: 1.56 mm Hg at 25° C.
- Hydrolysis: Hydrolysis catalyzed by both acids and bases. Less easily hydrolyzed than GB.

k. (U) Method of Dissemination. Not known.

l. (U) Use. Developmental agent.

m. (U) Physiological Effect. Same as for Sarin.

n. (U) Therapy. Same as for Sarin.

o. (U) Decontamination. Same as for Sarin.

p. (U) Protection Required. Not known.

q. (U) Storage. Pure GE stored in Pyrex or mild steel shows no deterioration after 6 months. The impure product, containing acid and stored in steel bombs, deteriorates. The presence of even 0.2% chlorine will cause rapid breakdown.

r. (U) Toxicity.

- By inhalation -- Estimated LCt_{50} for man is 350-450 $mg\text{-}min/m^3$.
- Percutaneously -- Estimated LD_{50} is 220 mg/man.

s. (U) Persistence. Non-persistent.

t. (U) Detection. Same as for Sarin.

8. (U) GF

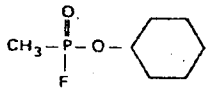
a. (U) Code or Alternate Designations.

- United States — GF.
- United Kingdom -- GF.

b. (U) Class. Nerve agent.

c. (U) Chemical Name. Cyclohexyl methylphosphonofluoridate.

d. (U) Formula. $C_7H_{14}FO_2P$



e. (U) Molecular Weight. 180.16.

f. (U) Alternate Chemical Names.

- Cyclohexyl ester of methylphosphonofluoridic acid.
- Cyclohexylmethanefluorophosphonate.
- Methylfluorocyclohexylphosphonite.

g. (U) Raw Materials.

- Phosphorus (P).
- Chlorine (Cl_2).
- Methyl alcohol, 99%, water-free (CH_3OH).
- Sodium fluoride 98% pure (NaF) or Hydrogen fluoride, 98% (HF)
- Metallic sodium (Na).

- Methyl chloride (CH_3Cl).
- Cyclohexyl alcohol ($C_6H_{11}OH$).

h. (U) Method of Manufacture. Same as for GB except that cyclohexyl alcohol is substituted for isopropyl alcohol and the conditions for the final step of the rearrangement process are changed to 40° to 60° C at 100 to 200 mm Hg.

i. (U) Physical and Chemical Properties.

- Physical state and color: Clear liquid.
- Melting point: Less than -30° C.[4]
- Volatility: 438 mg/m^3 at 20° C, 581 mg/m^3 at 25° C.[4]
- Vapor pressure: 0.042 mm Hg at 20° C, 0.06 mm Hg at 25° C.[4]
- Hydrolysis: Decomposed by alkali.

j. (U) Methods of Dissemination. Not known.

k. (U) Use. Same as for Sarin.

l. (U) Physiological Effects. Same as for Sarin, but GF is more readily absorbed through the skin.

m. (U) Therapy. Same as for Sarin.

n. (U) Decontamination. Soap and water; solutions or pastes of washing soda; and calcium hypochlorite.

o. (U) Protection Required. Not known.

p. (U) Storage. Reasonably stable in steel cylinders at normal temperatures.

q. ~~(C)~~ Toxicity.

- (b)(1)

r. (U) Persistence. Persistent.

s. ~~(C)~~ Historical.

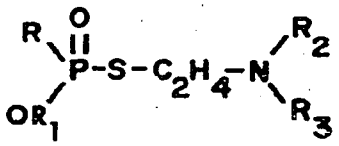
- (b)(1)

t. (U) Detection. Same as for Sarin.

C. V-AGENTS

9. (U) General

a. The V-agents are highly toxic, sulfur-containing organophosphorus compounds that were first described by the British scientists R. Ghosh and J. F. Newman in 1955. This new type of anticholinesterase has the general formula

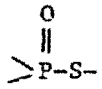


Nom. 513066

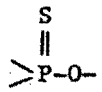
where R, R_1, R_2, and R_3 are alkyl groups. Compounds of this type can easily be quaternized at the nitrogen atom to form salts. One of the compounds synthesized and studied by Ghosh and Newman was O,O-dimethyl S-2-diethylaminoethyl phosphorothioate or VG.

b. The V-agents are liquids with high boiling points and low volatility. They are more persistent than the G-type agents, and may be disseminated in the form of droplets, aerosols, or vapor. They also are toxic via the respiratory route, but in contrast with the G-agents, are more readily absorbed into the body through the skin. The V-agents are highly persistent once deposited on a surface; aerosols (particle size of approximately 5 μm or larger), which are produced mechanically or explosively, can result in the deposition of serious or lethal concentrations of nerve agent upon impact on surface.

c. The basic difference between the V-agent and the organophosphorus insecticides lies in the position of the sulfur atom. The V-agents have the thiolo structure



while insecticides generally have the thiono structure



The thionate, which is the less toxic form, may isomerize to the toxic thiolate form spontaneously or upon application of heat. Because of this close chemical relationship between the V-agents and the insecticides, it has been suggested that facilities capable of producing organophosphorus insecticides can readily be converted to the production of the more toxic CW nerve agents. Others claim, however, that despite this close similarity in chemical structure, the processes required in their manufacture are grossly different and the basic requirements in material, equipment, and safety facilities may also differ.

10. ~~(C)~~ VE

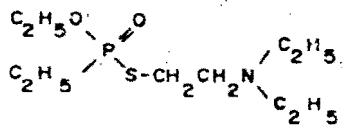
a. ~~(C)~~ Code or Alternate Designations.

- (b)(1) (~~C~~)
- (~~C~~)
- Canada—VE. (U)

b. (U) Class. Nerve agent.

c. (U) Chemical Name. O-Ethyl S-2-diethylaminoethyl ethylphosphonothiolate.

d. (U) Formula. $C_{10}H_{24}NO_2PS$



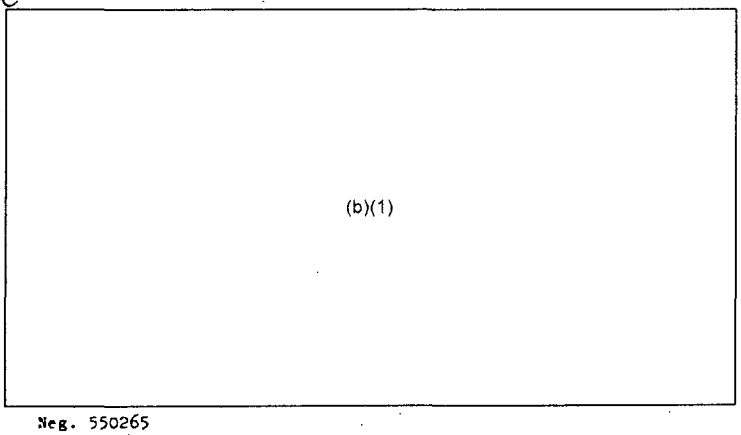
e. (U) Molecular Weight. 253.35.

f. (U) Raw Materials.

- Ethanol (C_2H_5OH).
- Sulfur (S).
- Sodium hydroxide (NaOH).
- Ethyldichlorophosphine ($C_2H_5Cl_2P$).
- 2-Diethylaminoethyl chloride $(C_2H_5)_2NCH_2CH_2Cl$.

g. ~~(C)~~

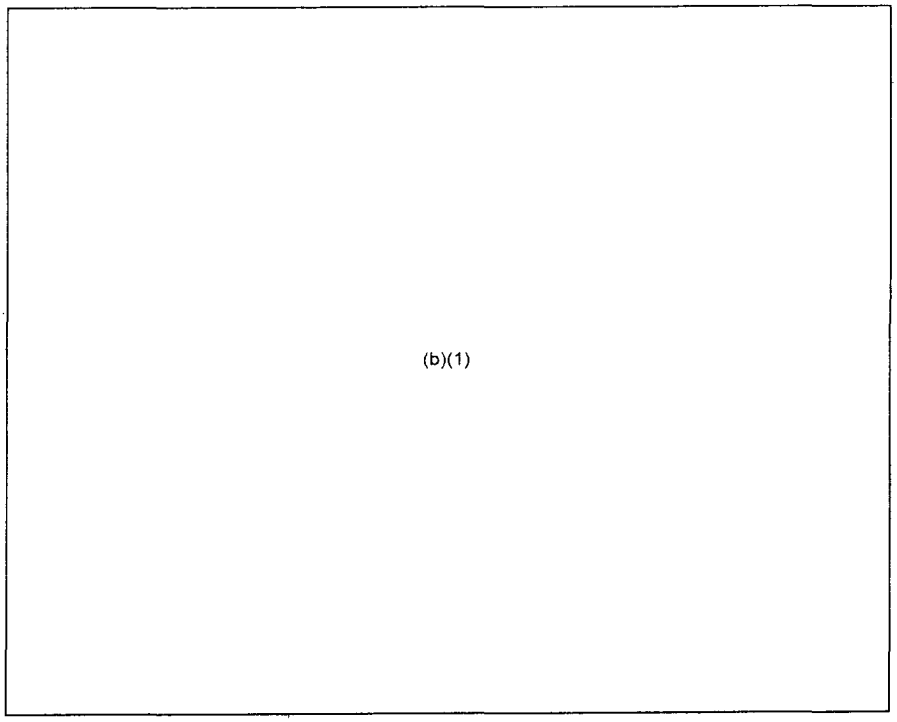
(b)(1)



Neg. 550265

h. (U) Equipment. Since there is no corrosion problem such as exists in the production of GD, no special equipment is necessary. Standard chemical plant reactors and accessory equipment can be used.

i. ~~(C)~~ Physical and Chemical Properties.



j. (U) Method of Dissemination. Not known.

k. (U) Use. Developmental agent.

l. (U) Physiological Effects. Typical cholinesterase inhibition symptoms (see Tabun), which may be delayed for an hour or two depending on the dosage. With percutaneous contamination, the eye symptoms may not occur at all. Effects are accelerated by super-lethal percutaneous dose or by inhaled aerosols.

m. (U) Therapy. Same as for Sarin.

n. (U) Decontamination.[6,8,27] DS-2, bleach slurry or 5% sodium hypochlorite solution, M5 protective ointment, DANC solution. Alkali solutions destroy V-agents much more slowly than G-agents. Plain hot water is generally ineffective, since the boiling water will contain a large amount of unhydrolyzed agent and the steam will distill some of the agent into the atmosphere. Liquid droplets on skin may be removed with the fuller's earth pad, and large drops of agent on clothing may be neutralized by the XXCC3 pad, both of which are found in the US M13 Individual Decontamination and Reimpregnating Kit.

o. ~~(U)~~ Protection Required. (b)(1)

(b)(1)

r. (U) Persistence. Persistent.

s. (C) Detection.

(1) (C) Detectors.

(a) (C) USSR

- (b)(1)

(b) (U) PRC -- Detector kit, type 64.[20]

(c) (C) US[21]

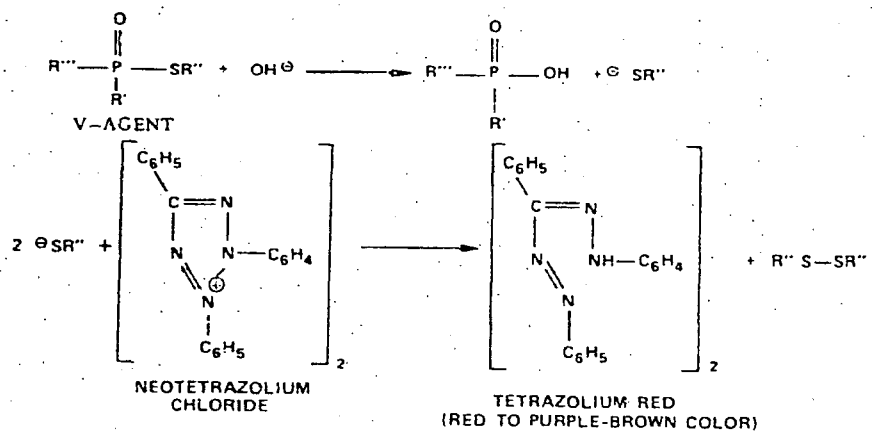
- (b)(1)

(2) (U) Chemical Reactions.[21]

(a) (U) Dragendorff's Test - See Tabun. A positive reaction occurs in presence of V-agents as well as GA and nitrogen mustards.

(b) (U) Enzyme, Oxime, and ODN-Molybdenum Peroxide reactions — See Sarin.

(c) (U) Tetrazolium Test (for mercaptans, -SR).



Neg. 550366

(d) (U) ABC-M8 Detector Paper. See Sarin for dyes used. VE, like all V-agents, produces a green color.

11. ~~(U)~~ VG

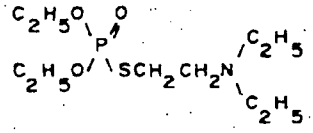
a. ~~(U)~~ Code or Alternate Designations.

- (b)(1)
- Canada -- VG. (U)
- West Germany -- Amiton. (U)
- Italy -- Inferno. (U)
- USSR -- GD-80, Amiton V-gas. (U)

b. (U) Class. Nerve agent.

c. (U) Chemical Name. O,O-Diethyl S-2-diethylaminoethylphosphorothioate.

d. (U) Formula. $C_{10}H_{24}NO_3PS$



e. (U) Molecular Weight. 269.35.

f. (C) Raw Materials.

- (b)(1)

g. (C)

(b)(1)

(b)(1)

h. (U) Equipment. Standard chemical processing equipment.

i. (C) Physical and Chemical Properties.

(b)(1)

(c)

- (b)(1)

j. (U) Methods of Dissemination. Not known.

k. (U) Use. Developmental agent. Although its toxicity is significantly lower than most candidate CW agents, it still is considered by some countries to be of importance as a potential agent. Analogs of VG have been studied by some countries.

l. (U) Physiological Effects. Same as for VE.

m. (U) Therapy. Same as for Sarin.

n. (U) Decontamination.[6] Same as for VE.

o. (U) Protection Required. Protective mask and full protective clothing.

(c) (b)(1)

q. (c) Toxicity.

- (b)(1)

r. (U) Persistence. Persistent.

s. (U) Historical.

- 1952: Synthesized by Ghosh at CDE Porton. Patented in 1955.
- 1953: Synthesized in Kabachnik's laboratory in USSR.

t. (U) Detection. Same as for VE.

12. (C) VM

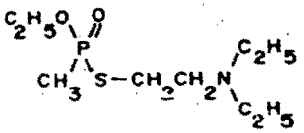
a. (C) Code or Alternate Designations.

- (b)(1) (C)
- (C)
- Canada -- VM. (U)
- Sweden -- Edemo. (U)
- USSR -- V-gas. (U)

b. (U) Class. Nerve agent.

c. (U) Chemical Name. O-Ethyl S-2-diethylaminoethyl methylphosphonothiolate.

d. (U) Formula. $C_9H_{22}NO_2PS$



e. (U) Molecular Weight. 239.28.

f. (C) Raw Materials.

- (b)(1)

g. (C) (b)(1)

(b)(1)

h. (U) Equipment. Standard chemical processing.

i. (C) Physical and Chemical Properties.

(b)(1)

j. (U) Method of Dissemination. Not known.

k. (U) Use. Developmental agent.

l. (U) Physiological Effects. Same as for VE.

m. (U) Therapy. Same as for Sarin.

n. (U) Decontamination.[6] Same as for VE.

o. (U) Protection Required. Protective mask and impermeable protective clothing.

p. ~~(C)~~ Storage. (b)(1)

(b)(1)

r. (U) Persistence. Persistent.

s. ~~(C)~~ Historical. Synthesized by Ford-Moore in United Kingdom.

t. (U) Detection. Same as for VE.

13. ~~(C)~~ VS

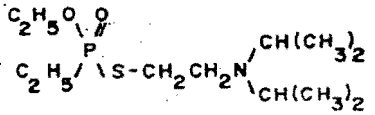
a. ~~(C)~~ Code or Alternate Designations.

- (b)(1) ~~(C)~~
- ~~(C)~~

b. (U) Class. Nerve agent.

c. (U) Chemical Name. O-Ethyl S-2-diisopropylaminoethyl ethylphosphonothioate.

d. (U) Formula. $C_{12}H_{28}NO_2PS$



e. (U) Molecular Weight. 281.36.

f. ~~(C)~~ Raw Materials.

- [redacted]
- [redacted]
- [redacted]
- [redacted]

(b)(1)

g. ~~(C)~~ Method of Manufacture.[2,12]

(b)(1)

h. (U) Equipment. Standard chemical processing equipment.

i. ~~(C)~~ Physical and Chemical Properties.

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

(b)(1)

- [redacted]
- [redacted]
- [redacted]
- [redacted]

j. (U) Method of Dissemination. Not known.

k. (U) Use. Developmental agent.

l. (U) Physiological effects. Same as for VE.

m. (U) Therapy. Same as for Sarin.

n. (U) Decontamination.[6] Same as for VE.

o. (U) Protection Required. Protective mask and full protective clothing.

p. ~~(C)~~ Storage. (b)(1) [redacted]

(b)(1) [redacted]

(b)(1)

r. (U) Persistence. Persistent.

s. (U) Historical. Synthesized in the United States and the United Kingdom.

t. (U) Detection. Same as for VE.

14. ~~(C)~~ VX

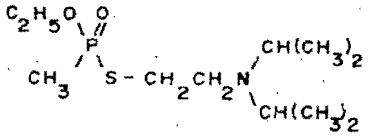
a. ~~(C)~~ Alternate Code or Designations.

- (b)(1) ~~(C)~~ ~~(C)~~
- France -- A-4. (U)

b. (U) Class. Nerve agent.

c. (U) Chemical Name. O-Ethyl S-2 diisopropylaminoethyl methylphosphonothioate.

d. (U) Formula. $C_{11}H_{26}NO_2PS$



e. (U) Molecular Weight. 267.37.

f. ~~(C)~~ Raw Materials.

- (b)(1)

g. (C) Method of Manufacture.[2,12]

(b)(1)

h. (U) Equipment. Standard chemical processing equipment.

i. (C) Physical and Chemical Properties.

- (b)(1)

(b)(1)

j. (U) Method of Dissemination. Same as for Sarin.

k. (U) Use. To produce casualties and cause death by inhalation of vapor or aerosol, by liquid droplet contamination of skin or eyes, or by ingestion with food or water. To cause harassment by requiring personnel to wear heavy, special clothing and masks, or to seek shelter.

l. (U) Physiological Effect. (b)(1)

(b)(1)

m. (U) Therapy. Same as for Sarin.

(b)(1)

(b)(1)

(b)(1)

o. (U) Protection Required.

(b)(1)

(b)(1)

p. (U) Storage.

(b)(1)

q. (C) Persistence.

(b)(1)

(b)(1)

r. (C) Toxicity.[10]

(b)(1)

(b)(1)

s. ~~(C)~~ Detection.[22] (b)(1) (b)(1)

15. RESERVED FOR FUTURE USE

16. (C) EA 1699

a. ~~(C)~~ Code or Alternate Designations.

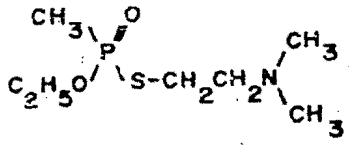
- (b)(1) ~~(C)~~
- Sweden--F-gas. (U)
- USSR--V-gas. (U)
- Romania and Yugoslavia--Vx. Also assign VX to the whole group of phosphorylthiocholines. (U)

b. (U) Class. Nerve agent.

c. (U) Chemical Names.

- O-Ethyl-S-(dimethylaminoethyl) ester of methylthiophosphonic acid.
- Ethoxydimethylaminothioethyl methylphosphonate.
- S-Thiocholine-O-ethylmethylphosphonothiolate.
- O-Ethyl S-2-dimethylaminoethyl methylphosphonothioate.

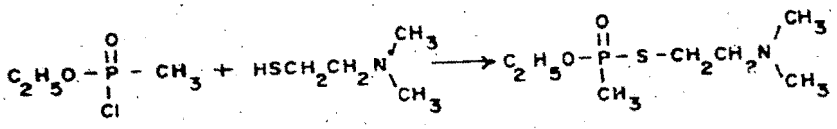
d. (U) Formula. $C_7H_{18}NO_2PS$



Neg. 550278

e. (U) Molecular Weight. 208.26.

f. (U) Method of Preparation.



Neg. 513071

EA 1699

g. (U) Physical and Chemical Properties.

- Odor: Odorless.
- Physical state and color: Colorless liquid.
- Boiling point: 80° C at 8 Pa.
- Solubility: Soluble in organic solvents, slightly soluble in water.
- Specific gravity (liquid): 1.0725 at 25° C.
- Volatility: Low.
- Hydrolysis: Hydrolyzed spontaneously in aqueous solution.
- Reactions: Reacts strongly with oxidizing agents such as chloride of lime, sodium hypochlorite, and potassium permanganate; also reacts with ammonia and amines.

h. (U) Dissemination. Can be disseminated as an aerosol.

i. (U) Physiological Effects. The effects are similar to VX. Vx has no irritating effect on the skin and is more liposcluble than Sarin. Vx penetrates the skin and mucous membrane rapidly and also penetrates the blood-brain barrier.

j. (U) Decontamination.[6] Same as for VE.

k. (U) Therapy. Same as for Sarin.

l. (U) Protection. Protective masks and clothing.

m. (U) Storage. Stable in storage, if dry.

n. (U) Toxicity. Fatal dosage in man is given as 5 to 10 mg-min/m^3 by inhalation route.[29] LD_{50} in mice is 0.05 mg/kg (IP); LD_{50} in rabbits is 0.014 mg/kg (IV) and 0.16 mg/kg (PC).

o. (U) Persistence. Persistent.

p. (U) Detection. Same as VE.

q. ~~(C)~~ ~~(U)~~ Historical.[11] (b)(1)

17. (U) (NOFORN) EA 3148[30 31]

a. ~~(C)~~ Code or Alternate Designation. (b)(1)

b. ~~(C)~~ Class. (b)(1)

c. ~~(C)~~ Chemical Name. (b)(1)

(b)(1)

d. ~~(C)~~ (b)(1)

e. (U) Molecular Weight. 279.37.

f. ~~(C)~~ Physical and Chemical Properties.

- (b)(1)

g. (U) Use (U). Developmental agent.

h. (C) Physiological Effects (U). (b)(1)

(b)(1)

(b)(1)

i. (C) Therapy (U). (b)(1)

j. (C) Decontamination (U). (b)(1)

k. (C-NOFORN) Toxicity (U). (b)(1)

l. (U) Detection (U). Same as for VE.

D. EXPERIMENTAL AND UNKNOWN AGENTS (U)

18. General (U)[32] [33]

(b)(1)

NOT Rreleasable TO FOREIGN NATIONALS

(b)(1)

(b)(1)

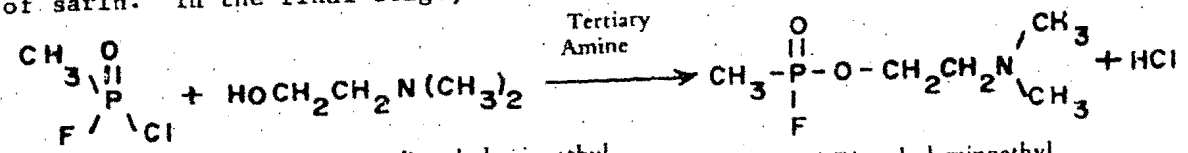
(b)(1)

(b)(1)

19. Methylfluorophosphorylcholine (U)[11]

a. (U) Code of Alternate Designations (U). Yugoslavia refers to the group of fluorophosphorylcholines as F-poisons or Tammelin poisons.

b. (U) Synthesis (U). The synthesis of methylfluorophosphorylcholine (2-dimethylaminoethyl methylphosphonofluoridate) is similar to that of sarin. In the final stage, the reaction is as follows:



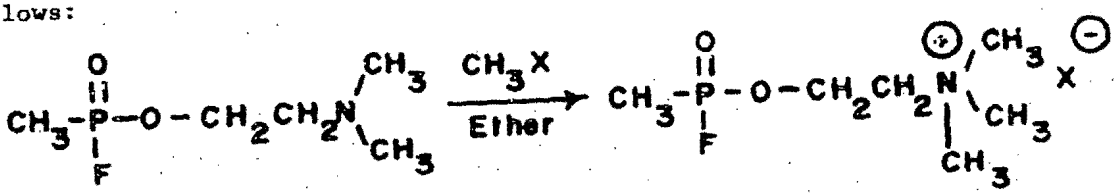
Methylphosphonic chloride fluoride

2-dimethylaminoethyl alcohol

2-Dimethylaminoethyl methylphosphonofluoridate

Neg. 513073

Quaternization of the unstable dimethylamino compound can be performed as follows:



Methhalide of 2-dimethylaminoethyl methylphosphonofluoridate

Neg. 513073

where X is a halide. The quaternized form is more stable.

19.1. VR-55 (U)

a. (U) Code or Alternate Designation (U). None.

b. (U) Class (U). A standard Soviet agent, probably a nerve agent.

c. (U) Chemical Name (U). Unknown; possibly thickened soman.

d. (U) Formula (U). Unknown.

e. (U) Physical and Chemical Properties (U). Liquid.

(b)(1)

(b)(1)

h. (U) Physiological Effects (U). Unknown. Probably same as soman.

i. (U) Decontamination (U). Individual decontamination kit, mobile showers, clothing decontamination units and decontamination truck-mounted sprays.

j. (U) Protection Required (U). Full protective clothing, protective masks.

k. (U) Storage (U). Unknown, presumed to be relatively stable.

l. (C-NOFORN) Toxicity (U). (b)(1)

(b)(1)

(b)(1)

n. (U) Historical (U). Soviet development.

20. Experimental Agents (U)

a. EA 5365 (U).[34] [35]

(1) (C) Alternate code or designation (U). (b)(1)

(2) (U) Class (U). Nerve agent.

(3) (C) Chemical name (U). (b)(1)

(b)(1)

NOT RELEASABLE TO FOREIGN NATIONALS

(4) ~~(C)~~ Formula (U). (b)(1)

(b)(1)

Neg. 550280

(5) ~~(C)~~ Molecular weight (U). (b)(1)

(6) ~~(C)~~ Raw Materials (U).

- (b)(1)

(7) ~~(C)~~ Method of preparation (U).

(b)(1)

NOT RELEASABLE TO FOREIGN NATIONALS

June 1977

(b)(1)

EA 5365

Neg. 550281

(8) ~~(C)~~ Physical and Chemical Properties.

(b)(1)

(9) ~~(C)~~ Method of dissemination.

(b)(1)

(b)(1)

(b)(1)

(10) ~~(C)~~ Use.

(b)(1)

(b)(1)

(11) ~~(C)~~ Physiological effects.

(b)(1)

(b)(1)

(b)(1)

(12) (C) Therapy.

(b)(1)

(b)(1)

(13) (C) Decontamination.

(b)(1)

(b)(1)

(14) (C) Protection required.

(b)(1)

(b)(1)

(b)(1)

(16) (C) Toxicity.

(b)(1)

(17) (C) Detection.

(a) (C) US detectors.

- (b)(1)

(b)(1)

(b)(1)

(b) (U) Chemical reactions. For enzyme reaction and ABC-M8 Detector Paper, see Sarin.

(b)(1)

c. (C) EA 5414.[12,34,36]

(1) (C) Code or alternate designation. (b)(1)

(2) (C) Chemical name. (b)(1) (b)(1)

(3) (C) (b)(1)

(4) (C) Molecular weight. (b)(1)

(5) (U) Physiological effects. Same as EA 5365.

(6) (U) Therapy. Probably similar to EA 5365.

(7) (U) Storage. No data.

(8) (C) Toxicity.[13] (b)(1)

(b)(1)

E. STUDIES IN SUPPORT OF BINARY MUNITIONS

21. (C) General[12]

(b)(1)

22. (C) Binary Systems for G-agents[37-39]

(b)(1)

(b)(1)

(b)(1)

23. (C) Binary Systems for VX[12,38-41]

(b)(1)

(b)(1)

F. CARBAMATES

24. (C) General[42]

(b)(1)

25. (C) EA 3990[43]

a. (U) Class. Nerve agent.

b. (C) Chemical Name. (b)(1)

(b)(1)

c. ~~(C)~~ Formula.[43] (b)(1)

(b)(1)

d. (U) Molecular Weight. 718.

e. ~~(C)~~ Raw Materials.[43]

- (b)(1)

(b)(1)

g. ~~(C)~~ Physical and Chemical Properties.[44]

(b)(1)

h. ~~(C)~~ Physiological Effects.[45-48] (b)(1)

(b)(1)

i. ~~(C)~~ Therapy.[46] (b)(1)

(b)(1)

j. ~~(C)~~ Storage.[44,46] (b)(1)

(b)(1)

k. ~~(C)~~ Toxicity.[44,45] (b)(1)

(b)(1)

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(b)(1)

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Section II.

VESICANTS (BLISTER AGENTS)

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1. (U) General

Vesicants (blister agents) are used for casualty effect. These agents blister or irritate the skin and also affect eyes and lungs. Most of these agents are insidious in action with little or no pain at the time of exposure; Lewisite and Phosgene Oxime, however, cause immediate pain on contact.

2. (U) Ethyldichloroarsine

a. Code or Alternate Designations.

- United States--ED.
- United Kingdom--ED.
- Germany--DICK, Yellow Cross 1, Green Cross 3.

b. Class. Blister agent--lung irritant.

c. Chemical Name. Ethyldichloroarsine.

d. Formula. $C_2H_5AsCl_2$

e. Molecular Weight. 174.88.

f. Raw Materials.

- Arsenous oxide (As_2O_3).
- Sodium hydroxide (NaOH).
- Hydrochloric acid (HCl).
- Ethyl chloride (C_2H_5Cl).
- Sulfur dioxide (SO_2).

- Diethyl sulfate [$(C_2H_5)_2SO_4$].
- Calcium chloride ($CaCl_2$) as a drying agent.

g. Method of Manufacture.

- American Method (yield 75-80%):

$$As_2O_3\,(Aq.\,Soln) + 6NaOH \longrightarrow 2Na_3AsO_3 + 3H_2O$$

Sodium arsenite

$$Na_3AsO_3 + (C_2H_5)_2SO_4 \longrightarrow C_2H_5NaSO_4 + C_2H_5AsO_3Na_2$$

Sodium ethyl sulfate — Disodium ethyl arsenite

$$C_2H_5AsO_3Na_2 + SO_2 \longrightarrow Na_2SO_4 + C_2H_5AsO$$

Ethyl arsenic oxide

$$C_2H_5AsO + 2HCl \longrightarrow C_2H_5AsCl_2 + H_2O$$

ED

- German Method (requires 2.5 days):

$$Na_3AsO_3 + C_2H_5Cl \longrightarrow C_2H_5AsO_3Na_2 + NaCl$$

DISODIUM ETHYL ARSENITE

$$C_2H_5AsO_3Na_2 + 2HCl \longrightarrow 2NaCl + C_2H_5AsO_3H_2$$

ETHYL ARSENIC ACID

$$C_2H_5AsO_3H_2 + SO_2 \longrightarrow C_2H_5AsO + H_2SO_4$$

ETHYL ARSENIC OXIDE

$$C_2H_5AsO + 2HCl \longrightarrow C_2H_5AsCl_2 + H_2O$$

ED

h. Equipment.

- Pfaudler kettle.
- Lead-lined iron kettle.
- Autoclave.

i. Physical and Chemical Properties.[5]

- Odor: Fruity, but biting and irritating.
- Physical state and color: Clear liquid.
- Boiling point: 156° C.
- Melting point: -64° C.
- Solubility: Soluble in ethyl chloride, alcohol, ether, benzene, acetone, and cyclohexane.
- Vapor density (relative to air): 6.0.
- Specific gravity (liq): 1.69 at 20° C.
- Volatility: 6,500 mg/m^3 at 0° C; 20,000 mg/m^3 at 20° C; 27,200 mg/m^3 at 25° C.
- Vapor pressure: 2.09 mm Hg at 20° C; 15.1 mm Hg at 50° C.
- Heat of vaporization: 52.5 cal/g.
- Flash point: High enough not to interfere with the military use of the agent.
- Decomposition temperature: Stable up to boiling point.
- Hydrolysis: Liquid rapidly hydrolyzed by water to give hydrogen chloride and ethylarsenious oxide. Vapor is more stable.

j. Method of Dissemination. Artillery and mortar shells.

k. Use. Delayed-action casualty agent.

l. Physiological Effect. ED is a delayed reaction agent. The vapor is irritating to eyes, and the liquid may cause eye injury. The agent causes respiratory irritation, pulmonary congestion, edema, and pneumonia. Both the liquid and vapor blister the skin, and absorption of sufficient amounts through the skin will cause systemic poisoning or death. Liquid ED has about 1/20 the blistering action of liquid Lewisite.[8]

m. Decontamination.[6,8] Not required in open field. For enclosed spaces use water, caustic soda, DS-2, DANC solution, bleach slurry or dry STB. For self-decontamination, skin decontamination pad in US M13 Individual Decontaminating and Reimpregnating Kit is recommended.

n. Protection Required. Protective masks and clothing.

o. Storage. Stable in steel, attacks brass at 50° C, and is destructive to rubber and plastics.

p. Toxicity.[5]

- By inhalation--LCt_{50} is 3000 to 5000 mg-min/m^3 depending upon the period of exposure since the agent is rapidly detoxified in the body; ICt_{50} is 5 to 10 mg-min/m^3.

- Percutaneously--LCt_{50} is 100,000 mg-min/m^3.

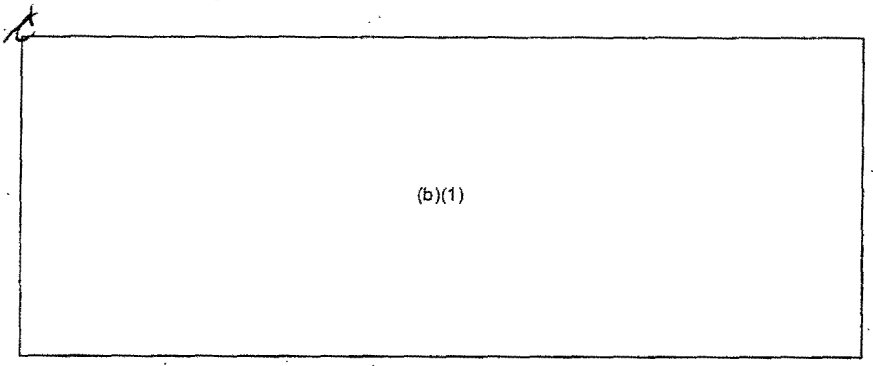
q. Persistence. Persistent enough to knock out enemy forces, but not enough to deny the area to the attacking forces. Persistence in summer is 1 to 2 hr in the open and 2 to 6 hr in the woods; in winter, 2 to 4 hr in the open and 12 hr in the woods.

r. Historical. March 1918: Introduced by Germans in an attempt to produce a volatile nonpersistent agent that would be quicker acting than diphosgene and mustard, more lasting than diphenylchloroarsine.

s. Detection.

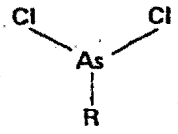
(1) US Detectors.[12,21]

- Yellow band tube (Molybdenum blue test) in M18A2 and M19 kits. Sensitivity, about 10 mg/m^3.



(2) Chemical reactions.[21]

(a) Molybdenum Blue test (for strong reducing agents and volatile arsenical compounds).



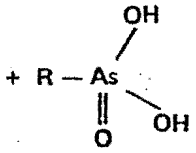
$+ (NH_4)_2 MoO_4 + H_2O$

AMMONIUM MOLYBDATE

TRIVALENT ARSENIC COMPOUND WHERE R = C_2H_5, CH_3 OR C_2H_2Cl

OXIDATION REDUCTION →

MOLYDENUM BLUE COMPLEX (BLUE COLOR)



$+ NH_4OH + NH_4Cl$

PENTAVALENT ARSENIC COMPOUND

Neg. 513076

(b) DB3-SO_3 test. Gel is speckled with black spots. Reaction unknown.

(c) ABC-M8 Detector Paper. See Sarin. ED produces a red color.

(d) Gutzeit test. See Lewisite.

3. (U) Lewisite

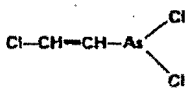
a. (U) Code or Alternate Designations.

- United States--L. (U)
- United Kingdom--M-1, L. (U)
- USSR--Lyuizit. (U)
- (b)(1) (U)
- Germany--Lewisite. (U)
- (b)(1) (U)

b. (U) Class. Vesicant.

c. (U) Chemical Name. Dichloro(2-chlorovinyl)arsine.

d. (U) Formula. $C_2H_2AsCl_3$



e. (U) Molecular Weight. 207.35.

f. (U) Alternate Chemical Names.

- Chlorovinylarsine dichloride.
- 2-Chlorovinyldichloroarsine.

g. (U) Raw Materials.

- Hydrochloric acid (HCl).
- Acetylene (C_2H_2).
- Aluminum chloride ($AlCl_3$) as a catalyst.
- Mercuric chloride ($HgCl_2$).

- Cupric chloride ($CuCl_2$).
- Silicon tetrachloride ($SiCl_4$).
- Aluminum monoxychloride (Al_2OCl_4).
- Arsenic trichloride ($AsCl_3$).

h. (U) Method of Manufacture.

(1) (U) US Method:

$$C_2H_2 + AsCl_3 \xrightarrow[30\,C]{AlCl_3} ClCH{=}CHAsCl_2$$

LEWISITE

Wash with HCl to extract excess $AsCl_3$ and distill.

(2) (U) Soviet Methods:

- Method A:

$$C_2H_2 + AsCl_3 \xrightarrow{HgCl_2 \text{ OR } CuCl_2} ClCH = CHAsCl_2$$

LEWISITE

- Method B:

$$C_2H_2 + SiCl_4 \xrightarrow{Al_2OCl_4} ClCH = CHSiCl_3$$

TRICHLORO (2-CHLOROVINYL) SILICIDE

$$ClCH = CHSiCl_3 + AsCl_3 \longrightarrow ClCH = CHAsCl_2 + SiCl_4$$

LEWISITE

This method forms only the primary Lewisite. The American method produces a mixture of primary, secondary, and tertiary forms which must be distilled in order to obtain the desired primary Lewisite.

i. (U) Equipment. Enameled autoclave.

j. (U) Physical and Chemical Properties.

- Odor: Geranium odor; very faint if agent is pure.[5]
- Physical state: Liquid.

- Boiling point: 76° to 77°C (12.5 mm Hg); 93°C (26 mm Hg); 190°C (760 mm Hg).[3]
- Melting point: -18° C.[5]
- Solubility:[3,11] Soluble in ordinary organic solvents; insoluble in water and dilute mineral acids. Because of its good miscibility with other CW agents, Lewisite is suitable for the preparation of tactical mixtures.
- Vapor density (relative to air): 7.2.[5]
- Liquid density: 1.89 at 20° C.[5]
- Volatility: 967 mg/m^3 (0° C), 2300 mg/m^3 (20° C), 8890 mg/m^3 (30° C).[5]
- Vapor pressure: 0.087 mm Hg at 0° C; 0.394 mm Hg at 20° C; 32.50 mm Hg at 100° C.[5]
- Heat of vaporization: 58 cal/g (0° to 190° C).[5]
- Flash point: None.
- Decomposition temperature: Above 100° C.[5]
- Hydrolysis: Rapidly hydrolyzed in liquid or vapor state. Products include hydrogen chloride and chlorovinyl arsenious oxide. The latter is a solid with blister properties. These properties are destroyed by alkaline hydrolysis.

k. (U) Method of Dissemination. Land mines, spray tanks, bombs, rockets, artillery and mortar shells.

l. (U) Use. Used in the summer against living targets; in the winter it is an effective terrain contaminant.

m. (U) Physiological Effects. Lewisite produces effects similar to Sulfur Mustard (see para 10) but, in addition, acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure. In order of severity and appearance of symptoms it is: a blister agent; a toxic lung irritant; and, when absorbed in the tissues, a systemic poison. The liquid causes

an immediate searing sensation in the eye and permanent loss of sight if not decontaminated within 1 min. Lewisite produces an immediate and strong stinging sensation to the skin; reddening of the skin starts within 30 min. Blistering does not appear until after about 13 hours. Like Sulfur Mustard, it is a cell poison, but its skin burns are much deeper. When inhaled in high concentrations, it may be fatal in as short a time as 10 min. It is a cumulative poison since it is not significantly detoxified in the body. It is rapid in action, but its duration of effectiveness is slightly shorter than sulfur mustard.[8]

n. (U) Decontamination. Water, DANC solution, DS-2, caustic soda, bleach slurry or dry STB,[6] or treatment with a solution of sodium hydroxide in glycerin followed by soap and water. Liquid agent may be decontaminated with skin decontamination pad in US M13 Individual Decontamination and Reimpregnating Kit.[8] The Soviets also include a 10% aqueous or alcoholic solution of chloramine.[50]

o. (U) Therapy. BAL (British anti-Lewisite, dimercaprol) either on the skin as ointment or injected intramuscularly in oil. Also, 30% lanoline based unithiol ointment (USSR).[50]

p. (U) Protection Required. (b)(1)

(b)(1)

q. (U) Storage. Stable in steel or glass containers. Attacks aluminum. Storage of Lewisite in shells and bombs is made possible by use of stabilizers and corrosion inhibitors.[11]

r. (U) Toxicity.

- By inhalation—LCt_{50} is 1200 to 1500 mg-min/m^3.[5] Lethal concentration is also given as 500 to 1300 mg/m^3 (PRC).[51]
- Skin absorption[5]—LCt_{50} is 100 000 mg-min/m^3 for vapor (when humidity is high, Lewisite hydrolyzes so rapidly that it is difficult to maintain a concentration sufficient for blistering bare skin). The estimated LD_{50} for liquid on the skin is 38 mg/kg. A dose of 0.02 to 0.04 mg liquid on the skin causes blisters.

s. (U) Persistence. Summer—24 hours in the open and 1 week in the woods. Winter—1 week. Has a very short duration under humid conditions.

t. (U) Historical.

- 1917: First prepared by Dr. W. Lee Lewis in United States.
- 1917-1918: Germans claim manufacture independently.
- Nov. 1918: First lot manufactured shipped overseas. Armistice intervened, material destroyed at sea.

u. (C) Detection.

(1) (C) Detectors.

(a) (C) USSR.

- [redacted]
- [redacted] (b)(1)

(b) (U) PRC—Detector Kits Model 1950? and Type 64.[19,20] A three yellow band tube produces an orange to red color in presence of L. Sensitivity, 2 mg/m^3.[51]

(c) (U) US[21]

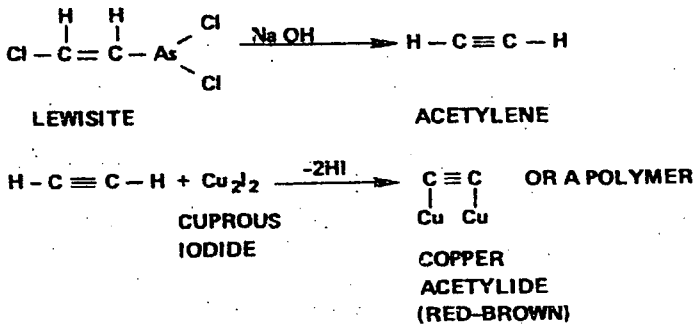
- Double yellow band tube (Acetylide test) in M19 kit. Sensitivity, 8 mg/m^3.[12]
- One yellow band tube (Molybdenum Blue Test) in M18A2 and M19 kits. Sensitivity, about 10 mg/m^3.[12]
- M7A1 Vesicant Detection Crayon.[53] ABC-M8 Detector paper for liquid agent. AN-M2 Water Testing kit (Gutzeit test).[8] White band sampling tube using Dithiophenylcarbazone Reagent.

d. (U) East Germany—Three yellow band indicator paper in CHNS kit.[54]

(2) (U) Chemical reactions.

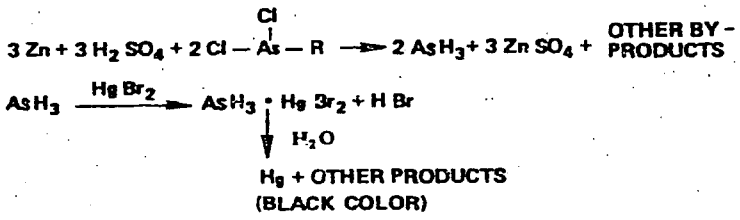
(a) (U) Molybdenum Blue test. See Ethyldichloroarsine.

(b) (U) Acetylide test.



Neg. 513077

(c) (U) Gutzeit test.



Neg. 513078

(d) (U) M7A1 Vesicant Detector Crayon. See Sulfur Mustard. L produces a blue color. Reaction is unknown.

(e) (U) ABC-M8 Detector Paper. See Sarin for dye components. L produces a red color.

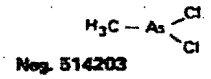
4. (U) Methyldichloroarsine

a. Code or Alternate Designation. United States—MD.

b. Class. Blister agent.

c. Chemical Name. Methyldichloroarsine.

d. Formula. CH_3AsCl_2



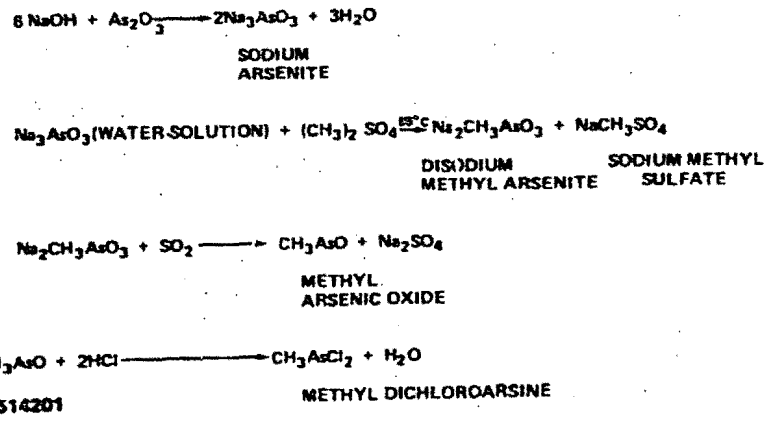
Neg. 514203

e. Molecular Weight. 160.86.

f. Raw Materials.

- Arsenous oxide (As_2O_3).
- Sodium hydroxide (NaOH).
- Dimethyl sulfate [$(CH_3)_2SO_4$].
- Sulfur dioxide (SO_2).
- Gaseous hydrogen chloride (HCl).

g. Method of Manufacture.



Neg. 514201

h. Equipment. Pfaudler kettle.

i. Physical and Chemical Properties.[5]

- Odor: Odorless (does cause burning sensation).
- Physical state and color: Colorless liquid.
- Boiling point: 133° C.
- Melting point: -55° C.
- Solubility: Soluble in common organic solvents. Slightly soluble in water.
- Vapor density (relative to air): 5.5.
- Specific gravity (liq): 1.830 at 20° C.
- Volatility: 74,900 mg/m^3 at 20° C.
- Vapor pressure: 2.17 mm Hg (0° C), 7.6 mm Hg (20° C).
- Heat of vaporization: 49 cal/g.
- Flash point: Sufficiently high not to interfere with military use.
- Decomposition temperature: Stable to the boiling point.
- Hydrolysis: Rapidly hydrolyzed to give hydrogen chloride and methyl arsenious oxide.

j. Method of Dissemination. Not known.

k. Use. Developmental agent.

l. Physiological Effect. MD causes immediate irritation of eyes and nose and produces lung injury upon sufficient exposure. The liquid may produce severe eye injury, but is less irritating to the skin than ED. MD penetrates fabrics faster than Sulfur Mustard, and the lesions produced are less severe and heal faster than those caused by Sulfur Mustard.

m. Decontamination.[6] Same as for Ethyldichloroarsine.

n. Protection Required. Protective masks and clothing.

o. Storage. Stable in steel containers.

p. Toxicity. By inhalation, LCt_{50} is approximately 3000 to 5000 mg/m^3, varying with time of exposure, and the ICt_{50} is 25 mg-min/m^3. MD is detoxified at an appreciable rate.

q. Persistence. Summer--1 hr. Winter--2 to 3 hr.

r. Historical.

- 1858: Prepared by Bayer.
- 1918: Prepared by Uehlinger and Cook. Not used by either side in World War I. Prepared too late.

s. Detection. (US)—Same as for Ethyldichloroarsine.

5. (C) Nitrogen Mustard (HN-1)[5]

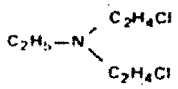
a. (C) Code or Alternate Designation.

- United States--HN-1, TL 329. (U)
- United Kingdom--Ethyl S. (U)
- Germany--Stickstoff Lost. (U)
- USSR--TO(?) (U)
- (b)(1) (C)

b. (U) Class. Blister agent.

c. (U) Chemical Name. 2,2'-Dichlorotriethylamine.

d. (U) Formula. $C_6H_{13}Cl_2N$

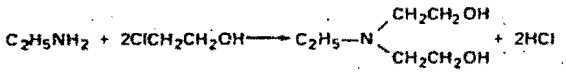


e. (U) Molecular Weight. 170.08.

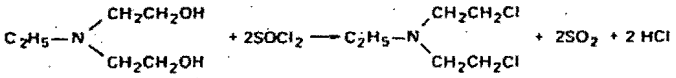
f. (U) Raw Materials.

- Ethylamine ($C_2H_5NH_2$).
- Ethylene chlorohydrin ($ClCH_2CH_2OH$).
- Ethylene oxide (C_2H_4O).
- Ammonia (NH_3).
- Thionyl chloride ($SOCl_2$).

g. (U) Method of Manufacture.

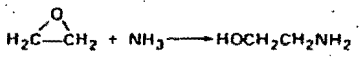


ETHYL DIETHANOLAMINE

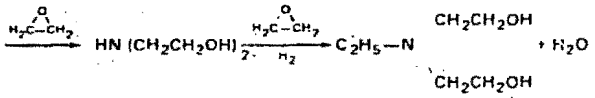


HN-1 MUSTARD

Alternate Method (1)

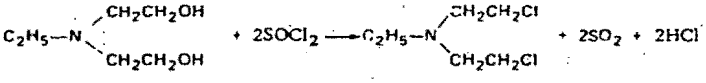


ETHANOLAMINE



DIETHANOL AMINE

ETHYL DIETHANOL AMINE



HN-1 MUSTARD

h. (U) Physical and Chemical Properties.[5]

- Odor: Faint fishy or musty odor.
- Physical state and color: Colorless to pale yellow liquid.
- Boiling point: 85° C at 10 mm Hg, decomposes below boiling point at atmospheric pressure.
- Melting point: -34° C.
- Solubility: Soluble in acetone.
- Vapor density (relative to air): 5.9.
- Specific gravity (liq): 1.0858 at 25° C.
- Volatility: 140 mg/m^3 at -10° C, 329 mg/m^3 at 0° C, 1590 mg/m^3 at 20° C, and 3240 mg/m^3 at 30° C.
- Vapor pressure: 0.25 mm Hg at 25° C.
- Heat of vaporization: 77 cal/g.
- Flash point: High enough not to interfere with military use of the agent.
- Decomposition temperature: Decomposes before boiling point is reached.
- Hydrolysis: Slow rate of hydrolysis. Products include hydroxyl derivatives and condensation products. Toxic intermediates are produced during hydrolysis.

i. (U) Method of Dissemination. Not known.

j. (U) Physiological Effects. The agent irritates the eyes in dosages that do not significantly damage the skin or respiratory tract for single exposures. This irritation appears in a shorter time than that from HD; after a mild vapor exposure, there may be no skin lesions. After severe vapor exposure, or exposure to liquid HN-1, erythema may appear earlier than in HD contamination along with irritation and itching.

Later, blisters may appear in the erythematous areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and a persistent cough. Fever, labored respiration, and moist rales may develop. Broncho-pneumonia may appear after the first 24 hr. Following ingestion or systemic absorption, HN-1 causes inhibition of cell mitosis resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be hemorrhagic, occurs. Lesions are most marked in the small intestine and consist of degenerative changes and necrosis in the mucous membranes. Ingestion of 2 to 6 milligrams causes nausea and vomiting. Susceptibility to secondary infection is not as great as with HN-2 and HN-3. It is essentially a cumulative poison. Onset of symptoms are delayed for 12 hr or longer.[8]

k. (U) Decontamination.[6] Bleach slurry, DANC solution, DS-2, M5 protective ointment.

l. (U) Protection Required. Protective mask and protective clothing. Impregnated clothing protects against mustard vapor, and impermeable clothing protects against liquids.[8]

m. (U) Storage. HN-1 is relatively stable, but is not as stable as Sulfur Mustard. Some precipitation occurs after 180 hr at 60° C; 4% to 5% polymerization occurs in steel after 30 days at 65° C.

n. (U) Toxicity.[5]

(1) (U) Median lethal vapor dosage.

- By inhalation--LCt_{50} is 1500 mg-min/m^3.
- Skin absorption (masked personnel)--LCt_{50} is 20,000 mg-min/m^3.

(2) (U) Median incapacitating vapor dosage.

- Eye injury--ICt_{50} is 200 mg-min/m^3.
- Skin absorption (masked personnel)--ICt_{50} is 9000 mg-min/m^3.

o. (U) Persistence. Much less persistent than Sulfur Mustard.

p. ~~(c)~~ Detection.u

(1) ~~(c)~~ Detectors.u

(a) ~~(c)~~ USSR.u

- c

=

(b)(1)

(b) (U) PRC[19,20,55]--Detector Kits Model 1950? and Type 64. A two yellow band tube produces a yellow to orange color in presence of L. Sensitivity, about 1 mg/m^3.

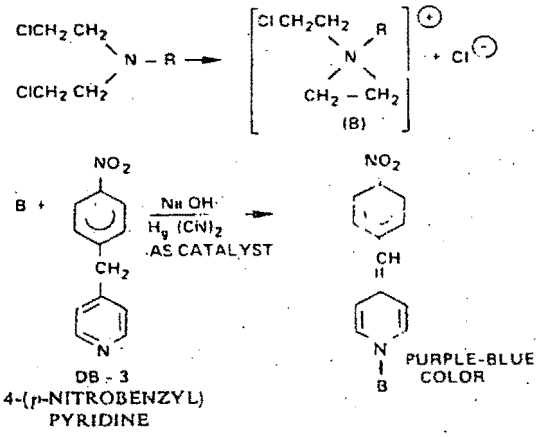
(c) (U) US.[21]

- Blue band tube (DB3-NaOH test) in M15A2A, M18A2, and M19 kits. Sensitivity, about 1 mg/m^3.
- White band sampling tube (Dragendorff's test using appropriate reagents) in M19 kit. Sensitivity, about 20 mg/m^3.[12]
- ABC-M8 Detector paper for liquid agent.
- AN-M2 Water testing kit.[12]

(2) (U) Chemical reactions.

(a) (U) Dragendorff's test. See Tabun.

(b) (U) DB3-NaOH test (for alkylating and acylating agents).



(c) (U) ABC-M8 Detector paper. See Sarin for dye components. HN-1 produces a red color.

6. ~~(C)~~ Nitrogen Mustard (HN-2)[5c]

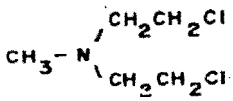
a. ~~(C)~~ Code or Alternate Designations

- United States--HN-2. (U)
- United Kingdom--S. (U)
- Germany--Stickstoff Lost. (U)
- (b)(1) ~~(C)~~

b. (U) Class. Blister agent.

c. (U) Chemical Name. Bis(2-chloroethyl) methylamine.

d. (U) Formula. $C_5H_{11}Cl_2N$



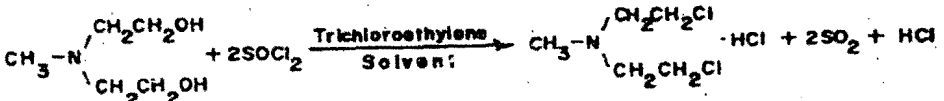
e. (U) Molecular Weight. 156.07.

f. (U) Raw Materials.

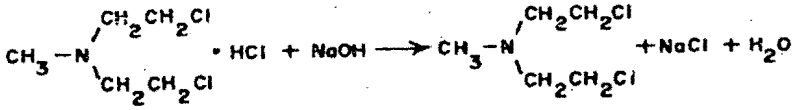
- Ethylene oxide (C_2H_4O).
- Monomethylamine (CH_3NH_2).
- Thionyl chloride ($SOCl_2$).
- Sodium hydroxide (NaOH).
- Trichloroethylene ($Cl_2C{=}CHCl$) as solvent.

g. (U) Method of Manufacture.

Diethanol–methylamine



Bis (2-chloroethyl) methylamine HCl



HN-2

Yield about 95%, with 96% purity.

h. (U) Physical and Chemical Properties.

- Odor: High concentrations give a fruity odor.
- Physical state and color: Pale yellow liquid.[5]
- Boiling point: 75° C at 15 mm Hg and 93° C at 23 mm Hg; decomposes below boiling point at atmospheric pressure.[5]
- Melting point: -65° to -60° C.[5]
- Solubility: Soluble in organic solvents.
- Vapor density (relative to air): 5.4.[5]
- Specific gravity (liq): 1.15.[5]
- Volatility: 2580 mg/m^3 at 25° C; 5106 mg/m^3 at 30° C; 9300 mg/m^3 at 40° C.[5]
- Vapor pressure: 0.29 mm Hg at 20° C; 0.427 mm Hg at 25° C; 1.16 mm Hg at 40° C.[5]
- Heat of vaporization: 78.8 cal/g.[5]
- Flash point: High enough not to interfere with military use of the agent.
- Decomposition temperature: Decomposes below boiling point. Instability of HN-2 is associated with its tendency to polymerize or condense; the reactions involved could generate sufficient heat to cause an explosion.
- Hydrolysis: Fairly rapid, catalyzed by alkalies. Hydrolysis products include complex condensates or polymers.

i. (U) Methods of Dissemination. Not known.

j. (U) Physiological Effects. Same as HN-1. It is a cumulative poison.

k. (U) Decontamination.[6] Bleach slurry, DANC solution, DS-2, decontaminant 40 (trichlorocyanuric acid), M5 protective ointment.

l. (U) Protection Required. Protective clothing and protective mask. See HN-1.

m. (U) Storage.[8] It is relatively unstable. It does not corrode metals, but dimerizes in glass and metal containers. HN-2 should never be stored in single containers in excess of 50-gal capacity in view of the fact that dimerization evolves so much heat as to render bulk storage hazardous. Ferric chloride is a powerful catalyst of dimer formation, as are water and oxygen. Normal dimerization occurs at a rate of about 18% per annum.

n. (U) Toxicity.[5,8] Median lethal vapor dosage = 3000 mg-min/m^3, and the median incapacitating vapor dosage for eye injury is 100 mg-min/m^3. For skin absorption in liquid form (masked personnel), HN-2 is intermediate between HN-1 and HN-3; in vapor form, HN-2 has the greatest blistering power of all the mustards.

o. (U) Persistence. HN-2 decomposes on damp ground, and is not suitable for hot climates. It persists from 1.5 to 3 hr at 4° C, and from 1/4 to 1/2 hr at 32° C.

p. (U) Detection. Same as for HN-1.

7. (U) Nitrogen Mustard (HN-3)

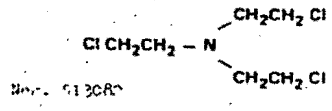
a. (U) Code or Alternate Designations.

- United States--HN-3, TL 145. (U)
- United Kingdom--T-773. (U)
- Germany--Stickstoff Lost, Green Ring 1. (U)
- USSR--TO. (U)
- (b)(1) (U)

b. (U) Class. Blister agent-vesicant

c. (U) Chemical Name. 2,2',2"-Trichlorotriethylamine.

d. (U) Formula. $C_6H_{12}Cl_3N$

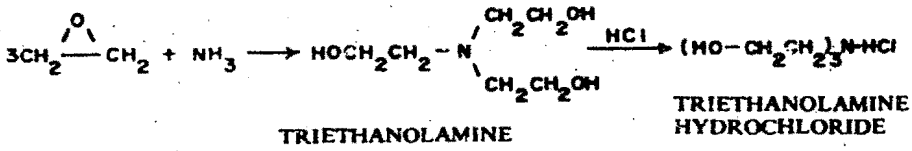


e. (U) Molecular Weight. 204.54

f. (U) Raw Materials.

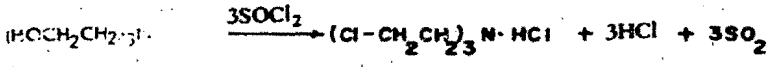
- Gaseous hydrogen chloride (HCl).
- Ethylene oxide (C_2H_4O).
- Sodium carbonate (Na_2CO_3).
- Triethanolamine [$N(CH_2CH_2OH)_3$].
- Thionyl chloride ($SOCl_2$).

g. (U) Method of Manufacture.[2]

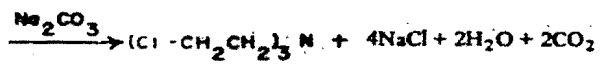


TRIETHANOLAMINE

TRIETHANOLAMINE HYDROCHLORIDE



TRICHLOROTRIETHYLAMINE HYDROCHLORIDE



HN-3

Note - 60 to 75° yield for pure product and 80 to 90% yield for technical product.

h. (U) Physical and Chemical Properties.

- Odor: Faint odor of geraniums.
- Physical state/color: Colorless oily liquid becoming a yellow liquid after 3 to 4 days.[11]
- Boiling point: 137° to 138° C at 15 mm Hg; decomposes before boiling at atmospheric pressure.[5]
- Melting point: -4° C.[5]
- Solubility: Soluble in Sulfur Mustard and chloropicrin. Insoluble in water, being less soluble than Sulfur Mustard.[11] Soluble in ether, benzene, and acetone.
- Vapor density (relative to air): 6.9.[5]
- Specific gravity (liq): 1.24 at 25° C.[5]
- Volatility: 24 mg/m^3 at 0° C, 120 mg/m^3 at 25° C, 257 mg/m^3 at 30° C, 400 mg/m^3 at 40° C (too low to yield an effective vapor concentration).[5]
- Vapor pressure: 0.0109 mm Hg at 25° C.[5]
- Heat of vaporization: 72 cal/g.[5]
- Flash point: High enough not to interfere with military use.[5]
- Decomposition temperature: Decomposes below boiling point.[5]
- Hydrolysis: Slow rate of hydrolysis.

i. (U) Method of Dissemination. Not known.

j. (U) Physiological Effect. Similar to those for HN-1. It has a low rate of detoxification, being essentially a cumulative poison.

k. (U) Decontamination.[6] Same as for HN-2.

l. (U) Protection Required. Protective mask and protective clothing.

m. (U) Storage. HN-3 is not entirely stable at room temperature in glass. The agent darkens slightly and deposits a small amount of black precipitate. Carbon disulfide and triphenyl carbinol are good stabilizers. The agent is stable in high carbon steel at 25° C for 40 to 50 weeks, also in low carbon steel if stabilizer is added.

n. (U) Toxicity.[5]

(1) (U) Median lethal vapor dosage:

- By inhalation--LCt_{50} is 1500 mg-min/m^3.
- Skin absorption (masked personnel)--LCt_{50} is 10,000 mg-min/m^3.

(2) (U) Median incapacitating dosage:

- Eye injury--ICt_{50} is 200 mg-min/m^3.
- Skin absorption (masked personnel)--ICt_{50} is 2500 mg-min/m^3.

o. (U) Persistence. Summer--24 hr in open areas and 1 week in the woods. Winter--several weeks.

p. (U) Detection. Same as for HN-1.

8. (U) Phosgene Oxime

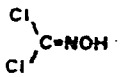
a. Code or Alternate Designations.

- United States--CX.
- USSR--Fosgen Oksim.
- Germany--Kanton.

b. Class. Irritant.

c. Chemical Name. Phosgene oxime.

d. Formula. $CHCl_2NO$



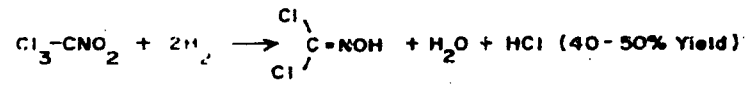
e. Molecular Weight. 113.94.

f. Alternate Chemical Name. Dichloroformoxime.

g. Raw Materials.

- Chloropicrin (Cl_3CNO_2).
- Hydrogen (H_2).
- Iron powder (Fe).
- Zinc (Zn).

h. Method of Manufacture.



This process may be carried out on a continuous basis and results in a very pure product. The reaction may also be catalyzed with iron powder or zinc.

i. Physical and Chemical Properties.

- Odor: Unpleasant, penetrating.
- Physical state and color: Colorless prismatic crystals; impure product is light yellow.
- Boiling point: 129° C.
- Melting point: 39° C.
- Solubility: Dissolves slowly but completely in water; soluble in organic solvents.

- Volatility: 1800 mg/m^3 at 20° C.
- Vapor pressure: 11.2 mm Hg at 25° C.
- Heat of vaporization: 100.9 cal/g.[56]
- Hydrolysis: Hydrolyzes slowly in water at room temperature; not hydrolyzed by dilute acids. Rapidly destroyed by alkali.

j. Method of Dissemination. Effective only when disseminated as an aerosol. Usually disseminated as a nonpersistent spray and preferably sprayed directly on human targets.

k. Use. As an immediate urticant. Not persistent enough for use as a ground contaminant.

l. Physiological Effects.[8] On contact with the skin, Phosgene Oxime produces immediate pain varying from a mild prickling sensation to a feeling resembling a severe bee sting. A wheal forms in about 30 min with a scab forming in about a week. Itching may be present throughout the healing process. Large doses of liquid cause deep-seated lesions and painful wounds. Resorption of the agent by the skin is considerable, and the effects can reappear if the skin becomes moist. The agent irritates the eyes, mucous membrane of the nose and can cause blindness if agent droplets come in contact with the eye. The agent also causes edema, convulsions, hemorrhage, and cyanosis.

m. Decontamination.[6] Large amounts of water, DS-2.

n. Protection Required. Agent penetrates ordinary clothing. Protective mask is satisfactory unless concentration is excessively high.

o. Storage. Extremely unstable in presence of traces of metals or other impurities. Even traces of iron chloride may cause explosive decomposition. Pure material stable only for 1 to 2 months. It may be stabilized by nitromethane, chloropicrin, glycine, ethyl acetate, or ether--but only in glass vessels below 20° C. Apparently, it is most stable in aromatic solvents.

p. Toxicity. The lowest irritant concentration after a 10-sec exposure is 1 mg/m^3. The effects of the agent become unbearable after 1 min at 3 mg/m^3.

q. Persistence. Persists in soil approximately 2 hr; has about 1/100 the persistence of mustard.

r. Historical.

- 1928: Prepared by Germans and rejected.
- 1929: Prepared by Prandtl and Sennewald in Germany.
- 1932: Prepared by G. Endres.
- 1941: Renewed interest after capture of Russian records claiming that it was as good as Sulfur Mustard.

s. Detection.

(1) US detectors.[21,22]

- Blue band tube (DB3-NaOH) in M19, M15A2, and M18A2 kits.
- M8 Point Alarm. Sensitivity, about 1 mg/m^3.

(2) Chemical reactions.[12,21] DB3-NaOH test--CX produces a red-brown color. Reaction is unknown.

9. (U) Sesqui Mustard

a. (U) Code or Alternate Designations.

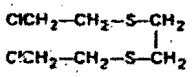
- United States--Q.
- Germany--Doppel-O, DO.

b. (U) Class. Vesicant.

c. (U) Chemical Names.

- 1,2-bis(2-chloroethylmercapto)ethane.
- 1,2-di(chloroethylthio)ethane.
- Ethylene bis-B-chloroethylsulfide.

d. (U) Formula. $C_6H_{12}Cl_2S_2$



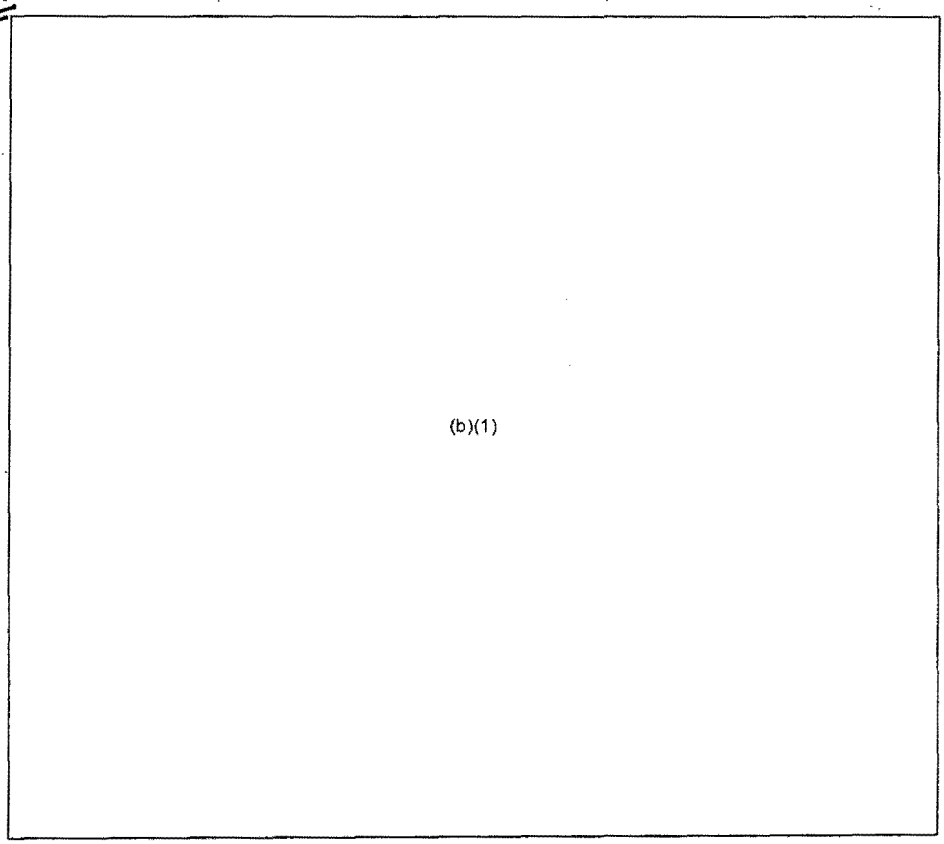
e. (U) Molecular Weight. 219.21.

f. (U) Raw Materials.

- Sodium salt of monothioglycol or MTG($HOCH_2CH_2SNa$).
- Ethylene chlorohydrin ($ClCH_2CH_2OH$).
- Disodium salt of ethane 1,2-dithiol ($NaSCH_2CH_2SNa$).
- Ethylene dibromide (BrC_2H_4Br).
- Thionyl chloride ($SOCl_2$).
- Thiodiglycol or TG [$S(CH_2CH_2OH)_2$].

g. (C) Method of Manufacture.[2]

(b)(1)



h. (U) Physical and Chemical Properties.

- Odor: Nauseating.
- Physical state: Solid.
- Boiling point: 80° C at 0.01 mm Hg.
- Melting point: 54° C.
- Solubility: Soluble in oils, carbon tetrachloride, Sulfur Mustard, benzene, acetone, chloroform, and alcohol.
- Specific gravity: 1.27 at 20° C.

- Volatility: 0.4 mg/m^3 24° C.
- Vapor pressure: 0.000013 mm Hg at 20° C.
- Decomposition temperature: 200° C under reduced pressure.
- Hydrolysis: Rapidly hydrolyzed by water.

i. ~~(C)~~ Method of Dissemination.

- (b)(1)
-

j. ~~(C)~~ Use. (b)(1)

(b)(1)

k. (U) Physiological Effects. Sesqui Mustard is five times more vesicant than Sulfur Mustard and is the most vesicant substance known. The agent inflames the eyes and causes vomiting, and prolonged exposure may cause blindness. Sesqui Mustard is absorbed through the skin and lung tissues to produce lesions that heal slowly.

l. (U) Decontamination. Bleaching powder, alcoholic solution of alkali, DANC, M5 protective ointment.

m. (U) Protection Required. Protective mask and clothing. Liquid HQ penetrates ordinary clothing and some types of impregnated clothing.

n. (U) Storage. Stable in steel containers.

o. ~~(C)~~ Toxicity.

- (b)(1)
-

p. (U) Persistent. Extremely persistent.

q. (U) Historical. 1921: Prepared by Bennett and Whincop.

r. (U) Detection.[21]

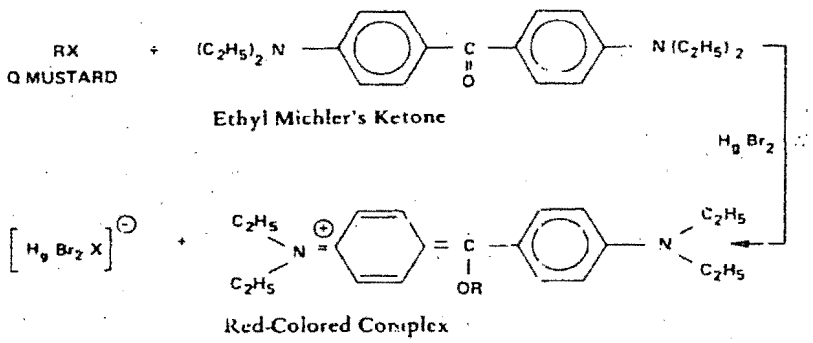
(1) (U) US detectors.

- Blue band tube (DB3-NaOH or DB3-NH_4OH test) in M19, M15A2, and M18A2 kits.
- EMK test in M19 kit. Maximum detectable range, 0.1 to 10 mg/m^3.

(2) (U) Chemical reactions.

(a) (U) DB3-NaOH Test (produces a blue color)-see Sulfur Mustard. With NH_4OH instead of NaOH, a purple blue color is obtained.

(b) (U) Ethyl Michler's Ketone (EMK) test.



10. ~~(C)~~ Sulfur Mustard[5]

a. (b)(1)

- USSR--Iprit, yperite. (U)
- (b)(1) (c)1
- French--Yperite, mustard gas, Yc, Yt. (U)[11]
- (b)(1) (c)

b. (U) Class. Blister agent.

c. (U) Chemical Names.

- Bis(2-chloroethyl)sulfide
- 2,2' Dichlorodiethyl sulfide.

d. (U) Formula. $C_4H_8Cl_2S$

$ClCH_2CH_2-S-CH_2CH_2Cl$

e. (U) Molecular Weight. 159.08.

f. (U) Alternate Chemical Names.

- Dichloroethyl sulfide.
- 1-Chloro-2-(chlorethylthio)ethane.
- 2,2'-Dichloro-diethylsulfide.

g. (U) Raw Materials.

- Ethyl alcohol (C_2H_5OH).
- Aluminum oxide (Al_2O_3).
- Sulfur (S).
- Chlorine (Cl_2).
- Ethylene chlorohydrin ($ClCH_2CH_2OH$).
- Sodium monosulfide (Na_2S).
- Hydrochloric acid (HCl).

h. (U) Method of Manufacture.

(1) (U) Levenstein Process:

$$C_2H_5OH + Al_2O_3 \xrightarrow{300^\circ C} C_2H_4 + Al_2O_3H_2O$$

Ethylene Aluminum oxide hydrate

$$2S + Cl_2 \longrightarrow S_2Cl_2$$

Sulfur monochloride

$$2C_2H_4 + S_2Cl_2 \longrightarrow ClCH_2CH_2-S-CH_2CH_2Cl + S$$

Mustard (H)

"H" mustard is purified by washing and vacuum distillation to produce "HD" mustard.[5]

(2) (U) German Method: (produces a pure product with a high yield).

$$2ClCH_2CH_2OH + Na_2S \longrightarrow HOCH_2CH_2-S-CH_2CH_2OH + 2NaCl$$

Thiodiglycol

$$S(CH_2CH_2CH)_2 + 2HCl \longrightarrow ClCH_2CH_2-S-CH_2CH_2Cl + 2H_2O$$

Mustard

i. (U) Physical and Chemical Properties.

- Odor: Garlic-like; HD has less odor than H.[4,5]
- Physical state and color: Amber or colorless oily liquid depending upon purity.[4,5,11]
- Boiling point: 227.8° C at 760 mm Hg, 93° C at 10 mm Hg.[4]

- Melting point: 14° C.[4,5]
- Solubility:[11,12,57] Poorly soluble in water (<1%); mustard on or under water undergoes hydrolysis only at the phase boundary and as a result, new mustard is constantly diffusing in small amounts into the water at the interface to replace that which had been hydrolyzed. Miscible with Diphosgene, Lewisite, Ethyldichloroarsine, Phenyldichloroarsine, and the organophosphorus nerve agents. Soluble in oils, Chloropicrin, alcohol, carbon tetrachloride, and titanium tetrachloride.
- Vapor density (relative to air): 5.4.[4,5]
- Specific gravity: 1.27 at 20° C (liq);[4,5] 1.37 at 0° C (solid).[4,5]
- Volatility: 22 mg/m^3 (-18° C, solid), 108 mg/m^3 (0° C, solid), 628 mg/m^3 (20° C, liquid), 2860 mg/m^3 (40° C, liquid).[5]
- Vapor pressure: 0.025 mm Hg at 0° C; 0.072 mm Hg at 20° C; 0.090 mm Hg at 30° C.[3,4,5]
- Heat of vaporization: 94 cal/g.
- Flash point: 105° C. Low enough to cause occasional ignition, if explosive charges in the shell are too great.[4,5]
- Decomposition temperature: 149° to 177° C.[4,5]
- Hydrolysis: Slow rate of hydrolysis at ordinary temperature; half-life is 8 min at room temperature when agent is in solution.[12] Hydrolysis products include HCl and thiodiglycol.[5]

j. (U) Methods of Dissemination.[5,6,8,11]

(1) (U) Sulfur Mustard. Aerial spray and bombs, artillery and mortar shells, land mines, and possibly rockets. A serious drawback in the use of mustard is its melting point. Since it solidifies at about 14° C, the solid phase tends to interfere with shell ballistics and cause serious problems with airplane spray tanks. To lower the

freezing point, Lewisite (see Agent Mixture, HL) or solvents such as chlorobenzene, nitrobenzene, benzene, and carbon tetrachloride may be added. Mustard thickened with methyl methacrylate may be used to disseminate the agent from great heights so that it can hardly be detected from the ground and can maintain its droplet form on its way to the ground.

(2) (U) Simulated mustard. Simulated mustard (MR) was developed as a substitute for H in the testing of dispersion apparatus and munitions as well as for training purposes. MR is a solution of 25% molasses in water, with cresol as a stabilizer. It is a dark brown liquid with a thin, syrupy consistency; it has a viscosity and surface tension sufficiently close to H to insure comparable flow characteristics; its low freezing point makes it suitable in moderately cold weather without danger of freezing. The patterns obtained by dispersion from airplane smoke tanks, chemical land mines, and thin-case bombs are similar to those produced by H. Although it has a pH of 4.5, MR causes no corrosion when used as a fill in these munitions.

k. (U) Use. The primary military application of Sulfur Mustard is to deny terrain or to lower mobility of an enemy force on a contaminated area. The effects are optimal on heavily vegetated tropical terrain. Since the agent is effective by inhalation as well as through the skin (penetrates ordinary clothing, rubber, and leather), special protective clothing as well as protective masks must be worn, thus lowering the efficiency of the troops. The agent is very persistent and may poison the soil for several weeks, denying the territory to enemy forces.[8]

l. (U) Physiological Effects. Mustard is primarily a vesicant, blisters being formed by either liquid or vapor contact. It also attacks the eyes and lungs, and is a systemic poison. The agent acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. The first symptoms of mustard poisoning usually appear in 4 to 6 hr. The higher the concentration, the shorter the interval of time between exposure to the agent and the first symptoms; thus, the effects resulting from liquid mustard are more rapid in onset than mustard vapor.[57] The physiological action results in conjunctivitis or inflammation of the eyes and erythema, which may be followed by blistering or ulceration and inflammatory reaction of the nose, throat, trachea, bronchi, and lung tissue. Susceptibility varies with individuals. Injuries produced by mustard heal much more slowly and are more liable to infection than burns of similar intensity produced by physical means or by other chemicals.[5] The rate of detoxification is very low. Mustard exerts a casualty effect at lower concentrations in hot humid weather since wet skin absorbs more mustard than dry skin.

m. (C) Decontamination.[8,27,57] (b)(1)

(b)(1)

n. (U) Therapy. Basically symptomatic, but antibiotics such as chloramphenicol should be used to prevent infection.[57] For small doses, a dressing alone is sufficient.

o. (C) Protection Required.[8,3] (b)(1)

(b)(1)

p. (U) Storage. Stable in steel or aluminum containers and can be stabilized with acridine or naphthoquinoline. HD is more stable than H.[5]

q. (U) Toxicity.[4,5,8,11]

(1) (U) Median lethal dosage.

- By inhalation--LCt_{50} = 1500 mg-min/m^3.
- Skin absorption (masked personnel)--LCt_{50} = 10,000 mg-min/m^3. LD_{50} for liquid on skin is 20 to 25 mg/kg, depending on amount of moisture present on skin; LD_{100} is given as 60 to 70 mg/kg.[58]

(2) (U) Median incapacitating dosage.

- Eye injury--ICt_{50} = 200 mg-min/m^3.
- Skin absorption (masked personnel)--ICt_{50} = 2000 mg-min/m^3 at 21° to 27° C. Wet skin absorbs more mustard than dry skin; above 27° C, perspiration increases so that at 32° C the ICt_{50} for skin absorption is reduced to

1000 mg-min/m^3. Absolute erythemata occurs with 0.01 mg of H/cm^2 of skin; small blisters form at 0.1 to 0.15 mg/cm^2 and larger ones at 0.5 mg/cm^2.

r. (U) Persistence. Summer--3 to 4 days in the open and 1 week in the woods. Winter--several weeks, both in the open and in the woods. Considered to be nonpersistent if released as an aerosol. Liquid agent can be very persistent, since it vaporizes very slowly at ambient temperatures.[57]

s. (U) Historical.

- 1822: First obtained by Despritz (ethylene and sulfur monochloride).
- 1854: Prepared by Richie.
- 1860: Prepared by Guthrie, also Niemann, independently.
- 1886: Meyer, in Germany, used a new process (thiodiglycol and phosphorus trichloride).
- 1912: Clarke used thiodiglycol and HCl.
- July 1917: First used by the Germans. The German term "lost" was formed from the two names of the scientists, Lommel and Steinkopf, who investigated the characteristics of Sulfur Mustard.
- 1920: Gibson and Pope perfected Guthrie's method, used dry and alcohol-free ethylene and sulfur monochloride.

t. (U) Detection.

(1) (U) Detectors.

(a) (U) USSR.

- (b)(1)

(b) (U) PRC.

- Detector kits Model 1950? and Type 64.[19,20] One yellow band tube to produce a yellow to red color. Sensitivity, about 2 mg/m^3.[59]

(c) (U) US.[12,21]

- Blue band tube (DB3-NaOH test) in M15A2A, M18A2, and M19 kits. Sensitivity, about 1 mg/m^3.
- White band sampling tube (Dragendorff's test to differentiate Sulfur Mustard from Nitrogen Mustard using appropriate reagents) in M19 kit.
- ABC-M8 Indicator paper.
- M7A1 Vesicant Detector Crayon.
- AN-M2 Water Testing kit (DB3 test).

(d) (C) (b)(1) (b)(1)

(2) (U) Chemical reactions.[12,21]

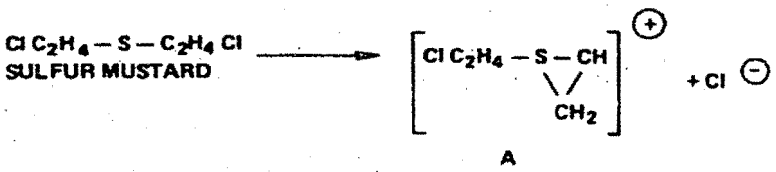
(a) (U) Dragendorff's Test—See Tabun. Test is positive for Nitrogen Mustard but negative for Sulfur Mustard.

(b) (U) M7A1 Vesicant Detector Crayon.

Sulfur Mustard $\xrightarrow{\text{Chloramine}}$ HCl $\xrightarrow{\text{Congo Red}}$ Blue color.

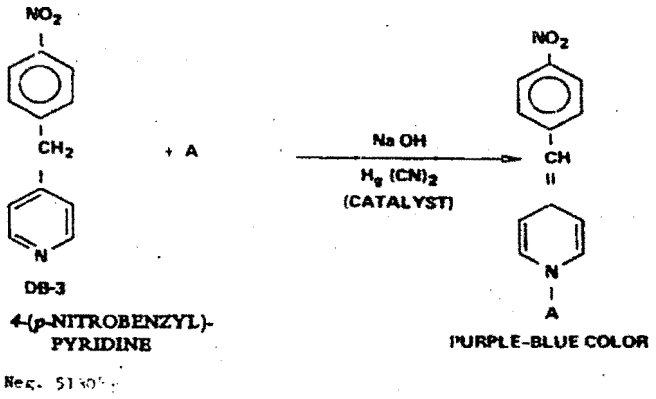
L, ED, and MD also respond to this test, but the nitrogen mustards do not.

(c) (U) DB3-NaOH Test (for alkylating and acylating agents).



A

Neg. 513089



Neg. 51305

(d) (U) ABC-M8 Detector Paper. See Sarin for dye content. H produces a red color.

11. ~~(C)~~U T - Mustard

a. ~~(C)~~ Code or Alternate Designations.

- (b)(1)

b. (U) Class. Vesicant.

c. (U) Chemical Name. Bis[2-(2-chloroethylthio)ethyl] ether.

d. (U) Formula.

$C_8H_{16}Cl_2OS_2$

$ClCH_2CH_2-S-CH_2CH_2-O-CH_2CH_2-S-CH_2CH_2Cl$

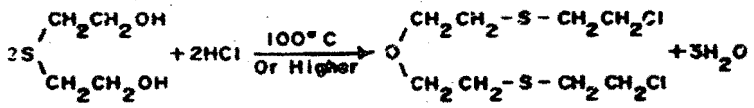
e. (U) Molecular Weight. 279.26.

f. (U) Alternate Chemical Names. 2,2-di(chloroethylthio)diethyl ether.

g. (U) Raw Materials.

- Thiodiglycol $(C_2H_4OH)_2S$.
- Gaseous hydrogen chloride (HCl).

h. (U) Method of Manufacture.



(Yields a 60-40 Mixture of H and T)

i. (U) Physical and Chemical Properties.

- Odor: Mustard-like.
- Physical state: Liquid.
- Boiling point: 80° C at 0.02 mm Hg; 120° C at 0.5 mm Hg.
- Melting point: 8.97° C. The H and T mixture (60:40) has a lower freezing point than H alone.[8]
- Solubility: Soluble in oils, carbon tetrachloride, methyl alcohol, chloroform, ether, acetone, benzene, toluene, monochlorobenzene, and Sulfur Mustard. Insoluble in water and petroleum ether.
- Specific gravity (liq): 1.24 at 20° C.
- Volatility: 2.8 mg/m^3 at 25° C.
- Vapor pressure: 0.000029 mm Hg at 25° C.
- Decomposition temperature: 174° C at 2.0 mm Hg.

j. (U) Method of Dissemination. Standard chemical munition charged with a 60:40 mixture with Sulfur Mustard.

k. (U) Use. 60:40 mixture of H and T.

l. ~~(C)~~ Physiological Effects. (b)(1)

(b)(1)

m. (U) Decontamination. Alcoholic KOH or NaOH, bleach slurry, sodium hypochlorite, DANC solution, and M5 protective ointment. Decontaminants also apply to the H and T mixture.[5]

n. (U) Protection Required. Protective mask and protective clothing. T is less effective than Sulfur Mustard through clothing.

o. (U) Storage. Stable in steel containers. The H and T mixture (60:40) is more stable than H alone.[8]

p. ~~(C)~~ Toxicity.

- (b)(1)
-

q. ~~(C)~~ Persistence. (b)(1)

(b)(1)

r. (U) Detection. Same as for Sesqui Mustard.

Section III.

SYSTEMIC (BLOOD AGENTS)

1. (U) General

Blood agents are absorbed into the body primarily by inhalation. They affect bodily functions through action on blood hemoglobin or on the enzyme cytochrome-oxidase system so as to prevent the normal transfer of oxygen from the blood to body tissue and cellular respiration.

2. (U) Arsine

a. Code or Alternate Designations.

- United States--SA.
- United Kingdom--SA.

b. Class. Systemic poison.

c. Chemical Name. Arsenic trihydride.

d. Formula. AsH_3.

e. Molecular Weight. 77.95.

f. Alternate Chemical Names.

- Hydrogen arsenide.
- Arseniuretted hydrogen.

g. Raw Materials.

- Sodium arsenide (Na_3As).
- Sodium hydroxide (NaOH).
- Water (H_2O).
- Arsenic trichloride ($AsCl_3$).
- Hydrogen (H_2).

h. Method of Manufacture.

- Method A:

$$Na_3As + NaOH + 3H_2O \longrightarrow AsH_3 + 4NaOH$$

SA

- Method B:

$$AsCl_3 + 3H_2 \longrightarrow AsH_3 + 3HCl$$

SA

i. Physical and Chemical Properties.

- Odor: Disagreeable garlic odor.
- Physical state and color: Colorless neutral gas.
- Boiling point: -63° C.
- Melting point: -117° C.[5]
- Solubility: Soluble in carbon disulfide, trichloroethylene, acetone, phosgene, carbon tetrachloride. Slightly soluble in water.
- Vapor density (relative to air): 2.69.
- Liquid density: 1.34 at 20° C.
- Volatility: 30,900,000 mg/m^3 at 0° C.[5]
- Vapor pressure: 11,360 mm Hg at 20° C.[5]
- Heat of vaporization: 53 cal/g.[5]
- Flash point: Very low. SA ignites so easily that it cannot be used in shells; it tends to explode in air.
- Decomposition temperature: 300° C. Decomposes on exposure to light.[8]
- Hydrolysis: Hydrolyzes rapidly.

j. Method of Dissemination. No munitions available.

k. Physiological Effects. Rapidly absorbed through the lungs into the bloodstream, arsine reacts immediately with the hemoglobin. The compound has no effect on the eyes, nose, respiratory tract, or skin. Damage to the liver and kidneys can occur. Slight exposure causes headache and uneasiness. In larger doses the victim becomes jaundiced, loses appetite, trembles, becomes weak, has abdominal pains, nausea and vomiting. In severe cases, collapse occurs followed by convulsions, delirium, coma, and death. Effects may be delayed from 2 hr to 11 days.

l. Use. Delayed action casualty agent.

m. Therapy. Morphine sulfate, oxygen inhalation, unithiol, whole blood transfusion.

n. Decontamination. None required.

o. Protection Required. Protective mask.

p. Storage. Stable if stored in varnished steel containers at room temperature, away from light. Metal catalyzes decomposition. Relatively stable in mild steel and Swedish iron if hydrogen sulfide is added as a stabilizer. Stability is impaired by small amounts of water.

q. Toxicity. Median incapacitating dosage is 2,500 mg-min/m^3. It is estimated that a dose of 2 mg/kg would be lethal to man. Maximum allowable concentration for prolonged exposure is 0.05 ppm.

r. Persistence. Nonpersistent.

s. Detection.[21]

(1) US Detectors.

- Blue band tube (DB3 test) in M19 kit.
- AN-M2 Water Test Kit (Gutzeit test).

(2) Chemical reactions.

- DB3 test--SA produces a yellow to orange color.
- Gutzeit test--$AsH_3 + HgBr_2$ (on impregnated paper) $\longrightarrow$ Hg
  Black color

t. Historical. 1873: Prepared by Janowsky.

3. (CNU) Cyanogen Chloride

a. (CNU) Code or Alternate Designations.

- United States--CK. (U)
- United Kingdom--CK. (U)
- France--Mauginite, Vitrite. (U)
- USSR--Klortsian. (U)
- (b)(1) (U)

b. (U) Class. Systemic poison and lacrimator.

c. (U) Chemical Name. Cyanogen chloride.

(U) Formula. CNCl.

e. (U) Molecular Weight. 61.48.

f. (U) Alternate Chemical Names.

- Chlorine cyanide.
- Chlorocyanide.

g. (U) Raw Materials.

- Hydrogen cyanide (HCN).
- Chlorine (Cl_2).
- Sodium cyanide (NaCN) or Potassium cyanide (KCN).

h. (U) Method of Manufacture.

- Method A.

$$HCN + Cl_2 \longrightarrow \underset{\text{Cyanogen chloride}}{CNCl} + HCl$$

- Method B.

$$NaCN + Cl_2 \longrightarrow \underset{\text{Cyanogen chloride}}{CNCl} + NaCl$$

i. (U) Equipment. Iron vessel and cooling coils.

j. (U) Physical and Chemical Properties.

- Odor: Irritating and lacrimatory to extent that odor is unnoticed.
- Physical state and color: Colorless liquid.
- Boiling point: 14° C.[5]
- Melting point: -6° C.[5]
- Solubility: Soluble in water, alcohol, carbon disulfide, acetone, benzene, carbon tetrachloride, Chloropicrin, Sulfur Mustard, and HCN.[11]
- Vapor density (relative to air): 2.1.
- Specific gravity: 1.18 at 20° C.
- Volatility: 6,132,000 mg/m^3 at 25° C.[5]
- Vapor pressure: 1,010 mm Hg at 20° C.[5]
- Heat of vaporization: 103 cal/g.[5]
- Flash point: None.
- Decomposition temperature: Above 100° C.
- Hydrolysis: Very slowly hydrolyzed by moisture; products are HCl and HOCN.

k. (U) Method of Dissemination.[6] Artillery and mortar shells, bombs, grenades. Mixed with HCN as an airplane spray.

l. (U) Use. CK is a toxic gas which remains close to the ground and produces immediate casualties, usually lethal. CK does not hydrolyze in damp regions, and is thus effective in rain or fog. The gas is usable both in the tropics and in cold climates.

m. (U) Physiological Effect. CK irritates the eyes and lungs and rapidly paralyzes nerve centers, especially those controlling the respiratory system. The gas causes delayed deaths in low concentrations and very rapid deaths in high concentrations. Rate of detoxification in body is 0.02 to 0.1 mg/kg-min. Unlike Hydrogen Cyanide, it has a lacrimating effect and does not stimulate breathing rate.

n. (U) Decontamination.[6] Sodium hydroxide and DS-2. None generally required under field conditions.

o. (U) Therapy. Amyl nitrite; artificial respiration is used if breathing fails or threatens to fail. Alternate injections of sodium nitrite and sodium thiosulfate (subcutaneously or intravenously) could be administered. Also the use of dicobalt edetate (Kelocyanor) is suggested.[57]

p. (U) Protection Required. Protective mask. CK will break or penetrate a protective mask canister or filter element more readily than most other agents. To protect against CK, the charcoal is impregnated with salts of copper, chromium, and silver. Canister life is shortened if humidity is high.

q. (U) Storage.[8] The pure product will stand for 30 days at 65° C without excessive decomposition. It polymerizes in 40 to 60 days; impurities tend to promote polymerization which may occur with explosive violence. The impure product may be stabilized by propylene oxide or arsenic trichloride.

r. (U) Toxicity.[5] LCt_{50} is 11,000 mg-min/m^3 and ICt_{50} is 7000 mg-min/m^3. Lethal dose also is given as 4,000 mg-min/m^3 for 10 min and about 3,500 mg-min/m^3 for ½ min (East Germany).[11]

s. (U) Persistence. Summer--10 min in the open and 20 min in the woods. Winter--20 min in the open and 2 hr in the woods.

t. (U) Historical.

- Discovered by Wurtz in Germany.
- 1802: First prepared by Berthollet in France.
- 1916: Used by French as "Vitrite" stabilized with $AsCl_3$.

u. ~~(C)~~ u Detection.

(1) ~~(C)~~ Detectors.

(a) ~~(C)~~ USSR.

(b)(1)

(b) ~~(C)~~ US.[12,21]

(b)(1)

(c) ~~(C)~~ East Germany.

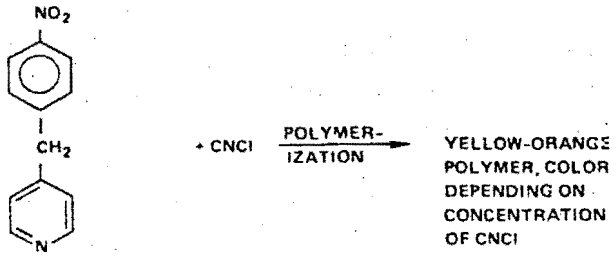
(b)(1)

(d) (U) PRC.

- Two green band tube to produce a yellow to red color. Sensitivity, about 8 mg/m^3.[61]

(2) (U) Chemical reactions.

(a) (U) DB3 test (for highly reactive alkylating and acylating agents, i.e., carbonium ion formation).



4-(*p*-NITROBENZYL)-PYRIDINE

Ref. 513093

(b) (U) DB3-NaOH test--Unknown chemical reaction. Forms a red to black color.

(c) (U) Pyrazolone test--See Hydrogen Cyanide for chemical reaction. Forms red-purple color.

(d) (U) Prussian Blue test (for cyanide ion)--see Hydrogen Cyanide for chemical reaction. Forms a blue color.

(e) (U) Tetra-Base test--See Hydrogen Cyanide for chemical reaction. Decomposing CK gives a positive light to deep blue color.

(f) (U) DB3-SO_3 test--Reaction is unknown. CK produces a purple color.

4. ~~(C)~~ (U) Hydrogen Cyanide

a. ~~(C)~~ (U) Code or Alternate Designations.

- United States--AC. (U)
- United Kingdom--AC. (U)
- France--Vincennite (50% AC, 30% arsenic trichloride, 15% stannic chloride, and 5% chloroform to reduce volatility), Manguinite (mixture of AC and CK), Vincornite, Fragenite, Forestite.[11] (U)
- (b)(1) ~~(C)~~ [1]
- (b)(1) ~~(C)~~ [1]
- Germany--Blausaure, Cyklon. (U)
- (b)(1) ~~(C)~~

b. (U) Class. Systemic poison.

c. (U) Chemical Names.

- Hydrogen cyanide.
- Hydrocyanic acid.

d. (U) Formula. HCN.

e. (U) Molecular Weight. 27.02.

f. (U) Alternate Chemical Name. Prussic acid.

g. (U) Raw Materials.

- Sodium cyanide (NaCN).
- Sulfuric acid (H_2SO_4).
- Acetylene (C_2H_2).
- Nitrogen (N_2).
- Chloroform ($CHCl_3$).
- Ammonia (NH_3).

h. (U) Method of Manufacture.[2]

- Method A.

$$2NaCN + H_2SO_4 \xrightarrow{Heat} 2HCN + Na_2SO_4 \text{ (Industrial Process)}$$

- Method B.

$$C_2H_2 + N_2 \xrightarrow{\text{Electric Spark}} 2HCN$$

- Method C.

$$CHCl_3 + NH_3 \xrightarrow{Heat} HCN + 3HCl$$

i. (U) Equipment. Cooling coils, distillation apparatus, and electrodes to produce an electric spark.

j. (U) Physical and Chemical Properties.

- Odor: Bitter almonds.
- Physical state and color: Colorless gas.
- Boiling point: 26.5° C.
- Melting point: -13.4° C. AC congeals at this temperature to a fibrous crystalline mass which melts at 15° C. Vaporization occurs so rapidly in air that the cooling effect causes some of the agent to congeal.[11]
- Solubility: Miscible in water and alcohol. Soluble in ether, glycerine, chloroform, benzene, tricresyl phosphate, and organophosphates.
- Vapor density (relative to air): 0.95.

- Specific gravity (liq): 0.697 at 10° C.
- Volatility: 1,075,000 mg/m^3 at 25° C;[5] 37,000 mg/m at -40° C.[8]
- Vapor pressure: 756 mm Hg at 26° C.[5]
- Heat of vaporization: 210 cal/g.[5]
- Flash point: Low; agent is ignited 50% of the time when disseminated from an artillery shell.
- Decomposition temperature: Above 66° C.
- Hydrolysis: Slow under field conditions. Hydrolysis products NH_3, HCOOH.

k. (U) Method of Dissemination. Rockets, mortar shells, and aerial bombs.

l. (~~C~~) Use. (b)(1)

(b)(1)

m. (U) Physiological Effect. HCN interferes with utilization of oxygen by body tissues due to inhibition of cytochrome-oxidase enzyme system. HCN causes a marked stimulation of the breathing rate. Symptoms appear within a few sec to min after inhalation of vapors; high doses usually are fatal in a few min. Symptoms of poisoning include weakness, convulsions, loss of consciousness, respiratory paralysis, and finally, death.[52] Its rate of detoxification in the body is 0.017 mg/kg-min.[11]

n. (U) Decontamination.[6] None required under field conditions.

o. (U) Therapy. Amyl nitrite (or propyl nitrite) are used as inhalants to oxidize hemoglobin to methemoglobin; the latter binds with cyanide to prevent inhibition of the cytochrome-oxidase system. Aminophenol, sodium thiosulfate, and dicobaltic ethylenediaminetetraacetate also are claimed to be effective antidotes.

p. (U) Protection Required. Protective mask with canister containing charcoal impregnated with salts of copper, zinc, and chromium. Extremely high concentrations of HCN tend to degrade the chemical impregnants and could cause death even against masked personnel if there is a long exposure time.[11]

q. (U) Storage. The pure material, in even small admixtures of water or alkali, forms an explosive polymer on standing;[58] it can be stabilized by adding small amounts of phosphoric acid and sulfur dioxide, or by dissolving in solvents. AC is also unstable when impure.[8]

r. (U) Toxicity. The median lethal dosage varies with concentration due to high rate of detoxification by the body. The following human estimates have been reported:[63]

Exposure Time (Min)	LCt_{50} (mg-min/m^3)
0.5	2032
1	3404
3	4400
10	6072
30	20632

Note--The Soviets' values of LCt_{50} for AC are considerably lower than the US estimates given above. AC penetrates healthy skin, the ICt being about 220,000 mg-min/m^3, for 10 min.[62,64]

s. (U) Persistence. Although AC is lighter than air, the concentrations that can be generated by modern means of delivery are stable for short periods of time, up to 10 min in summer and under favorable conditions of terrain (plant cover), up to 1 hr in winter.[11] AC probably is the Soviet's principal nonpersistent agent, and would be used on target areas where immediate occupation of an area is contemplated.[16]

t. (U) Historical.

- 1782: Discovered by Scheele.
- July 1916: Used by French at Somme as Vincennite and later as Manguinite.

u. ~~(C)~~ Detection.

(1) (C) Detectors.

(a) ~~(C)~~ USSR.

-
- (b)(1)

(b) (U) US.[21]

- Red band tube (Tetra-Base test) in M19 kit. Sensitivity, 5 mg/m^3.
- White band sampling tube (Pyrazolone test using appropriate reagents) in M19 kit.
- Prussian Blue test in M19 kit.
- M8 Point Alarm; minimum detectable range, 0.1 to 0.3 mg/m^3.[22]

(c) ~~(C)~~ East Germany.

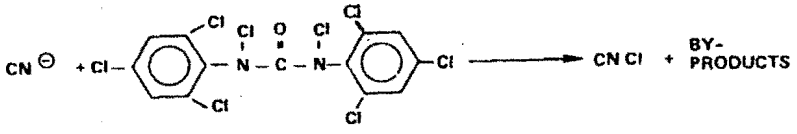
- (b)(1)
-

(d) (U) PRC.

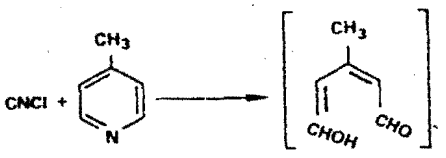
- One black band tube to produce an orange to red color. Sensitivity, about 5 mg/m^3.[65]

(2) ~~(C)~~ (U) Chemical reactions.[21]

(a) (U) Pyrazolone test (for hydrolyzable cyanide ion).

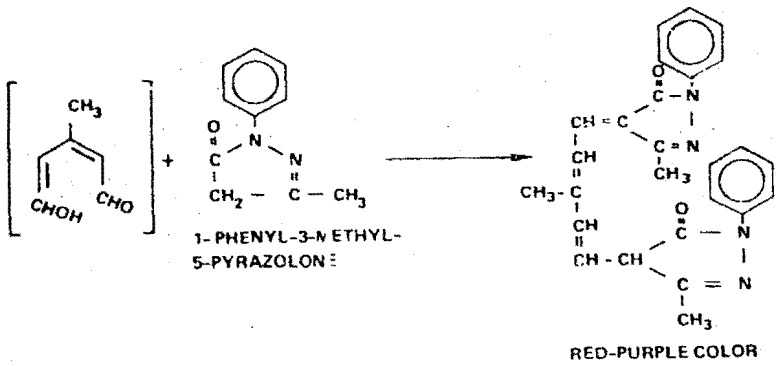


OCTOCHLORO-*SYN*-DIPHENYLUREA



4-PICOLINE AN NTERMEDIATE

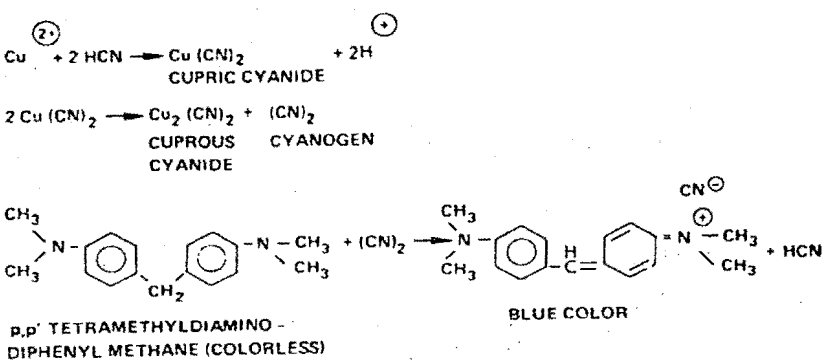
Neg. 513097



NOTE: GA, CK, AC AND DC GIVE POSITIVE TESTS BECAUSE THEY CONTAIN HYDROLYZABLE CYANIDE.

Ref: 513097

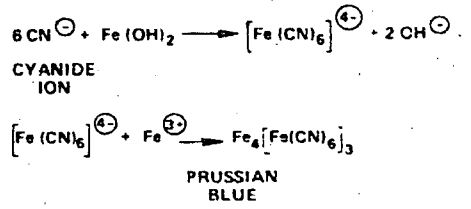
(b) (U) Tetra-Base test.



Nascent cyanogen oxidizes color reagent to a deep blue compound.

Note--Free cyanide, usually associated with Tabun, will give a positive test. Decomposing CK and DC also will produce a color change.

(c) (U) Prussian Blue test (for hydrolyzable cyanide ion).



(d) ~~(C)~~ (b)(1)

(b)(1)

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Section IV.

RESPIRATORY (CHOKING AGENTS)

1. (U) General

Choking agents injure unprotected personnel chiefly in the lungs. Irritation and inflammation result in edema. Lungs become filled with liquid in severe cases, and death results from lack of oxygen (known as dry-land drowning).

2. (U) Chlorine

a. Code or Alternate Designations.

- United States--Cl.
- United Kingdom--Cl.
- France--Bertholite.
- Germany--KLOP (mixture with chloropicrin).

b. Class. Lung injurant.

c. Chemical Name. Chlorine.

d. Formula. Cl_2

e. Molecular Weight. 70.91.

f. Raw Materials.

- Sodium chloride (NaCl).
- Water (H_2O).
- Nitric acid (HNO_3).
- Nitrosyl chloride (NOCl).
- Oxygen (O_2).
- Hydrochloric acid (HCl).
- Ferric oxide (Fe_2O_3).

g. Method of Manufacture.[2]

- Electrolytic Method:

$$2NaCl + 2H_2O \xrightarrow[Current]{Direct} Cl_2 + 2NaOH + H_2$$

Neg. 513100

- Salt and Nitric Acid Method:

$$3NaCl + 4HNO_3 \longrightarrow Cl_2 + 3NaNO_3 + NOCl + 2H_2O$$

$$2NOCl + O_2 \longrightarrow Cl_2 + 2NO_2$$

Neg. 513101

- Hydrochloric Acid and Air Method:

$$6HCl + Fe_2O_3 \longrightarrow 2FeCl_3 + 3H_2O$$

$$4FeCl_3 + 3O_2 \longrightarrow 6Cl_2 + 2Fe_2O_3$$

Neg. 513102

h. Equipment. Nelson cell (electrolysis).

i. Physical and Chemical Properties.

- Odor: Pungent.
- Physical state and color: Greenish-yellow gas.
- Boiling point: -34.6° C.
- Melting point: -101.0° C.
- Solubility: Soluble in water, Phosgene, Chloropicrin, carbon tetrachloride.
- Vapor density (relative to air): 2.4.
- Specific gravity (liq): 1.41 at 20° C.
- Volatility: 19,369,000 mg/m^3 at 20° C.[5]

- Vapor pressure: 4992 mm Hg at 20° C.[5]
- Heat of vaporization: 68.8 cal/g.[5]
- Flash point: None.
- Decomposition temperature: Greater than 1000° C.
- Hydrolysis: Hydrolyzes slowly to HCl and HOCl.

j. Method of Dissemination. There are no standard munitions for chlorine.

k. Use. Training.

l. Physiological Effect. The agent causes intense irritation of the eyes and throat and causes coughing. Chlorine burns the upper respiratory tract and can cause fatal pulmonary edema. Chlorine is rapidly detoxified in the body.

m. Decontamination. None required.

n. Protection Required. Protective mask.

o. Storage. Stable in iron cylinders, if dry.

p. Toxicity. LCt_{50} is 19,000 mg-min/m^3. ICt_{50} is 1800 mg-min/m^3.[8]

q. Persistence. Summer--5 min in open areas and 20 min in the woods. Winter--10 min in open areas and 1 hr in the woods.

r. Historical. April 1915: First gas used on an effective scale in World War I. Employed by the Germans against French and British Colonial troops in Ypres, Belgium.

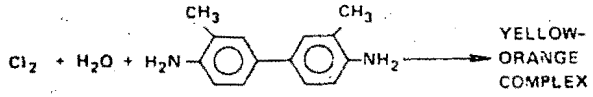
s. Detection.[21]

(1) US Detectors.

- Blue band tube (DB3-SO_3) in M19 kit.
- AN-M2 Water Testing Kit (*o*-Tolidine Test).

(2) Chemical reactions.

- DB3-SO_3 test--Reaction unknown. Cl produces a purple color.
- *o*-Tolidine Test.



3. (U) Dichlorodimethyl Ether

a. Code or Alternate Designations. None.

b. Class. Toxic lung irritant.

c. Chemical Name. 1,1'-Dichlorodimethyl ether.

d. Formula. $C_2H_4Cl_2O$

$ClCH_2-O-CH_2Cl$

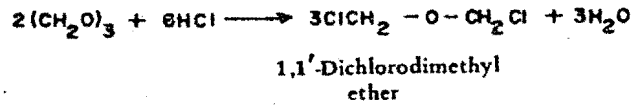
e. Molecular Weight. 114.96.

f. Raw Materials.

- Trioxymethylene $[(CH_2O)_3]$.
- Chlorosulfonic acid ($HOSO_2Cl$).
- Monochloroacetic acid ($ClCH_2COOH$).
- Hydrochloric acid (HCl).
- Formaldehyde (CH_2O).

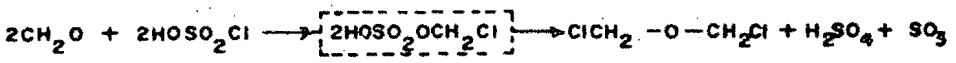
g. Method of Manufacture.[2]

- Method A:



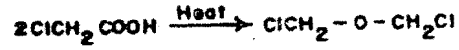
1,1'-Dichlorodimethyl ether

- Method B:



Chloromethoxysulfonic acid

- Method C:



Neg. 513106

h. Equipment. Iron vessels (1100 gal capacity) coated internally with acid-resistant materials and fitted with stirring apparatus and lead cooling coils.

i. Physical and Chemical Properties.

- Color: Colorless liquid.
- Boiling point: 104° C.
- Solubility: Insoluble in water; miscible in methanol and ethanol; soluble in benzene and acetone.
- Vapor density (relative to air): 3.9.
- Specific gravity: 1.33 at 25° C.
- Volatility: 180 mg/m^3 at 20° C.

j. Method of Dissemination. Aerial spray, bombs, land mines, artillery shells.

k. Use. Considered too unstable for military use.

l. Physiological Effect. The agent has a powerful irritant effect and is more toxic than Phosgene (see Phosgene, IV para 7). The organs of equilibrium are also affected; the victim staggers and reels and cannot maintain his balance.

m. Decontamination. Alkaline solutions.

n. Protection Required. Protective mask.

o. Storage. Unstable in presence of moisture, heat, or sunlight.

p. Toxicity. Lowest irritant concentration for 10 min exposure is 15 mg/m^3. Lethal concentration for 10 min exposure is 470 mg/m^3.

q. Historical. January 1918: First used by Germans, in mixture with ethyl dichloroarsine.

4. (U) Dimethyl Sulfate

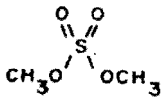
a. Code or Alternate Designators.

- United States--None.
- Germany--D-Stoff (with methylchlorosulfonate).
- France--Rationite (with chlorosulfonic acid).

b. Class. Toxic lung injurant, vesicant, lacrimator.

c. Chemical Name. Dimethyl sulfate.

d. Formula. $C_2H_6O_4S$.



e. Molecular Weight. 126.13.

f. Raw Materials.

- Methyl nitrite (CH_3ONO).
- Methyl chlorosulfonate (CH_3SO_3Cl).
- Chlorosulfonic acid ($ClSO_3H$).
- Methanol (CH_3OH).
- Sulfuryl chloride (SO_2Cl_2).
- Sulfuric acid (H_2SO_4).

g. Method of Manufacture.

- Method A:

$$2CH_3OH + SO_2Cl_2 \longrightarrow \underset{\text{Dimethyl sulfate}}{(CH_3)_2SO_4} + 2HCl$$

- Method B:

$$2CH_3OH + H_2SO_4 \longrightarrow (CH_3)_2SO_4 + 2H_2O$$

- Method C:

$$CH_3ONO + CH_3SO_3Cl \longrightarrow (CH_3)_2SO_4 + NOCl$$

Neg. 513109

- Method D:

$$2CH_3OH + ClSO_3H \xrightarrow{CCl_4} (CH_3)_2SO_4 + HCl + H_2O$$

Neg. 513110

h. Physical and Chemical Properties.

- Odor: Faint odor of onions.
- Physical state and color: Colorless liquid.

- Boiling point: 188° C with decomposition.
- Melting point: -3° C to -7° C.
- Solubility: Soluble in water, ether, dioxane, acetone, aromatic hydrocarbons.
- Vapor density (relative to air): 4.35.
- Specific gravity: 1.33 at 15° C.
- Volatility: 3,300 mg/m^3.
- Flash point: 182° C.
- Hydrolysis: Rapidly hydrolyzes in water at or above 18° C.

i. Method of Dissemination. Artillery shells, hand grenades.

j. Use. Use too limited to establish combat value. Vapor too easily decomposed by moisture to make it militarily effective. Used at present in industry as a methylating agent for amines and phenols. Also used as a catalyst in preparation of cellulose esters.

k. Physiological Effect. Delayed appearance of symptoms may permit unnoticed exposure to lethal quantities. Powerful irritant of mucous membrane, especially the eyes, nose, throat, and lungs. Action on lungs results in bronchitis, pneumonia, and lung edema. It also has a blistering and necrotic action on skin which may last 6 months. Causes prostration, convulsions, delirium, paralysis, coma, and death. Also damages liver, heart, and kidneys.

l. Decontamination. Alkaline solutions and steam.

m. Protection Required. Protective mask and protective clothing.

n. Storage. May be stored if kept dry Decomposes in presence of moisture.

o. Toxicity. Lethal concentration for 10 min exposure is 500 mg/m^3.

p. Historical.

- August 1915: Introduced by Germans as filling for artillery shells.
- September 1918: Used by French for artillery shells and hand grenades.

5. ~~(C)~~ (U) Diphosgene

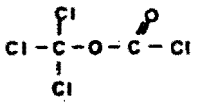
a. ~~(C)~~ (U) Code or Alternate Designations.

- United States--DP. (U)
- United Kingdom--DP. (U)
- Germany--Perstoff, Green Cross (mixture with chloropicrin). (U)[11]
- France--Superpalite. (U)
- USSR--Difosgen. (U)
- (b)(1) ~~(C)~~[1]
- (b)(1) ~~(C)~~

b. (U) Class. Lung injurant.

c. (U) Chemical Name. Trichloromethyl chloroformate.

d. (U) Formula. $C_2Cl_4O_2$.



Neg. 513111

e. (U) Molecular Weight. 197.83.

f. (U) Alternate Chemical Names.

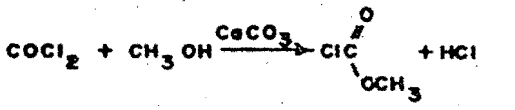
- Trichloromethyl ester of chloroformic acid.
- Perchloromethyl formate.

g. (U) Raw Materials.

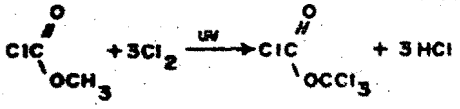
- Phosgene ($COCl_2$).
- Formic acid (HCOOH).
- Methanol (CH_3OH).
- Chlorine (Cl_2).

h. (U) Method of Manufacture.[2]

- US Method:

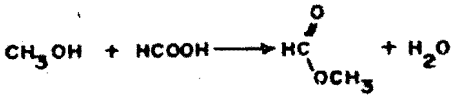


Methyl chloroformate

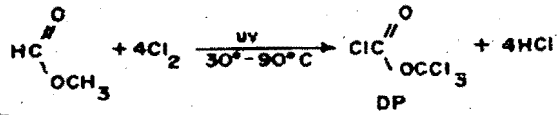


Neg. 513112 DP

- USSR Method:



Methyl formate



Neg. 513113 DP

i. (U) Equipment. Special tile-lined reaction vessels and an ultraviolet light source.

j. (U) Physical and Chemical Properties.

- Odor: Newly mown hay or grass.
- Physical state and color: Colorless oily liquid.
- Boiling point: 127° C.
- Melting point: -57° C.
- Solubility: Its solubility in Phosgene, Chloropicrin, Diphenyl chloroarsine as well as certain smokes make DP valuable for preparing tactical agent mixtures.[8]
- Vapor density (relative to air): 6.9.
- Specific gravity: 1.66 at 20° C.
- Volatility: 19,300 mg/m^3 at 0°C; 54,300 mg/m^3 at 20° C.[5]
- Vapor pressure: 2.4 mm Hg at 0° C; 10.3 mm Hg at 20° C.[5]
- Flash point: None.
- Decomposition temperatures: 301° to 351° C (yields two molecules of CG). Metals tend to catalyze the conversion of DP to CG.[8]
- Hydrolysis: Slow at ordinary temperatures. Hydrolysis products are HCl and CO_2.

k. (U) Method of Dissemination. Artillery shells, bombs, grenades, and rockets.

l. (U) Use. Casualties are produced and enemy troops are incapacitated without denying the area to the attacking forces. DP is a delayed or immediate-action casualty agent, depending on its dosage.[8]

m. (U) Physiological Effect. The agent irritates eyes, throat and respiratory tract. By its conversion to Phosgene in the body, it exerts its primary effect on the lungs by producing edema; lethal quantities of DF cause flooding of lungs with watery fluid so that the victim dies of oxygen deficiency. DP is slightly lacrimatory and differs from CG in this respect. DP is not significantly detoxified in the body; thus, its effect is cumulative.[8]

n. (U) Decontamination.[6] Alkaline solutions (including ammonia), live steam, and aeration in confined areas; however, decontamination is not required in the field.

o. (U) Protection Required. Protective mask.

p. (U) Storage. Less active than Phosgene. Pure product can be stored for longer periods of time. Needs no artificial refrigeration; therefore, shells can be filled in the field. The impure product is unstable in storage. Soviet material is stabilized with 1% to 2% phenol.

q. (U) Toxicity.[4,5] LCt_{50} is 3200 mg-min/m^3 and the ICt_{50} is 1600 mg-min/m^3.

r. (U) Persistence. Summer--15 min in the open and 60 min in the woods. Winter--30 min in the open and 3 hr in the woods. DP is more persistent in the field than CG because of its lower vapor pressure.

s. (U) Historical. May 1916: Used by Germans in retaliation for French Phosgene shells.

t. ~~(C)~~(U) Detection.

(1) ~~(C)~~(U) Detectors.

(a) ~~(C)~~ USSR.

- (b)(1)

(b) (U) US.[21]

- Single green band tube (PDB-PAN Test) in M19 and M18A2 kits.
- Blue band tube (DB3-SO_3 Test) in M19 kit.

(c) ~~(C)~~ East Germany.[60]

- (b)(1)

(2) (U) Chemical reactions.

- PDB-PAN test--DP produces a green color. See Phosgene for reactions.
- DB-SO_3 test--DP produces an orange to red color. Reaction is unknown.

6. (U) Phenyl Dichloroarsine

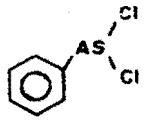
a. Code or Alternate Designations.

- United States--PD.
- Germany--Blue Cross #1, Pfifficus.
- France--Sternite.

b. Class. Toxic lung injurant and vesicant.

c. Chemical Name. Phenyl dichloroarsine.

d. Formula. $C_6H_5AsCl_2$



e. Molecular Weight. 222.93.

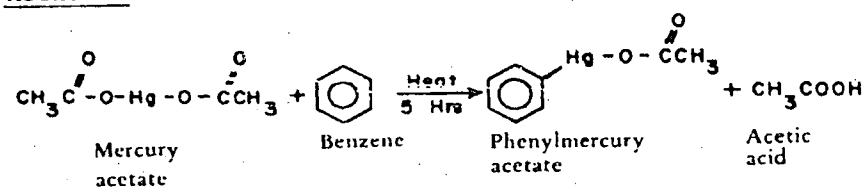
f. Alternate Chemical Name. Dichlorophenylarsine.

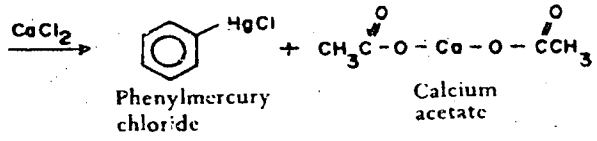
g. Raw Materials.

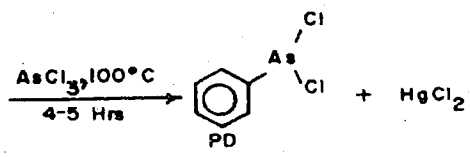
- Mercury acetate $[(CH_3COO)_2Hg]$.
- Arsenic trichloride ($AsCl_3$).
- Diphenylmercury $[(C_6H_5)_2Hg]$.
- Triphenyl arsine $[(C_6H_5)_3As]$.
- Benzene (C_6H_6).
- Calcium chloride ($CaCl_2$).

h. Method of Manufacture[2]:

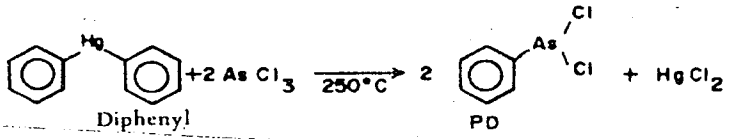
- Method A:





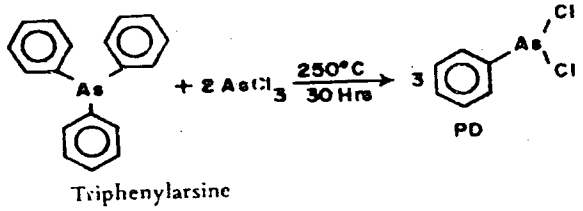


- Method B:



Neg. 513116

- Method C:



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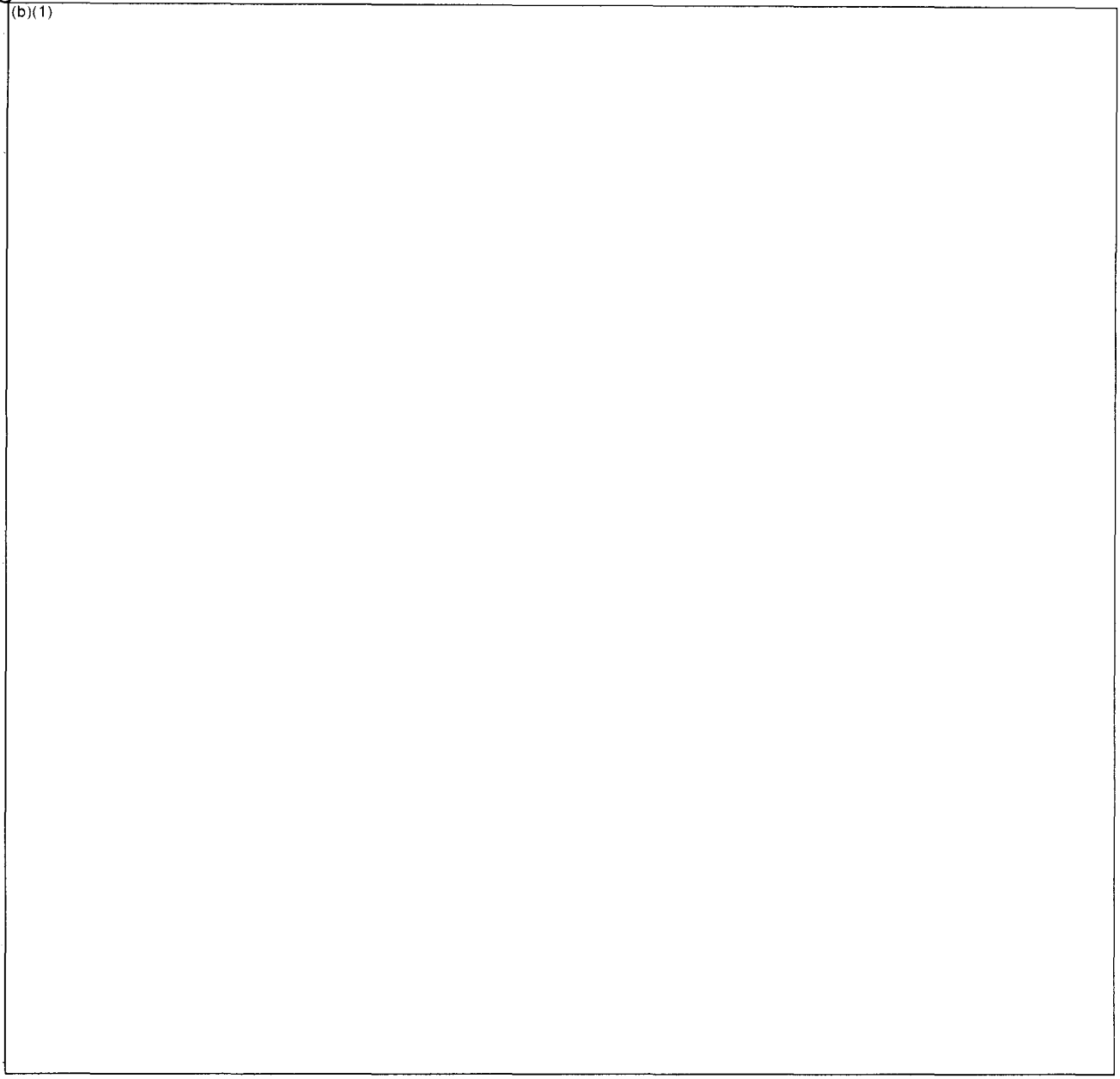
(b)(1)



m. Decontamination. Bleach, caustic soda, DS-2 and DANC. Also the skin decontamination pad in the US M13 Individual Decontaminating and Re-impregnating kit.[8]

n. Protection Required. Protective mask and protective clothing.

o. Storage. May be stored in iron cylinders if dry. Does not attack iron.

p. Toxicity. LCt_{50} by inhalation for 10 min exposure is 2600 mg-min/m^3. ICt_{50} is 16 mg-min/m^3 as a vomiting agent, and 1800 mg-min/m^3 as a blister agent.

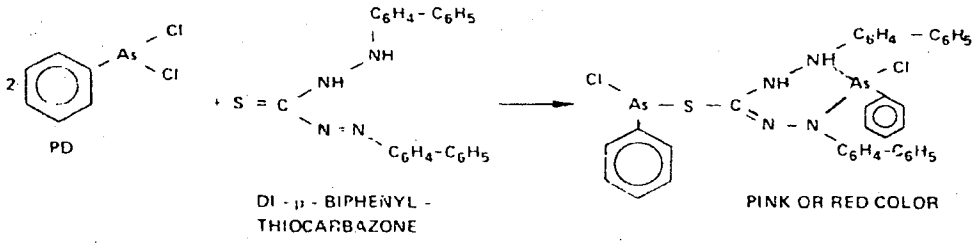
q. Historical.

- 1878: Prepared by LaCoste and Michaelis.
- 1914: Roeder and Blasi developed method used commercially.
- 1917: Used by Germans as solvent for Diphenyl cyanoarsine. Later used by French with Diphenyl chloroarsine as "Sternite."

r. Detection.[21]

(1) US Detectors. DBT-Benzene test in M19 kit. Sensitivity, 1.0 mg/m^3.[12]

(2) Chemical reaction. DBT-Benzene test (for arsenicals and heavy metal salts).



Note - In absence of PD, a tan, light orange-brown, or yellow-orange color develops in the presence of DM, DC, or DA.

7. ~~(C)~~ Phosgene

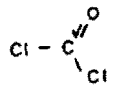
a. ~~(C)~~ Code or Alternate Designations.

- United States--CG. (U)
- United Kingdom--CG, G-1 PG (mixture with Chloropicrin). (U)[11]
- Germany--D-Stoff. (U)
- France--Collognite (Phosgene mixed with tin tetrachloride).
- USSR--Fosgen (U) (b)(1) ~~(C)~~
- (b)(1) ~~(C)~~
- (b)(1) ~~(C)~~

b. (U) Class. Lung injurant.

c. (U) Chemical Name. Carbonyl chloride.

d. (U) Formula. CCl_2O



e. (U) Molecular Weight. 98.92.

f. (U) Alternate Chemical Names.

- Carbon oxychloride.
- Chloroformyl chloride.

g. (U) Raw Materials.

- Bone charcoal (catalyst).
- Oxygen (O_2) from liquid air.
- Coke (C).
- Dry chlorine (Cl_2).

h. (U) Method of Manufacture.

$$C + O_2 \longrightarrow CO_2$$

$$CO_2 + O_2 + 3C \longrightarrow 4CO$$

$$CO + Cl_2 \longrightarrow Cl-C(=O)-Cl$$

i. (U) Physical and Chemical Properties.

- Odor: Newly mown hay or grass.
- Physical state and color: Colorless liquid, impure product yellow.
- Boiling point: 8.2° C.
- Melting point: -104° C to -128° C.
- Solubility: Soluble in Chlorine, Chloropicrin, titanium tetrachloride, mustard, Diphosgene, and other organic liquids. Slightly soluble in water.
- Vapor density (relative to air): 3.42.
- Specific gravity: 1.4.
- Volatility: 2,200,000 mg/m^3 at -10° C; 6,370,000 mg/m^3 at 20° C.[5]
- Vapor pressure: 555 mm Hg at 0° C; 1180 mm Hg at 20° C.[5]
- Heat of vaporization: 60 cal/g.[5]
- Flash point: None.
- Hydrolysis: Not readily hydrolyzed under field conditions; however, rain destroys its effectiveness. Hydrolysis products are HCl and CO_2.[8]

j. (U) Method of Dissemination. Mortar shells and aerial bombs.

k. (U) Use. Delayed action casualty gas in cloud gas attacks.

l. (U) Physiological Effects. Same as for Diphosgene, except that it has no lacrimatory effect. It is not significantly detoxified in body; thus its effects are cumulative.[8]

m. (U) Decontamination.[6] DS-2, water followed by alkaline solutions (including ammonia) may be used to destroy Phosgene. Although decontamination is not required in the field, aeration is desirable in confined areas.

n. (U) Therapy. Oxygen should be administered initially in high concentration and at positive pressure (hyperbarically) where there is cough, cyanosis, labored breathing, or restlessness. Artificial respiration procedures are undesirable.[5,7]

o. (U) Protection Required. Protective mask.

p. (U) Storage. Stable in dry steel containers. Requires refrigeration for filling shells.

q. (U) Toxicity. LCt_{50} is 3200 mg-min/m^3, and ICt_{50} is 1600 mg-min/m^3.[5] Exposure to 1000 mg/m^3 for 5 min is given as lethal in 50% to 75% of cases, i.e. LCt_{50-75}=5000 mg-min/m^3 (East Germany).[11]

r. (U) Persistence. Summer--30 min in the open and 30 min in the woods. Winter--20 min in the open and 2 hr in the woods.

s. (U) Historical.

- 1812: Prepared by John Davy, English chemist, using carbon monoxide, chlorine, and sunlight.
- 1848: Bone charcoal first used as catalyst.
- 1915: Manufactured on large scale by Germans. Used against British.
- 1916: Used in artillery shells against French by Germans.
- 1916: Used by British against Germans.

t. ~~(C)~~(U) Detection.

(1) ~~(C)~~(U) Detectors.

(a) ~~(C)~~ USSR.

- (b)(1)

(b) ~~(C)~~ US.[21]

- (b)(1)

(c) ~~(C)~~ East Germany.

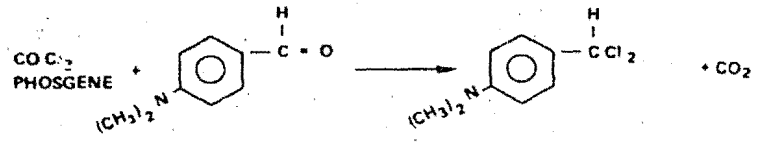
- (b)(1)

(d) (U) PRC.

- One green band tube to produce a yellow to purple color. Sensitivity, about 0.5 mg/m^3.[66]

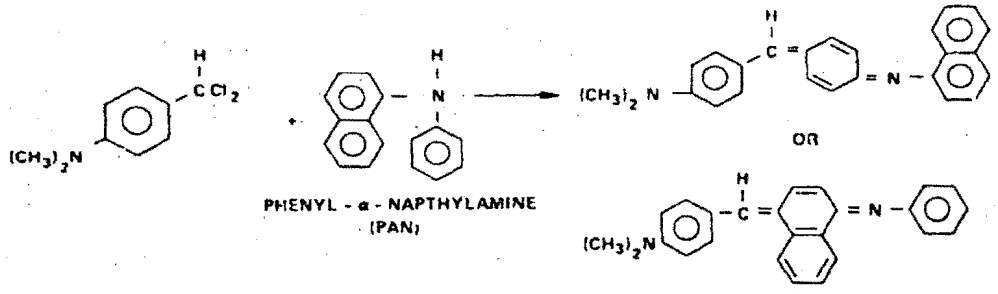
(2) (U) Chemical reactions.

(a) (U) PDB-PAN test.



P - DIMETHYLAMINO - BENZALDEHYDE (PDB)

P - DICHLOROMETHYL - N, N DIMETHYLANILINE



PHENYL - α - NAPTHYLAMINE (PAN)

Ncg. 513120

GREEN TO GREENISH-BLACK COLOR

Note - Very high concentration of CK, CG, and Triphosgene give positive reactions

(b) (U) DB3-NaOH test--CG produces a red-brown color. Reaction unknown.

(c) (U) DB3-SO_3 test--CG produces an orange to red color. Reaction unknown.

(d) (U) Detector Crayon. N-phenylbenzylamine, 4-(p-nitrobenzyl)-pyridine, and sodium carbonate react with Phosgene to produce a red color. Reaction not known.[53]

8. (U) Triphosgene

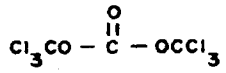
a. Code or Alternate Designations. None.

b. Class. Lung injurant.

c. Chemical Names.

- Hexachloromethyl carbonate.
- Carbonic acid-bis(trichloromethyl)ester.

d. Formula. $C_3Cl_6O_3$

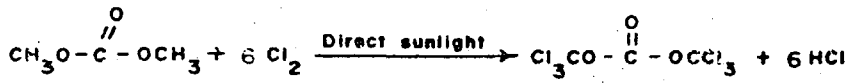


e. Molecular Weight. 296.75.

f. Raw Materials.

- Dimethyl carbonate $[CO(OCH_3)_2]$.
- Dry Chlorine (Cl_2).

g. Method of Manufacture.



h. Physical and Chemical Properties.

- Odor: Freshly mown hay or grass.
- Physical state and color: White crystals.
- Boiling point: 205° C with decomposition to CG and DP.[11]
- Melting point: 78° C.
- Solubility: Soluble in benzene, carbon tetrachloride, and ether.
- Decomposition temperature: Decomposes into Phosgene and Diphosgene on heating.
- Hydrolysis: Reacts rapidly with hot water.

i. Physiological Effect. Triphosgene causes coughing, tightness in chest, eye irritation; burns eyes, throat and respirator tract.

j. Decontamination. Excess methyl alcohol.

k. Protection Required. Protective mask.

l. Storage. Stable if dry. Does not corrode metals.

m. Historical. 1880: First prepared by Councler in Germany.

n. Detection. Same as for DP.

Section V.

RIOT CONTROL AGENTS

1. (U) General

a. Riot control agents are used when it becomes necessary for the civilian and military police, or other agencies of control, correction, or authority to dispell mobs, quell riots and rebellions, control public disturbances and maintain the public peace. Ideally, riot control agents are characterized by a combination of toxicological properties that will ensure that lethal exposures will be extremely rare.

b. In recent years, the irritant agent has found a place in combat operations to temporarily reduce the effectiveness of enemy personnel. One of its major advantages in tactical operations is its use to penetrate fortified positions for the purpose of flushing-out the enemy.

c. Riot control agents generally are algogenic (pain-producing) in nature. One important characteristic of these agents is the short interval between exposure to agent and onset of effects. Usually the effects disappear soon after exposure ceases.

d. General methods of dissemination include:

(1) Mechanical irritant gas dispensers (truck mounted) are capable of immediate action or prompt discontinuance when desired. They cover large areas by continuous use from one point or by movement while in action. They are designed to operate with a minimum of noise, and the operator is protected from the effects of the gas. The agents are disseminated in concentrations which will be effective against personnel, but not permanently harmful to them. The dispensers can be used at temperatures between -32° and 52° C.

(2) Portable gas dispensers are capable of being easily and safely carried and operated by one man. Like the truck-mounted item, they are capable of immediate action and prompt discontinuance when needed. They project micropulverized powdered agent a minimum of 40 feet.

(3) Bursting-type grenades provide for the dissemination of a non-lethal dose of an incapacitating agent under normal field conditions. The burster type explodes immediately and therefore cannot be kicked away or thrown back, as can the conventional burning-type grenades They are operational under all types of weather conditions.

(4) Helicopter-mounted dispensers disseminate riot control agents over a larger area than would be possible with ground dispensers. These facilitate the delivery of agent to the center and rear of enemy troops too large in numbers to be controlled from the ground. Further, the downdraft of the rotary blades assists in the dissemination of the agents. Commercial crop dusting equipment has been tried for this purpose and it is believed that, with certain modifications, it will be suitable for use in dispersing riot control agents.

2. (C) Bromobenzyl Cyanide

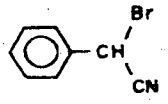
a. (U) Code or Alternate Designations.

- United States--BBC, CA.
- United Kingdom--BBC.
- France--Camite.
- Germany--T-Stoff.

b. (U) Class. Riot control, lacrimator.

c. (U) Chemical Name. α-Bromo-α-cyanotoluene.

d. (U) Formula. C_8H_6BrN

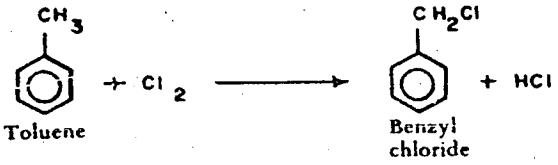


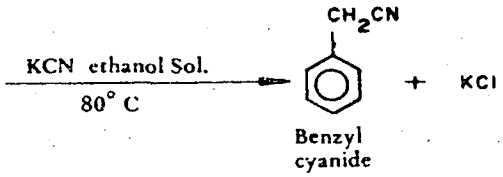
e. (U) Molecular Weight. 196.00.

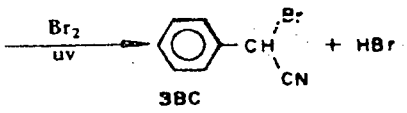
f. (U) Raw Materials.

- Toluene ($C_6H_5CH_3$).
- Chlorine (Cl_2).
- Potassium cyanide (KCN).
- Bromide (Br_2).

g. (U) Method of Manufacture.







h. (U) Physical and Chemical Properties.

- Odor: Bitter almonds or soured fruit.[5]
- Physical state and color: Yellowish-white crystalline solid.
- Boiling point: 242° C with decomposition.
- Melting point: 25° C to brownish oily liquid.
- Solubility: Soluble in Phosgene, Chloropicrin and organic solvents; insoluble in water and cold alcohol.
- Vapor density (relative to air): 6.6.
- Specific gravity: 1.47 at 25° C (liq).[5]
  1.52 at 20° C (solid).
- Volatility: 130 mg/m^3 at 20°C; 420 mg/m^3 at 30° C.[5]
- Vapor pressure: 0.012 mm Hg at 20° C.

- Heat of vaporization: 55.7 cal/g at boiling point.
- Flash point: None.
- Decomposition temperature: Decomposes slowly at 60° C; decomposes completely at 242° C with the formation of hydrobromic acid and dicyanostilbene.[5]
- Hydrolysis: Very slow; forms complex condensation products during hydrolysis.

i. (U) Methods of Dissemination. Grenades, candles.

j. (U) Use. For harrassment of troops and to deny terrain to enemy by contaminating the soil; for training and riot control.

k. (U) Physiological Effect. Severe lacrimation, nose irritation, acute pain in forehead, burning sensation of mucous membrane.

l. (U) Decontamination. A 20% alcoholic sodium hydroxide spray is effective but may damage material. Clothing can be decontaminated by boiling or steam.

m. (U) Protection Required. Protective mask.

n. (U) Storage. Slowly decomposes. Can be stored only in glass-, porcelain-, lead-, or enamel-lined containers. Vigorous corrosive action on all common metals except lead.

o. (U) Toxicity. LCt_{50} is approximately 8000 to 11,000 mg-min/m^3, but a lethal concentration cannot be obtained under field conditions. The ICt_{50} is about 30 mg-min/m^3.[8]

p. (U) Persistence. Depends upon the method of dissemination and the weather. Heavily splashed liquid persists 1 to 2 days under average weather conditions. Extremely persistent in soil.

q. (U) Historical.

- 1881: First prepared by Reinger in Germany by brominating benzyl cyanide.
- 1914: Manufacture in industry started.
- 1918: Introduced by French, also used simultaneously by United States.

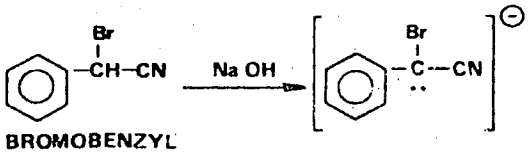
r. (C) Detection.

(1) (C) US Detectors.[12,21,22]

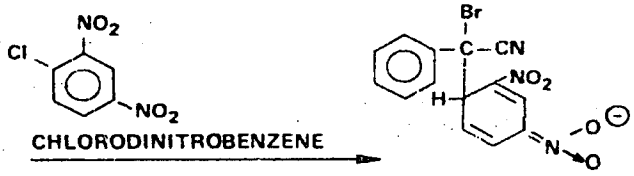
- (b)(1)

(2) (C) Chemical reactions.

(a) (U) DNB test (for carbanion).



BROMOBENZYL CYANIDE



CHLORODINITROBENZENE → RED-PURPLE COLORED COMPLEX

Neg. 513125

(b) (U) CK test--BBC produces a yellow to orange color. Reaction unknown.

(c) (U) (b)(1)

(b)(1)

3. (C) Chloroacetophenone

a. (U) Code or Alternate Designations.

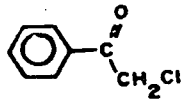
- United States--CN, Mace, and CNC (mixture of CN and chloroform, 30:70). (U)[8,57]
- United Kingdom--CN. (U)

- Germany--T-Stoff. (U)
- USSR--KhAF. (U)
- (b)(1) (C)

b. (U) Class. Riot control, lacrimator.

c. (U) Chemical Name. α-Chloroacetophenone.

d. (U) Formula. C_8H_7ClO



Neg. 513126

e. (U) Molecular Weight. 154.59.

f. (U) Alternate Chemical Names.

- Phenacylchloride.
- Phenylchloromethylketone.

g. (U) Raw Materials.

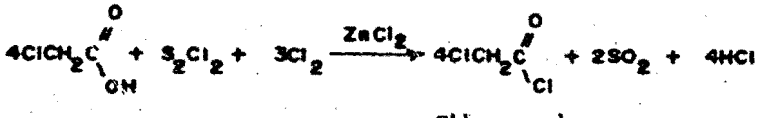
- Acetic acid (CH_3COOH).
- Chlorine (Cl_2).
- Sulfur monochloride (S_2Cl_2).
- Benzene (C_6H_6).

h. (U) Method of Manufacture.[2]

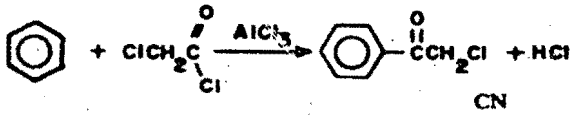
$CH_3COOH + Cl_2 \longrightarrow ClCH_2C(=O)OH + HCl$

Neg. 513127

Monochloroacetic acid



Chloroacetyl chloride



Reg. 513177

i. (U) Physical and Chemical Properties.

- Odor: Odor of apple blossoms in low concentrations.
- Physical state and color: Colorless crystalline solid.
- Boiling point: 244° to 245° C.
- Melting point: 54° to 56°C.
- Solubility: Soluble in chloroform, Chloropicrin, ethylene dichloride, chloroacetone and other organic solvents; insoluble in water.
- Vapor density (relative to air): 5.2.
- Specific gravity: 1.26 at 55° C (liq).
  1.32 at 15° C (solid).
- Volatility: 30 mg/m^3 at 0° C; 105 mg/m^3 at 20° C.
- Vapor pressure: 0.0054 mm Hg at 20° C; 0.158 mm Hg at 55° C.
- Heat of vaporization: 98 cal/g.

- Flash point: High enough not to interfere with military use.
- Decomposition temperature: Stable to boiling point.
- Hydrolysis: Not readily hydrolyzed, but the rate of hydrolysis is accelerated in the presence of alkali. The products of hydrolysis are HCl and hydroxymethylphenylketone.[11]

j. (U) Method of Dissemination. Artillery and mortar shells, pellets mechanical dispersers, candles and grenades as burning mixtures, and special cartridges fired from a pistol or riot gun.[5,57] (CNC may be disseminated by spray tanks, mortar shells, bombs, and grenades.)[8]

k. (U) Use. To harass the enemy troops; in mixtures, as riot control and training agents.

l. (U) Physiological Effects. CN causes lacrimation and irritates th upper respiratory passages. In higher concentrations, the agent produces burning and itching sensations especially on moist parts of the body. It is rapidly detoxified in the body.[8]

m. (U) Decontamination.[6] Hot soapy water, hot sodium carbonate (washing soda), hot sodium hydroxide. Aeration is sufficient in the field

n. (U) Protection Required. Protective mask.

o. (U) Storage. Stable in storage.

p. (U) Toxicity.[5] ICt_{50} is about 80 mg-min/m^3. LCt_{50} by inhalation for 10-min exposure is 11,000 mg-min/m^3 for smoke or aerosol.

q. (U) Historical.

- 1869: Discovered by German chemist, Graebe.
- 1919-1920: Suitable process for manufacture worked out by United States.[21]

r. (U) Detection.

(1) (U) Detectors.

(a) (U) USSR. (b)(1)

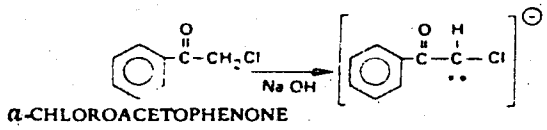
(b)(1)

(b) (U) US.[12,21]

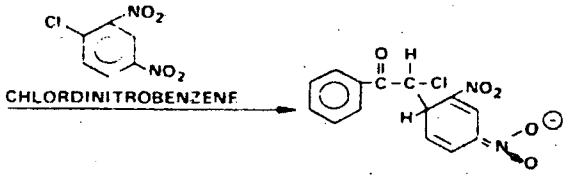
- Two green band tube (DNB test) in M19 kit. Sensitivity, about 2 mg/m^3.
- Blue band tube (DB3-NH_4OH test) in M19 kit. Sensitivity, about 2 mg/m^3.
- Blue band tube (DB3-NaOH test) in M19 kit. Minimum detectable range, 50 to 100 mg/m^3.
- Blue band tube (DB3-SO_3 test) in M19 kit.

(2) (U) Chemical reactions.

(a) (U) DNB test (for carbanion).



α-CHLOROACETOPHENONE



CHLORDINITROBENZENE

RED-PURPLE COLORED COMPLEX

(b) (U) DB3-NaOH test--CN produces a blue color. Reaction is unknown.

(c) (U) DB3-SO_3 test--CN produces an orange color. Reaction is unknown.

(d) (U) DB3-NH_4OH test--CN produces a blue or purple-blue color. Reaction is unknown.

4. Chloropicrin

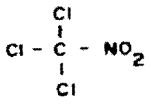
a. (U) Code or Alternate Designations.

- United States--PS.
- United Kingdom--NC, Vomiting gas, PS, G-8, PG (mixture with Phosgene).
- Germany--KLOP (mixture with Chlorine), Green Cross (mixture with DP).[11]
- France--Aquinite.
- USSR--Klorpikrin.

b. (U) Class. Riot Control--lacrimator, lung irritant.

c. (U) Chemical Name. Trichloronitromethane.

d. (U) Formula. Cl_3CNO_2.



e. (U) Molecular Weight. 164.39.

f. (U) Alternate Chemical Names.

- Nitrochloroform.
- Trichloropicromethane.

g. (U) Raw Materials.

- Nitromethane (CH_3NO_2).
- Chloride of lime ($CaOCl_2$).
- Chlorine (Cl_2).
- Calcium picrate ($[C_6H_2(NO_2)_3O]_2Ca$).

- Chloroform ($CHCl_3$).
- Calcium hypochlorite $Ca(OCl)_2$.
- Nitric acid (HNO_3).
- Hydrochloric acid (HCl).
- Trichloroethylene ($ClCHCCl_2$).
- Acetone [$(CH_3)_2CO$].
- Trichloroacetaldehyde (Cl_3CCHO).
- Sodium hypochlorite (NaOCl).
- Picric acid [$C_6H_2(NO_2)_3OH$].
- Sodium hydroxide (NaOH).

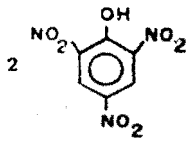
h. (U) Method of Manufacture.[2]

- French Method:

$$HNO_3 + 3HCl \longrightarrow NOCl + Cl_2 + 2H_2O$$

$$(CH_3)_2CO + NOCl + 8Cl_2 + 4H_2O \longrightarrow \underset{\text{Chloropicrin}}{Cl_3CNO_2} + 2CO_2 + 14HCl$$

- German Method:

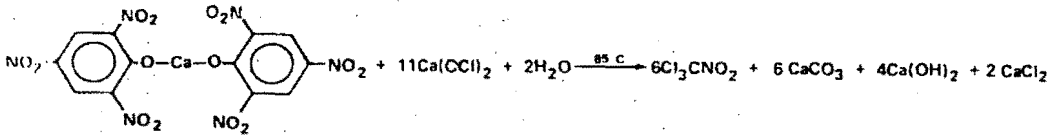


$$2 + 22\,Ca(OCl)_2 \longrightarrow 6Cl_3CNO_2 + 6CaCO_3 + 3Ca(OH)_2 + 13CaCl_2$$

- Romanian Method:

$$CH_3NO_2 + 3Cl_2 \xrightarrow{CuCl_2} Cl_3CNO_2 + 3HCl$$

- US Method:



- Other Methods:

Method A:

$$CHCl_3 + HNO_3 \longrightarrow Cl_3CNO_2 + H_2O$$

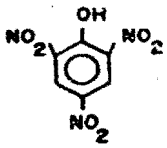
Method B:

$$ClCHCCl_2 + HNO_3 \longrightarrow Cl_3CNO_2 + HCHO$$

Method C:

$$Cl_3CCHO + HNO_3 \longrightarrow Cl_3CNO_2 + CO + H_2O$$

Method D:



$$+ 11Cl_2 + 5H_2O \xrightarrow{0-5°C} 3Cl_3CNO_2 + 3CO_2 + 13HCl$$

Note: 913158

Method E:

$$CH_3NO_2 + NaOCl + NaOH + 2Cl_2 \longrightarrow Cl_3CNO_2 + 2NaCl + 2H_2O$$

Method F:

$$CH_3NO_2 + 3NaOH + 3Cl_2 \longrightarrow Cl_3CNO_2 + 3NaCl + 3H_2O$$

i. (U) Physical and Chemical Properties.

- Odor: Intense stinging odor.
- Physical state and color: Colorless oily liquid.
- Boiling point: 112° C.
- Melting point: -69° C.
- Solubility: Soluble in organophosphorus compounds, mustards, Phosgene, Diphosgene, Chlorine, chloroform, carbon disulfide, benzene, and alcohol; insoluble in water.[11]
- Vapor density (relative to air): 5.6.
- Specific gravity (liq): 1.66.
- Volatility: 165,000 mg/m^3 at 20° C.
- Vapor pressure: 18.3 mm Hg at 20° C.

j. (U) Method of Dissemination. Aerial bombs, as a spray (alone or mixed with Phosgene), mixed with chloroacetophenone in artillery shells, mixed with 70% chlorine for cloud gas attacks (Yellow Star Gas).

k. (U) Use. In cloud gas attacks for harassment, terrain denial, and to produce casualties; in mixtures, as a riot control agent; and as an insecticide.

1. (U) Physiological Effect. Lacrimation and irritation of nose and throat; causes lung irritation as concentration increases; nausea and vomiting. Liquid Chloropicrin cause skin lesions.[11]

m. (U) Decontamination. Alcoholic or water solution of sodium sulfite.

n. (U) Protection Required. Protective masks.

o. (U) Storage. Stable for long periods in steel cylinders.

p. (U) Toxicity. Lowest irritant concentration for 10-min exposure is 9.0 mg-min/m^3. LCt_{50} by inhalation is 2000 mg-min/m^3.

q. (U) Persistence. Summer--1 hr in the open and 4 hr in the woods. Winter--12 hr in the open and 1 week in the woods.

r. (U) Historical.

- 1848: Discovered by English chemist, Stenhouse.
- 1916: Used by USSR, subsequently used by both Germans and Allies.

s. (U) Detection.[21]

(1) (C) Detectors.

- [redacted] (b)(1)
-
-

(2) (U) Chemical reactions. DB3-SO_3 Test--PS produces a red-purple color. Reaction is unknown.[21]

5. (C-NFD) CS

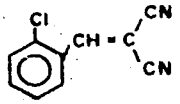
a. (U) Code or Alternate Designations.

- United States--EA 1779.
- United Kingdom--T 792.
- France--CB.[68]

b. (U) Class. Riot control--Lacrimator, sternutator.

c. (U) Chemical Name. Ortho-chlorobenzalmalononitrile.

d. (U) Formula. $C_{10}H_5ClN_2$



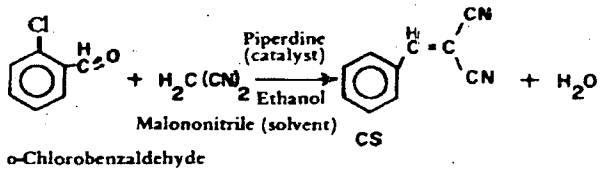
e. (U) Molecular Weight. 188.5.

f. (U) Alternate Chemical Name. o-Chlorobenzylidene malononitrile.

g. (U) Raw Materials.

- o-Chlorobenzaldehyde [$Cl(C_6H_4)CHO$].
- Malononitrile [$CH_2(CN)_2$].

h. (U) Method of Manufacture.[72]



i. (U) Physical and Chemical Properties.

- Odor: Pepper-like.
- Physical state and color: White crystalline powder.
- Boiling point: 310° to 315° C.
- Melting point: 93° to 96.5° C.
- Solubility: Soluble in hexane, methylene chloride; insoluble in water and ethanol.

- Specific gravity: 1.30.
- Volatility: 0.71 mg/m^3 at 25° C.[8]
- Heat of vaporization: 18.2 Kcal/mole.[69]
- Heat of sublimation: 25.6 Kcal/mole.
- Flash point: 197° C.
- Hydrolysis: Rate of hydrolysis is determined by rate of dissolution. Dissolved CS has a half-life of about 45 min. Solid CS in water hydrolyzes very slowly. Hydrolysis is fast in alkaline water containing detergents (half-life at pH 10 is less than 1 min).[69]

j. (U) Method of Dissemination.[6] Candles, aerosol cloud of finely divided particles, bursting and burning type grenades, vehicular and aircraft aerosol generators, aerial bomblets, mortar and artillery cartridges, or special cartridges fired from a pistol or riot gun.[6,8,57] CS can be disseminated in three forms: "CS", CS-1 and CS-2. "CS" is a pure crystalline material used in pyrotechnic munitions and is dispersed thermally to create an aerosol. CS-1 is a micropulverized mixture (particle diameter, 3 to 10 μ) of 96% raw CS and 4% silica aerogel. The aerogel reduces agglomeration. CS-2 consists of 93% to 96% micropulverized CS and 4% to 7% of a silicone-treated aerogel(silica-hexamethyldisilazane or hydrophobic-treated Cab-O-Sil). The silicone-treated aerogel prolongs the effectiveness of the agent in terrain-denial applications by preventing agglomeration, increasing flowability, and markedly increasing the agent's hydrophobicity. CS-1 and CS-2 are used in bursting-type munitions and bulk riot-control agent dispensers.[69]

k. (U) Use. CS, in its three forms, is used to control riots and mobs in major police actions. The agent is used to neutralize enemy forces when intermingled with civilians and nonlethal effects are desired. It is also used as a training agent.

l. (U) Physiological Effects. CS produces immediate effects even in low concentrations; "safe distance" and "no effect" concentrations of CS were given as 0.01 mg/m^3 and 0.004 mg/m^3, respectively.[70] The agent cloud causes severe burning sensation in the eyes with copious tears, coughing, difficulty in breathing, and tightness of the chest. The eyes close involuntarily, the nose runs, and there is a stinging sensation on moist skin, as well as dizziness or swimming of head. Heavy concentrations will

cause nausea and vomiting. Effects last 5 to 10 min after the affected individual is removed to fresh air. During this time, such personnel are incapable of effective action. Its rate of detoxification in the body is quite rapid.[8]

m. (U) Decontamination. Personnel should find fresh air, face the wind, and avoid rubbing the eyes. Area decontamination is not necessary. Personnel may shower after leaving the contaminated atmosphere but this action should be delayed for at least 6 hr if there is any particulate matter still on the skin, to avoid the stinging, itching, and reddening which could result from contact with water. A 1% sodium bicarbonate solution can be used to wash the eyes. A 10% monomethanolamine in water plus detergent or a 5% sodium bisulfite solution can be used as decontaminants.[6]

n. (U) Protection Required. Protective mask and ordinary field clothing fastened at neck, wrists, and ankles will give complete protection.

o. (U) Storage. Stable in storage; very slight action on steel.

p. (C-NFD) Toxicity. (b)(1)

(b)(1)

q. (U) Persistence. CS and CS-1 are nonpersistent. CS-2 is considered persistent.[71]

r. (U) Historical.

- 1928: Synthesized by B. B. Corson and R. W. Stoughton in United Kingdom.
- 1959: Designated United States Army standard riot control agent.

6. (C) Excelsior

a. (U) Code or Alternate Designations.

- United States--Excelsior.
- United Kingdom--Arsacridine.
- Germany--Excelsior, Ex.

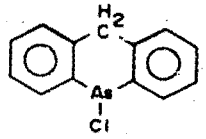
NO FOREIGN DISSEM

b. (U) Class. Riot control--lacrimator, sternutator.

c. (U) Chemical Name. 10-Chloro-9,10-dihydroarsacridine.

d. (U) Formula. $C_{13}H_{10}AsCl$

Neg. 513130



e. (U) Molecular Weight. 276.59.

f. (U) Alternate Chemical Names.

- 5-Chloro-5, 10-dihydroacridarsine.
- Arsacridine chloride.

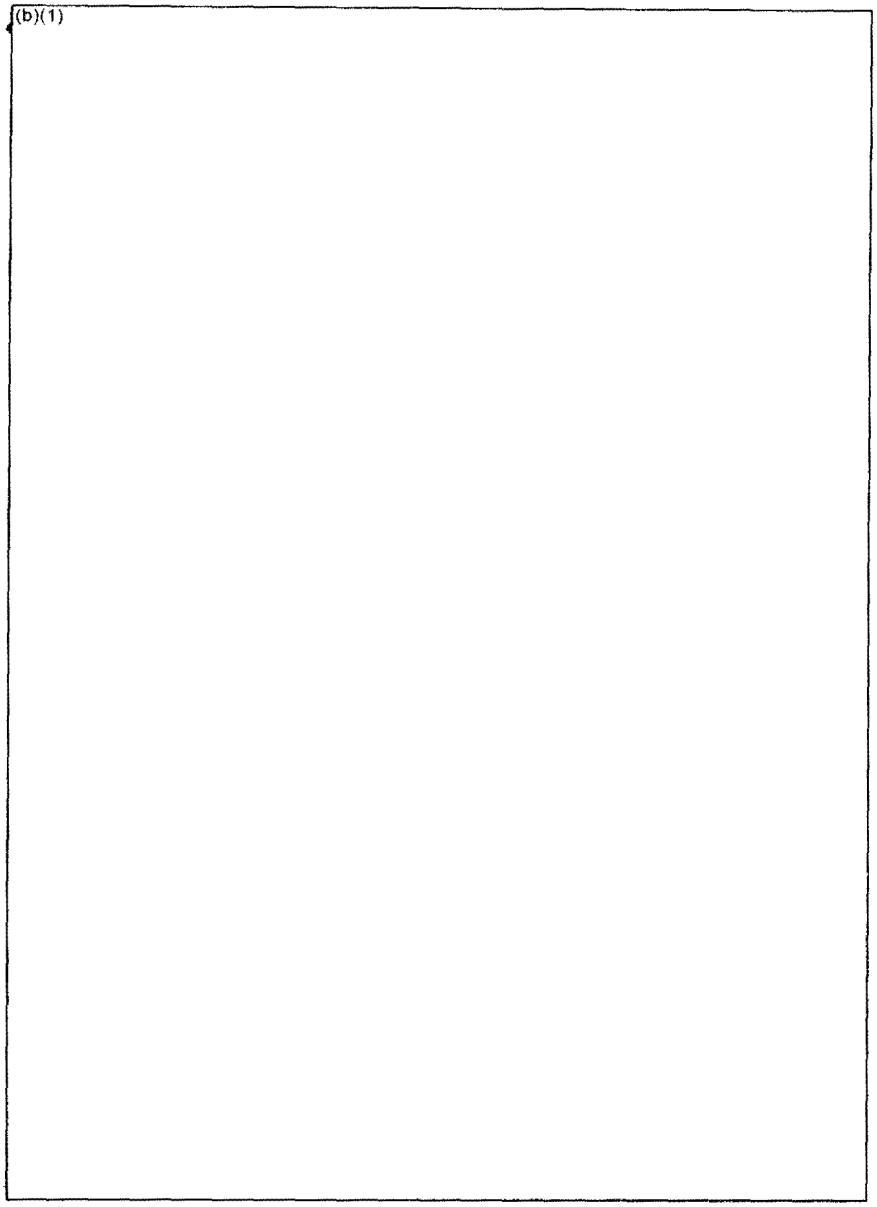
g. (~~C~~) Raw Materials.

(b)(1)

NO FOREIGN DISSEM

h. (C) Method of Manufacture.

(b)(1)



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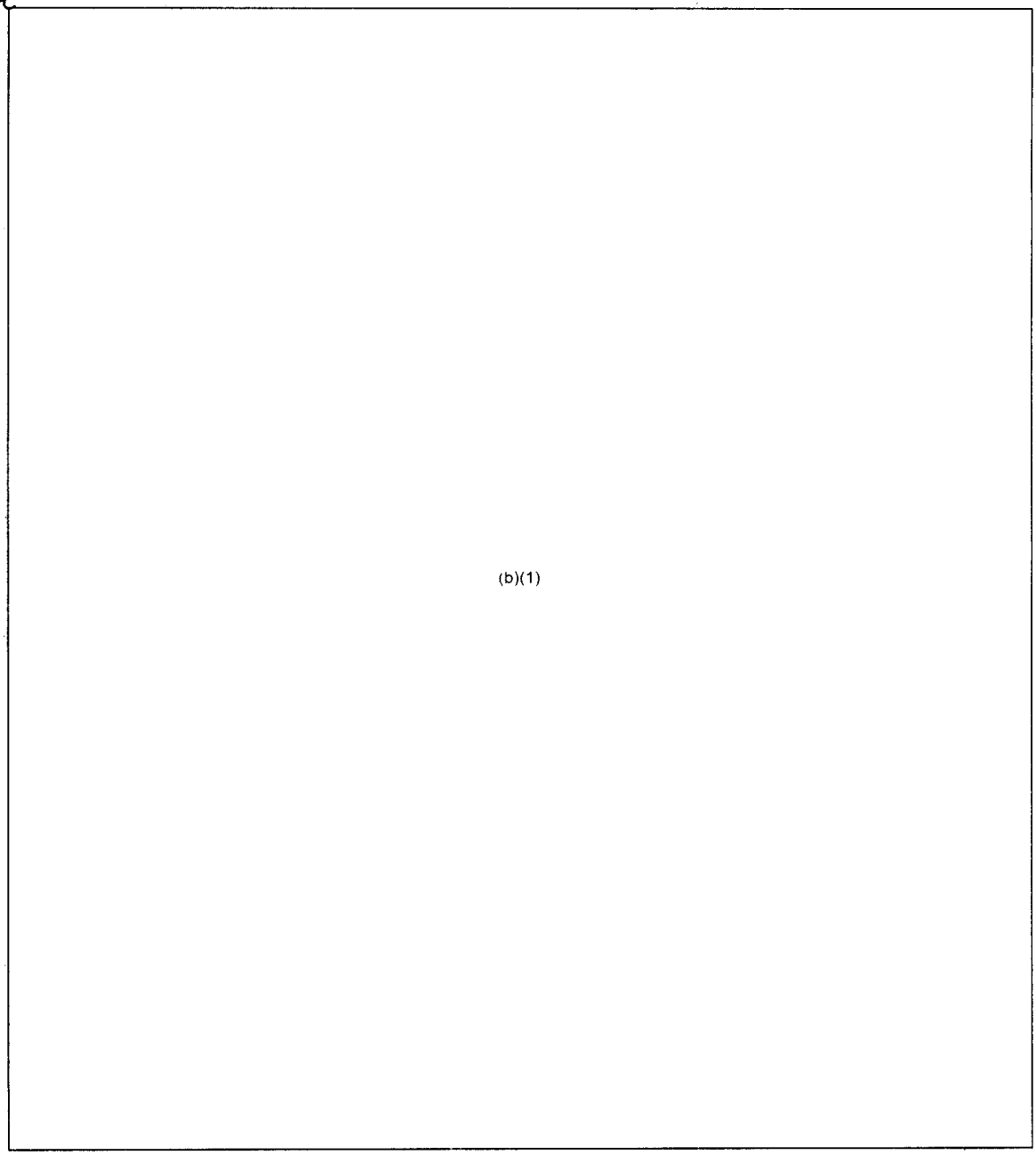


(b)(1)

i. (C) Physical and Chemical Properties.

- (b)(1)
- (b)(1)

i. (C) Method of Dissemination. (b)(1) (b)(1)

k. (U) Use. Riot control.

l. (C) Physiological Effect. (b)(1)

(b)(1)

m. (U) Decontamination. Caustic solutions.

n. (U) Protection Required. Protective mask.

o. (C) Storage. (b)(1) (b)(1)

p. (C) Toxicity. (b)(1) (b)(1)

q. (C) Historical. (b)(1)

7. ~~(C)~~ Experimental Agents

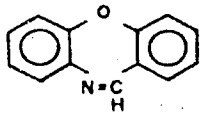
a. (C) EA 3547.

(1) (C) Code or alternate designations. (b)(1) (b)(1)

(2) (U) Class. Riot control agent.

(3) (U) Chemical name. Dibenz-(b,f)-1,4-oxazepine.

(4) (U) Formula. $C_{13}H_9NO$



(5) (U) Molecular weight. 122.17.[73]

(6) (C) Raw materials.[74]

- (b)(1)

(7) (C) Method of manufacture.[74]

(b)(1)

(8) (C) Physical and chemical properties.[73]

- (b)(1)

(9) (C) Use. (b)(1) (b)(1)

(10) (C) Physiological effects.[70,75-77] (b)(1)

(b)(1)

(11) (U) Decontamination. Not known.

(12) (C) Storage. (b)(1) (b)(1)

(13) (C) Toxicity. (b)(1) (b)(1)

b. (C) EA 4923.

(1) (U) Code or alternate designations. None.

(2) (U) Class. Riot control--irritant.

(3) (C) Chemical name. (b)(1)

(4) (C) Formula. (b)(1) (b)(1)

(5) (C) Molecular weight.

(6) (C) Physical and chemical properties.[73]

- (b)(1)

(7) (C) Use. (b)(1)

(8) (U) Physiological effects. Causes burning sensation in eyes, shortness of breath, and runny nose. Almost impossible to keep eyes open. Blurry vision and difficulty in focusing also results. Recovery occurs 12 min after being removed to fresh air.[73]

(9) (U) Decontamination. Not known.

(10) (C) Storage. (b)(1)

(b)(1)

(11) (U) Toxicity.[73,79,80]

(a) (U) By intravenous route, the LD_{50} in mice is greater than 20 mg/kg and the median effective dose (ED_{50}) is 1.8 mg/kg; the LD_{50} of a dog is five times greater than that of the mouse. The LCt_{50}'s for the rat and dog by the inhalation route are 184,000 and 63,000 mg-min/m^3, respectively.

(b) (U) The 1,3,7 isomers have been prepared and studied for their effects on rabbit's eyes (UK). The 1-isomer is a very strong irritant, but its effects are temporary and no adverse effects on the eye or tissue surrounding the eye are noticeable. The 3-isomer is non-irritating, but the 7-isomer produces permanent and irreversible damage to the eye (blindness) and to the tissue surrounding the eye.

Section VI.

VOMITING AGENTS

1. (U) General

a. Vomiting agents are used in combat operations as well as for mob and riot control. Under field conditions, vomiting agents cause great discomfort to their victims; when released indoors they may cause serious illness or death.

b. The act of vomiting is a complex series of movements which are controlled by a center located near the medulla.

2. (U) Adamsite

a. (U) Code or Alternate Designations.

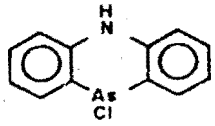
(b)(1)

(c)

b. (U) Class. Vomiting agent, lung irritant, sternutator.

c. (U) Chemical Name. 10-Chloro-5,10-dihydrophenarsazine.

d. (U) Formula. $C_{12}H_9AsClN$



e. (U) Molecular Weight. 277.57.

f. (U) Alternate Chemical Names.

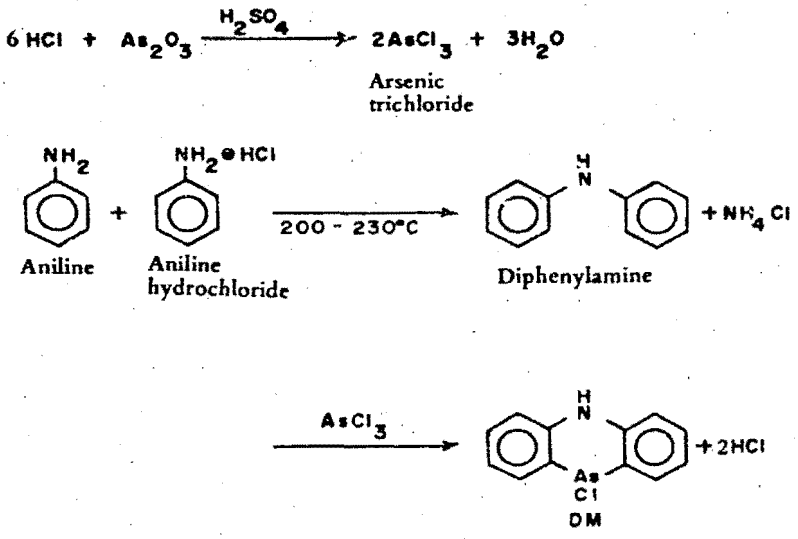
- Diphenylamine chloroarsine.
- Phenarsazine chloride.
- 5-Aza-10-arsenanthracene chloride.
- 10-Chloro-5,10-dihydroarsacridine.

g. (U) Raw Materials.

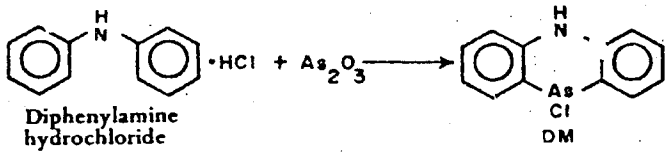
- Hydrochloric acid (HCl).
- Aniline hydrochloride ($C_6H_5NH_2 \cdot HCl$).
- Arsenious trioxide (As_2O_3).
- Diphenylamine hydrochloride [$(C_6H_5)_2NH \cdot HCl$].
- Aniline ($C_6H_5NH_2$).

h. (U) Method of Manufacture.

- US Method:



- Italian Method:



i. (U) Equipment. Large steam-jacketed kettle fitted with an agitator and reflux condenser.

j. (U) Physical and Chemical Properties.

- Odor: Faint aromatic.
- Color: Commercial (CW) grade, brownish green crystalline solid; pure, yellow crystalline solid.
- Boiling point: 410° C with decomposition.
- Melting point: 195° C.
- Solubility: Soluble in furfural and acetone; slightly soluble in common organic solvents; insoluble in water. Not readily soluble in any of the liquid CW agents.
- Specific gravity: 1.65.
- Volatility: 0.02 mg/m^3.
- Vapor pressure: Very low.
- Heat of vaporization: 54.8 cal/g.
- Hydrolysis: In aerosol form, hydrolyzes rapidly to diphenylarsenious oxide and HCl.

k. (U) Method of Dissemination. Candles, grenades.

l. (U) Use. DM is used to produce temporary casualties, or is mixed with Chloroacetophenone for use as a riot control agent and for military training purposes. DM and Chloroacetophenone also may be added to smoke mixtures to produce nauseating and lacrimatory effects.

m. (U) Physiological Effects. The first symptoms are a burning sensation in nose and throat, eye irritation, severe headache, violent sneezing, coughing, acute pain and tightness in the chest, nausea and vomiting. The symptoms appear more slowly, but last longer, than those of DA. (See Diphenylchloroarsine.) The rate of action is very high, and the effects may last up to 3 hr. In low doses, it is detoxified quite rapidly.[8]

n. (U) Decontamination.[6] Bleaching powder or DS-2 is used in enclosed areas. No decontaminant required in open fields.

o. (U) Protection Required. Protective mask.

p. (U) Storage. DM is stable in steel containers if pure. The agent corrodes iron, bronze, and brass.

q. (U) Toxicity. ICt_{50} is 22 mg-min/m^3 for 1 min. LCt_{50} is about 15,000 mg-min/m^3.

r. (U) Persistence. For candles, 10 min in the open for both summer and winter.

s. (U) Historical.

- 1915: Prepared by Weiland in Germany.
- 1918: Prepared independently by Adams in United States. Method of manufacture was greatly simplified and perfected by Contardi and Fernaroli in Italy.

t. (C) Detection.

(1) (C) Detectors.

(a) (C) USSR.[13] (b)(1) (b)(1) (b)(1)

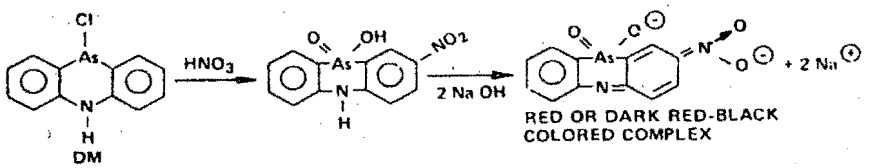
(b) (U) US.[12,21]

- DM test in M19 kit. Sensitivity, 0.2 mg/m^3.
- DBT-Benzene test in M19 kit. Sensitivity, 1.0 mg/m^3.

(c) (U) PRC.[81] Detector Kit, Model 1950? Two white band tube to produce a red color. Sensitivity, 0.1 mg/m^3.

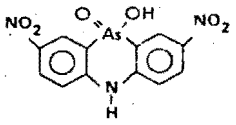
(2) (U) Chemical reactions.[21]

(a) (U) DM test.



RED OR DARK RED-BLACK COLORED COMPLEX

Note: In high concentrations of DM, a yellow color may be produced.



YELLOW COLORED COMPLEX

NcR. 513140

(b) (U) DBT-Benzene test--DM, as well as DA and DC, produces a tan, light orange-brown, or yellow-orange color. Chemical reaction is unknown.

Note--PD produces a pink-red color.

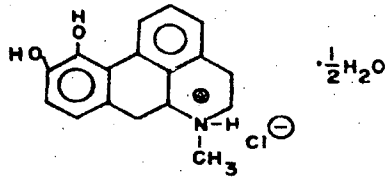
3. (U) Apomorphine Hydrochloride

a. Alternate Code or Designation. None.

b. Class. Vomiting agent.

c. Chemical Name. Apomorphinium chloride.

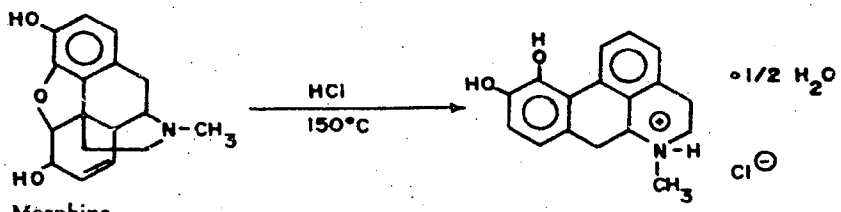
d. Formula. $C_{17}H_{17}NO_2 \cdot HCl \cdot \frac{1}{2} H_2O$



e. Molecular Weight. 312.80.

f. Raw Materials. Morphine, obtained from Papaver somniferum (opium poppy) by extraction.

g. Method of Manufacture.



Morphine

Apomorphine hydrochloride

h. Equipment. Standard chemical processing equipment.

i. Physical and Chemical Properties.

- Odor: Odorless.
- Physical state and color: White or grayish white crystals or powder, gradually acquires a green color on exposure to light and air.

- Melting point: 200° to 210° C.
- Solubility: Slightly soluble in water and alcohol (one gm dissolves in 50 ml of water or 50 ml of alcohol). Very slightly soluble in chloroform and ether.

j. Method of Dissemination. Aerosol.

k. Use. Incapacitating agent.

l. Physiological Effects. Its analgesic properties are diminished as compared with morphine; its emetic action is caused by a stimulating effect on the medulla. The agent may also cause considerable depression and excitation.

m. Protection Required. Protective mask.

n. Storage. Store away from light and air.

o. Toxicity. Subcutaneous doses of 6 to 7 mg will cause emesis. The latent period after subcutaneous injection is 3 to 10 min. It is also effective when inhaled as an aerosol. Doses over 100 mg/man may be fatal.[4]

4. (U) Diphenyl Chloroarsine

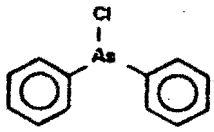
a. Code or Alternate Designations.

- United States--DA.
- United Kingdom--DA.
- Germany--Clark I.
- USSR--DIK, Klark-1.

b. Class. Vomiting agent, lung irritant, sternutator.

c. Chemical Name. Diphenyl chloroarsine.

d. Formula. $(C_6H_5)_2AsCl$.



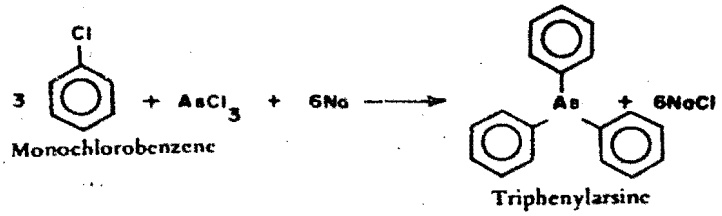
e. Molecular Weight. 264.5.

f. Raw Materials.

- Monochlorobenzene (C_6H_5Cl).
- Hydrochloric acid (HCl).
- Arsenic trichloride ($AsCl_3$).
- Sodium arsenite (Na_3AsO_3).
- Sodium (Na).
- Sodium hydroxide (NaOH).
- Aniline ($C_6H_5NH_2$).
- Sulfur dioxide (SO_2).
- Nitrous acid (HNO_2).

g. Methods of Manufacture.

- US Method:

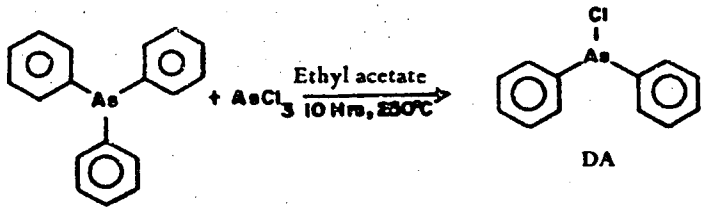


Monochlorobenzene

Triphenylarsine

Original

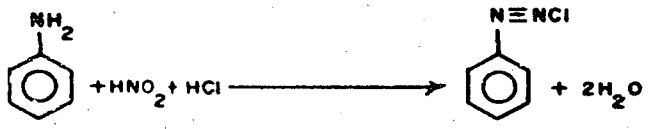
ST-HB-03-18-74



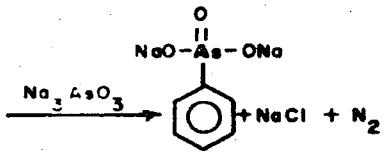
DA

Neg. 513145

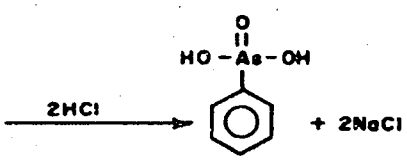
- German Method:



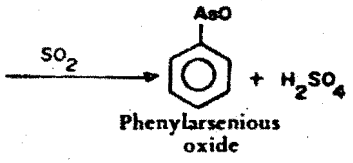
Benzene-diazonium chloride



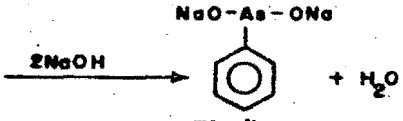
Disodium phenyl arsenite



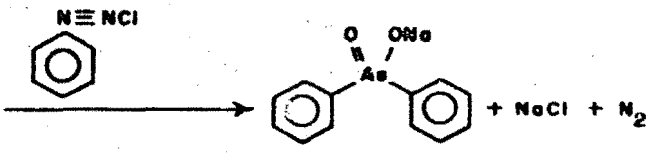
Phenylarsonic acid



Phenylarsenious oxide

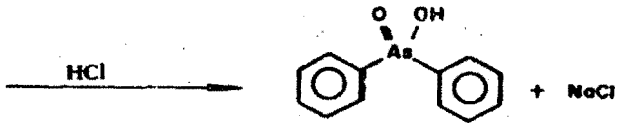


Disodium phenylarsenic oxide

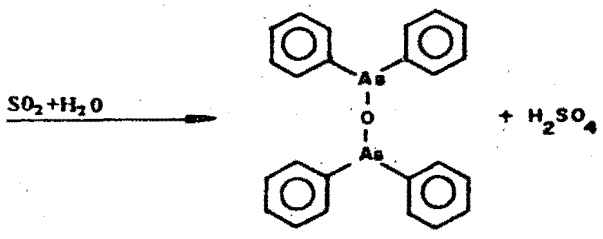


Sodium oxydiphenylarsenious oxide

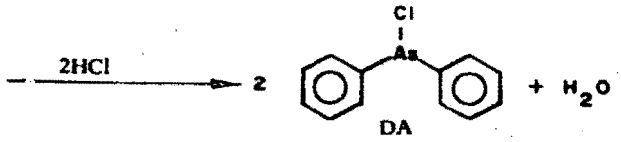
Neg. 513146



Diphenylarsenious oxide



Bis-diphenylarsenious oxide



h. Physical and Chemical Properties.

- Odor: None.
- Physical state and color: White crystalline solid; crude material may be liquid.
- Boiling point: 383° C with decomposition.
- Melting point: 39° to 40° C.
- Solubility: Soluble in acetone, ethanol, chloroform and Chloropicrin; insoluble in water.
- Specific gravity: 1.4.
- Vapor pressure: 0.0016 mm Hg at 20° C.[8]
- Volatility: 7.2 mg/m at 20° C.[8]
- Hydrolysis: Decomposes in water.

i. Method of Dissemination. Burning-type munitions (grenades and candles).

j. Use. Training and riot control purposes, and as a toxic smoke for harassment of enemy troops.

k. Physiological Effect. In minimum concentrations, DA causes great irritation to upper respiratory tract, sensitive peripheral nerves, eyes, and skin. When present in stronger concentrations, or inhaled in weaker concentrations for a long time, the agent attacks the deeper respiratory passages. DA causes a tickling sensation in the nose, followed by sneezing, with a flow of viscous mucous; irritation spreads down throat, and coughing and choking ensues. Headache, especially in the forehead, increases in intensity until it becomes almost unbearable; also, there is a feeling of pressure in the ears and pains in the jaws, teeth, and chest, shortness of

breath, and nausea with vomiting. The victim has an unsteady gait, dizziness, weakness in the legs, and a trembling all over the body. The effects appear in about 3 or 4 min after exposure to the agent. After 15 min in uncontaminated air, symptoms gradually disappear and recovery generally is complete in from 1 to 2 hr.

l. Decontamination.[6] Caustic solutions, DS-2 are used in enclosed spaces. No decontaminant is required in field.

m. Protection Required. Protective mask.

n. Storage. Agent DA decomposes slowly, but is quite stable when pure. The agent is very corrosive to steel.

o. Toxicity. ID_{50} for a 10-min exposure is 12 mg-min/m^3; LCt_{50} by inhalation of aerosol is 15,000 mg-min/m^3.

p. Persistence. For both summer and winter, 5 min by HE detonation and 10 min by candle dissemination.

q. Historical.

- 1881: Discovered by Michaelis and La Coste.
- 1918: Used by Germans in artillery shells (14 million were loaded; found to be ineffective). Solutions gave poor dispersions. When DA is mixed with high explosives, the explosion compresses the particles rather than blowing them apart. Allies later showed it could be dispersed effectively as a toxic smoke.

r. Detection. US--DBT-Benzene test in M19 kit to produce a tan, light brown or yellow-orange color. Reaction is unknown.[21]

5. (U) Diphenyl Cyanoarsine

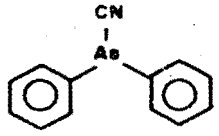
a. Code or Alternate Designations.

- United States--DC, CDA.
- United Kingdom--DC.
- Germany--Clark II.

b. Class. Vomiting agent, lung irritant, sternutator.

c. Chemical Name. Diphenyl cyanoarsine.

d. Formula. $(C_6H_5)_2AsCN$



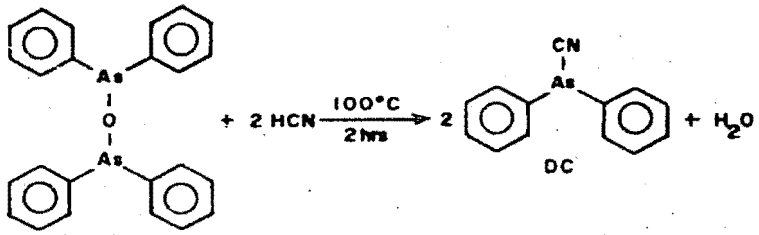
e. Molecular Weight. 255.0.

f. Raw Materials.

- Diphenylarsenious oxide $[((C_6H_5)_2As)_2O]$.
- Silver cyanide (AgCN).
- Hydrocyanic acid (HCN).
- Mercury cyanide (HgCN).
- Diphenyl chloroarsine $[(C_6H_5)_2AsCl]$.
- Potassium cyanide (KCN).
- Diphenylarsenious sulfide $[((C_6H_5)_2As)_2S]$.

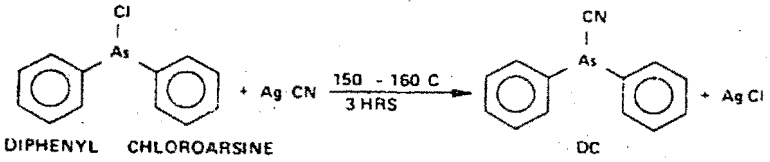
g. Method of Manufacture.

- Method A:

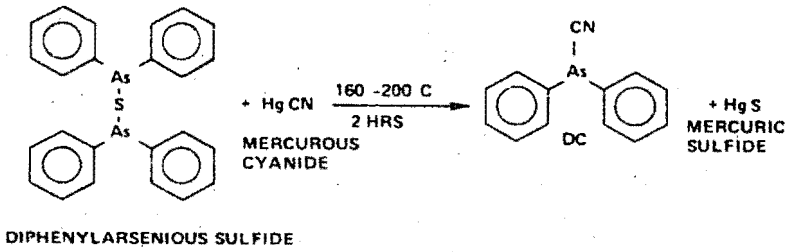


Diphenylarsenious oxide

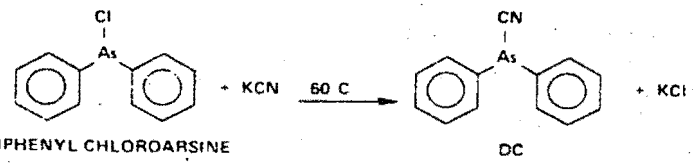
- Method B:



- Method C:



- German Method:



h. Physical and Chemical Properties.

- Odor: Garlic and bitter almonds.
- Physical state and color: Colorless crystalline solid.
- Boiling point: 290° C.

- Melting point: 31.5° C.
- Solubility: Soluble in chloroform and other organic solvents; insoluble in water.
- Vapor density (relative to air): 8.8.
- Specific gravity: 1.45.
- Heat of vaporization: 79.3 cal/g.[8]
- Vapor pressure: 4.7×10^{-5} mm Hg at 20° C.[8]
- Hydrolysis: Hydrolyzes slowly to hydrogen cyanide and diphenylarsenious oxide.[8]

i. Methods of Dissemination. Grenades, smoke candles.

j. Use. For general harassment of troops, and for training and riot control purposes.

k. Physiological Effects. DC causes irritation of eyes, running nose, sneezing, coughing, severe headache, acute pain in chest, nausea and vomiting. For moderate concentrations, its effects last about 30 min after individual leaves contaminated atmosphere; at higher concentrations, its effects may last up to several hr. It is rapidly detoxified in the body.[8]

l. Decontamination.[6] DS-2, caustic solutions (sodium hyroxide, sodium carbonate, sodium bicarbonate, or ammonia). No decontaminants are required in the field.

m. Protection Required. Protective mask.

n. Storage. DC is stable at all ordinary temperatures, but very corrosive on iron and steel.

o. Toxicity.[5] ID_{50} is 30 mg-min/m^3 for 30 sec exposure and 20 mg-min/m^3 for 5 min exposure. LCt_{50} is 10,000 mg-min/m^3; it is almost impossible to build up a lethal concentration in a practicable length of time.

p. Persistence. For both summer and winter, 5 min by HE detonation and 10 min by candle dissemination.

q. Historical.

- First prepared by Sturniolo and Bellinzone in Italy.
- 1918: Developed and adapted by Germans as an improvement over DA. (Physiologically more active than DA.) Considered the strongest of all irritant compounds used in World War I.

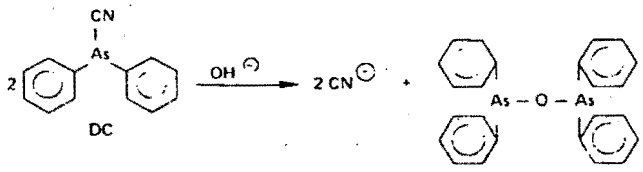
r. Detection.

(1) US Detectors.[12,21]

- White band sampling tube (Pyrazolone test using appropriate reagents) in M19 kit.
- Red band tube (Tetra-Base test) in M19 kit. Minimum detectable range, 0.1 to 10 mg/m^3.
- Prussian Blue test in M19 kit. Sensitivity, about 40 mg/m^3.
- DBT-Benzene test in M19 kit. Sensitivity, about 1 mg/m^3.

(2) Chemical reactions.[21]

- Prussian Blue test (for cyanide ion).



For the reaction of cyanide ion in the Prussian Blue Test, see AC.

- Pyrazolone test--DC produces a red-purple color. See AC for chemical reaction.

- Tetra-Base test--As it decomposes, DC produces a light to deep blue color. See AC for chemical reaction.

- DBT-Benzene test--DC produces a tan, light orange-brown, or yellow-orange color. Chemical reaction is unknown.

Section VII.

INCAPACITANTS

1. (U) General

a. (U) In recent years, a new concept of chemical warfare has developed which proposes the use of agents that are incapacitating rather than lethal for certain military operations. The advantage of the incapacitating agent lies in its ability to inactivate both civilian and military personnel for a relatively short period of time with very few, if any, fatalities. In areas with friendly populations, the use of these agents may prove advantageous.

b. (U) Incapacitating agents must fill the basic requirements common to all chemical agents: reasonable cost of manufacture from readily available materials; a high degree of stability in storage as well as during and after dissemination; routes of entry into the body that are compatible with present delivery systems; a relatively short time interval between exposure to the agent and the onset of desired effects. In addition, the difference between the effective and lethal doses of an agent must be wide enough to guarantee the spontaneous recovery of the victims with no after effects, and the agent must cause a disability that is visible to the eye and predictable.

c. (U) The incapacitant may be distinguished from the irritant (riot control agent) by its delayed onset of symptoms and its persistence for a period greatly exceeding that of exposure. Most of the incapacitating agents may be categorized according to their ability to alter or disrupt the nervous system:

(1) (U) Psychochemicals. These compounds (usually indole, tryptamine, or piperidine derivatives) may be described as psychotropic, psychotogenic, psychotomimetic, or hallucinogenic. The effects produced may include visual and aural hallucinations; a sense of unreality; and changes in mood, behavior, performance, memory, attitude, concentration, perception, and thought processes. Representative agents of this group are BZ, Benactyzine, and Lysergic Acid Diethylamide.

(2) (U) Paralyzants. Agents that interrupt nerve impulse transmission at the skeletal neuromuscular junction (for example, curare) and those that block transmission in autonomic ganglia (for example, hexamethonium) are found in this group.

d. (U) Some physical irritants may be considered as incapacitants. Representative of this group are the active principles of poison ivy which produce a delayed onset of symptoms with a persistent effect.

e. (U) (b)(1)

(b)(1)

2. (U) Benactyzine

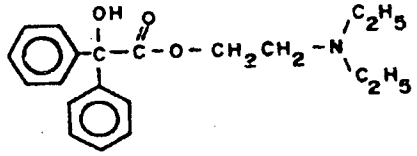
a. Code or Alternate Designations.

- United States--WIN 5606, Suavitil, Phobex.
- United Kingdom--Lucidil, Nutinal, Suavitil.
- France--Parasan.
- Sweden--Suavitil.
- Italy--Beatilina.
- USSR--IEM-22, Amizyl, Diazyl.
- Romania--Nervatil.

b. Class. Incapacitating agent.

c. Chemical Name. 2-Diethylaminoethyl benzilate.

d. Formula. $C_{20}H_{25}NO_3$



Neg. 513153

e. Molecular Weight. 327.4.

f. Alternate Chemical Names.

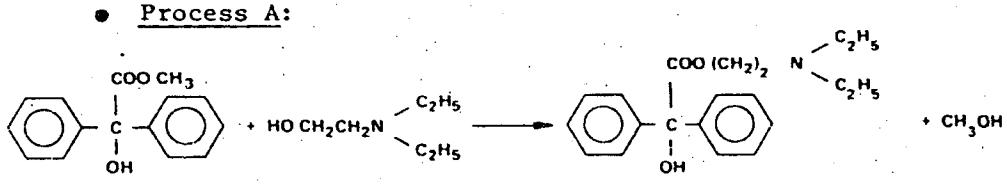
- Benzilic acid β-diethylaminoethyl ester.
- β-Diethylaminoethyl benzilate.
- 2-Diethylaminoethyl diphenylglycolate.

g. Raw Materials.

- 2-Diethylaminoethanol ($C_6H_{15}NO$).
- Benzilic acid ($C_{14}H_{12}O_3$).
- β-Chloroethyl-N,N-diethylamine ($C_6H_{14}ClN$).

h. Method of Manufacture.[12]

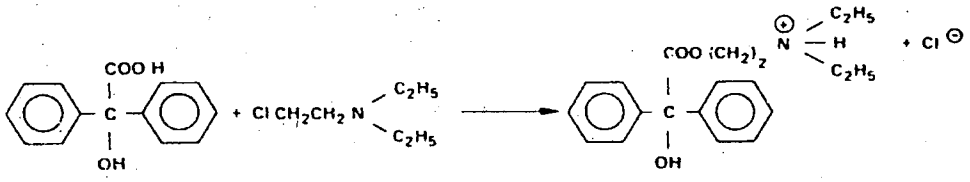
- Process A:



METHYL BENZILATE 2-DIETHLAMINOETHANOL BENACTYZINE

Neg. 513164

- Process B:



BENZILIC ACID β - CHLOROETHYL - N, N - DIETHYLAMINE BENACTYZINE HYDROCHLORIDE

Neg. 513165

i. Equipment. Standard chemical processing equipment.

j. Physical and Chemical Properties.

- Physical state and color: Hydrochloride is a white crystalline solid.

- Boiling point: 149° to 151° C at 0.01 mm Hg.
- Melting point: 51° C. Hydrochloride: 177° to 178° C.[3]
- Solubility: Hydrochloride is soluble in water (14.9 g per 100 ml at 25° C) and in alcohol; very slightly soluble in ether.[3]

k. Use. Incapacitating agent; medically, as a tranquilizer, sedative, hypnotic, antispasmodic, antihistamine, anesthetic.

l. Physiological Effects. Benactyzine, a cholinergic blocking agent, depresses function of subcortical formation and affects muscarine-cholinoreactive structures. Conditioned reflexes are disrupted to cause optical hallucinations, confused speech and incoherent thinking. Other symptoms are agitation, ataxia, blurred consciousness and partial amnesia of single events.

m. Toxicity (in man). An oral dose of 8 mg causes lassitude, sleepiness, and apathy. A 40 to 70 mg dose produces the psychotic effects within 15 to 20 min after intake. Psychosis reaches maximum after 2 to 3 hr and the effects last for 5 to 6 hr. Doses up to 90 mg may be given without fatalities.

n. Historical.

- 1936: Patented by Swiss Firm "CIBA."
- 1938: Horenstein and Pahlacke in Germany.
- 1946: US pat. 2,394,770, Hill and Holmes (American Cyanamide).

3. ~~(C)~~ BZ

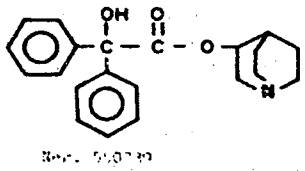
a. (C) Code or Alternate Designations.

- (b)(1) (C)
-

b. (U) Class. Incapacitating agent.

c. (U) Chemical name. 3-Quinuclidinyl benzilate.

d. (U) Formula. $C_{12}H_{23}NO_3$



e. (U) Molecular Weight. 337.41.

f. (C) Raw Materials.

- (b)(1)

g. (C) Method of Manufacture.[2]

(b)(1)

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Original

(b)(1)

h. (U) Equipment. Standard chemical processing equipment.

i. (C) Physical and Chemical Properties.

(b)(1)

j. (C) Method of Dissemination. (b)(1)

(b)(1)

k. (U) Use. Incapacitating agent. Its principal drawback is the unpredictability of its effects on troops in the field.

l. (C) Physiological Effects. (b)(1)

(b)(1)

m. (C) Therapy. (b)(1)

(b)(1)

n. (U) Decontamination.[6] Hot soapy water.

o. (U) Protection Required. Gas mask against inhalation.

p. (C) Storage. (b)(1)

(b)(1)

q. (U) Persistence. Persistent.

r. (C) Toxicity.[4]

(1) (C) (b)(1)

(b)(1)

(2) (C) (b)(1)

(b)(1)

s. (C) Historical. (b)(1)

(b)(1)

t. (U) Detection.

(1) (C) US detectors.[12 21]

- (b)(1)

(2) (C)

-

(b)(1)

4. (U) Lysergic Acid Diethylamide

a. Code or Alternate Designations.

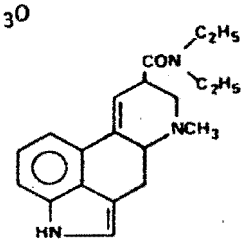
- LSD.
- LDS-25 (tartrate salt).
- Delysid.
- United States — EA 1729.

b. Class. Incapacitating agent.

c. Chemical Names.

- D-Lysergic acid diethylamide.
- 9,10-Didehydro-N,N-diethyl-6-methylergoline-8β-carboxamide.

d. Formula. $C_{20}H_{25}N_3O$



D-LYSERGIC ACID DIETHYLAMIDE

e. Molecular Weight. 323.42.

f. Raw Materials.

(1) Natural Source: Lysergic acid ($C_{16}H_{16}N_2O_2$) from ergot.

(2) Synthesis:

- N-Benzoyl-3-(β-carboxyethyl)-dihydroindole ($C_{18}H_{17}NO_3$).
- Thionyl chloride ($SOCl_2$).
- Diazomethane (CH_2N_2).
- Aluminum chloride ($AlCl_3$).
- Hydrazine (N_2H_4).
- Bromine (Br).
- Nitrous acid (HNO_2).
- Sodium methoxide ($NaOCH_3$).
- Diethylamine $(C_2H_5)_2NH$.
- Sodium brominehydride (NaBrH).
- Trifluoroacetate anhydride $(CF_3CO)_2O$.
- Sodium cyanide (NaCN).
- Sulfur trioxide (SO_3).
- Methanol (CH_3OH).

Original

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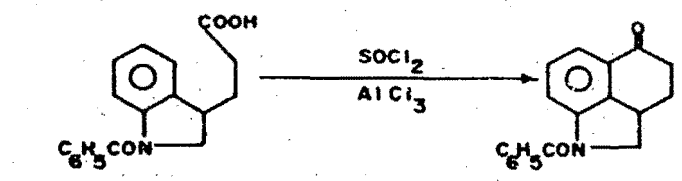
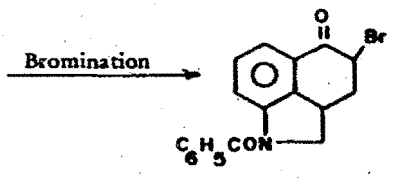
g. Method of Synthesis. [1] [2]

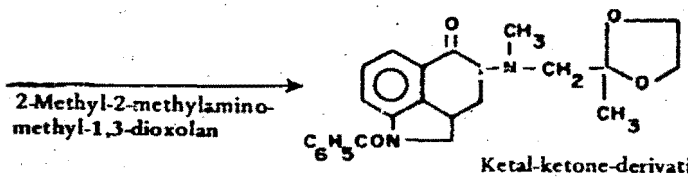


N-Benzoyl-3-(β-carboxyethyl) dihydroindole

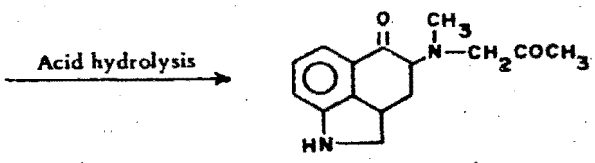
N-Benzoyl-5-keto-1,2,2a,3,4,5-hexahydrobenzindole



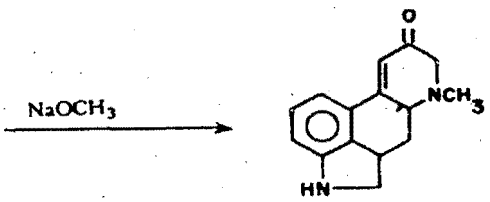
4-Bromo-derivative



Ketal-ketone-derivative

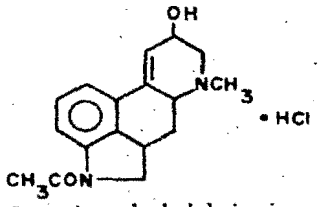


Diketone derivative



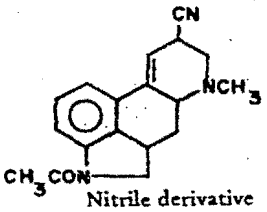
Tetracyclic ketone derivative

Acetylation
then reduction
with NaBrH



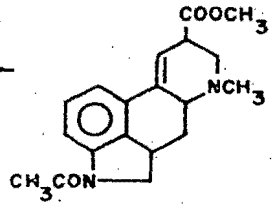
Secondary alcohol derivative

$SOCl_2$ in liquid S
then NaCN in
liquid HCN



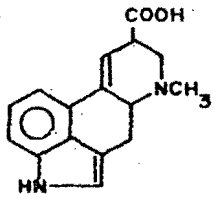
Nitrile derivative

CH_3OH



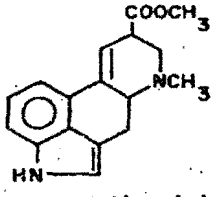
Methyl ester derivative

Alkaline hydrolysis
then dehydrogenation
with inactivated
Raney nickel



DL-Lysergic acid

CH_2N_2
Esterification



Lysergic acid methyl ester

Original

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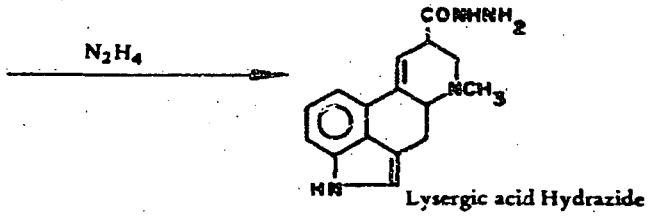
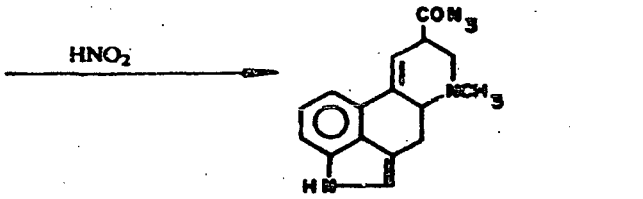
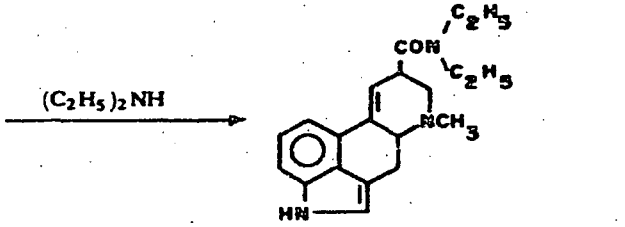


Lysergic acid Hydrazide



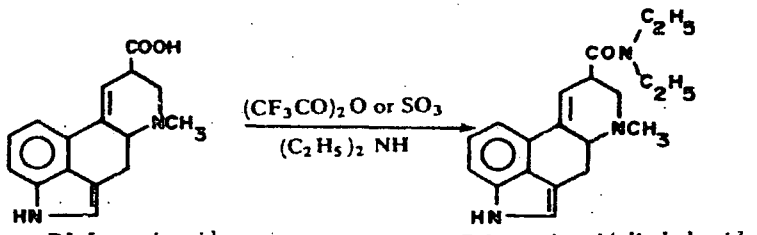
Lysergic acid Azide

Ser. 513158



D-Lysergic acid diethylamide

Alternate route on conversion of Lysergic Acid to LSD:



DL-Lysergic acid

D-Lysergic acid diethylamide

Ser. 513159

h. Equipment. Standard chemical processing equipment.

i. Physical and Chemical Properties.

- Physical state and color: Crystalline colorless solid.
- Melting point: 80° to 85° C, with decomposition.[11]
- Solubility: Insoluble in water; its salt (for example, tartrate) is soluble in water.

j. Methods of Dissemination. Aerosols, ingestion with food and water.

k. Use. Incapacitating agent.

l. Physiological Effects. Aerosols are absorbed rapidly through the mucous membrane. The same amount of LSD gives same reaction by oral or inhalation routes, but by inhalation, onset of symptoms is faster and the ion, shorter. The onset of symptoms also increases with the dos with larger doses intensifying and prolonging the effects. LSD causes disturbed visual perception, distortion of shapes and objects, hallucinations of color and geometric patterns as well as sound; and difficulty in concentration, making decisions, and communication. There is also a loss of time sense, dulling of senses of taste, smell, and touch. Reactions range from tenseness to panic and from friendliness to aggressiveness. Ingestion by normal human subjects produces temporary psychic changes simulating a schizophrenic state alternating between euphoria and depression, and including illusions and hallucinations, withdrawal from reality, and a sense of "lightness." A dose becomes effective in 5 to 10 min, and effects may last from 4 hr to several days. Insomnia may last 16 hr.

m. Therapy. Chlorpromazine; Frenquel (4-piperidylbenzhydrol), dibenzylamine, or barbiturates (Amytal).

n. Decontamination. Unknown.

o. Protection Required. Gas mask for protection against aerosol inhalation.

p. Storage. Stable in crystalline dry form; water solutions are stabilized with tartaric acid.

q. Persistence. Persistent.

r. Toxicity. There is a very wide margin of safety between incapacitating and lethal doses. ICt_{50} is 55 mg-min/m^3 with an inhalation rate of 15 liters/min for a 70-kg man. The effective oral dose is 1 µg/kg or about 70 µg/man.

s. History.

- 1943: Partial synthesis by Stoll and Hofmann.
- 1956: US pat. 2,736,728, Pioch (Eli Lilly & Co.).
- 1956: US pat. 2,774,763, Garbrecht (Eli Lilly & Co.).
- 1964: US pat. 3,141,887, Patelli, Bernardi (Farmitalia).

t. Detection. Unknown.

5. (U) Sernyl

a. (U) Code or Alternate Designations.

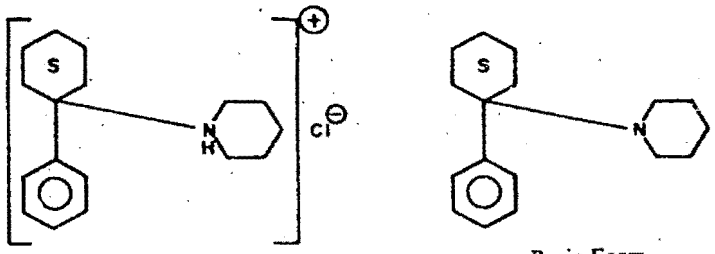
- (b)(1)

b. (U) Class. Incapacitating agent.

c. (U) Chemical Names.

- 1-Phenyl-1-piperidylcyclohexane hydrochloride (Acidic form)
- 1-Phenyl-1-piperidylcyclohexane (Basic form).

d. (U) Formula. Acidic form - $C_{17}H_{26}ClN$. Basic form - $C_{17}H_{25}N$.



Acidic Form Basic Form

e. (U) Molecular Weight.

- Acidic form — 279.66.
- Basic form — 243.20.

f. (U) Alternate Chemical Names.

- Phencyclidine hydrochloride (Acidic form).
- Phencyclidine (Basic form).

g. (U) Raw Materials and Method of Manufacture. Commercial process, not divulged by manufacturer.

h. (U) Equipment. Standard chemical processing equipment.

i. (U) Physical and Chemical Properties of Acid Form.

- Physical state and color: White or colorless crystalline powder.
- Melting point: 220° to 226° C with decomposition.
- Solubility: Soluble in water, alcohol, aniline, cresol, and methylene chloride; insoluble in ether, cyclohexane, toluene, and acetone.
- Vapor pressure: Less than 0.5 μ at 60° C.

j. (U) Physical and Chemical Properties of Basic Form.

- Physical state and color: White or colorless crystalline powder.

- Boiling point: 340° C.
- Melting point: 46.3° C.
- Solubility: Soluble in lipids, toluene, methanol, methylene choloride, and other organic solvents; insoluble in water.

k. (U) Method of Dissemination. Liquid splashed in eyes or on skin, ingestion with food or water, aerosols.

l. (U) Use. Incapacitant; originally developed as an anesthetic.

m. (U) Physiological Effects.

(1) (C) (b)(1)

(b)(1)

(2) (U) By the oral route, a 5 to 10 mg dose brings on effects similar to alcohol intoxication. Distance vision is blurred and the subjects give the impression that they are unable to think and that time is standing still. A 10 mg dose brings on vertigo and ataxia. The effects after a 5 mg dose last about 8 hr and for a 10 mg dose about 13 to 14 hr, with the peak occurring 2 to 4 hr after ingestion.

(3) (U) Intravenous injection of Sernyl results in mydriasis, ataxia, weakness, prostration, tonic and clonic convulsions, and death if the dose is large enough. A 0.1 mg/kg dose produces a "don't care" attitude. A dose of 0.25 mg/kg brings on anesthesia for 5 hr; subjects exhibit hallucinations, and even mania, upon emergence from the anesthesia. A 10 mg dose causes hallucinations, marked agitation, and maniacal excitement. For a 10 to 15 mg dose, catatonic stupor with cessation of reaction to painful stimuli results. The duration of these effects is dependent on age. In older subjects, both male and female, the effects last 1 to 2 hr and gradually disappear, leaving the subjects pain free and in a state of euphoria. In males, the stupor is followed in 15 to 20 min by noisy, restless, and violent delirium which, in some cases, requires forceful restraint for periods of up to 3 hr. Some complain of distorted vision and unpleasant hallucinations. The females are usually in a happily drunken state and require no restraint. A state of amnesia lasts for 3 to 4 hr after injection.

(4) (C) (b)(1)

(b)(1)

n. (U) Therapy. Unknown.

o. (U) Protection Required. Protective mask against aerosols and eye contamination.

p. (C) Storage. (b)(1)

(b)(1)

q. (U) Persistence. Persistent.

r. (C) Toxicity. (b)(1)

(b)(1)

s. (U) History.

- 1960: Brit. pat. 836,083 (Parke, Davis & Co.).
- 1963: US pat. 3,097,136 (Parke, Davis & Co.).

6. (C) Experimental Agents (Glycolates)[30,84-86,126]

(b)(1)

b. Chemical Name, Formula, and Molecular Weight.

(b)(1)

ST-HB-03-18-74

Original

(b)(1)

c. Physical and Chemical Properties.[30,84-86]

(b)(1)

* A=the hydrochloride, B=the free base.
** A melting point of 68° to 70° C was determined for a highly purified sample of EA 3580B. This is an unconfirmed observation.

(CONFIDENTIAL)

d. Toxicities and Physiological Data*. 30,84-87

a

(b)(1)

a

e. Therapy. (b)(1)

(b)(1)

(b)(1)

Section VIII.

AGENT MIXTURES

1. (U) General

Chemical warfare agents are mixed in order to change certain properties--such as boiling point, freezing point, volatility, viscosity, stability, toxicity, aerosol characteristics--and for greater effectiveness.

2. (C) HT

(b)(1)

3. (C) HQ

(b)(1)

4. (C) HL

(b)(1)

a. (U) Properties of HL Mixture (37:63). The ratio of H and L may be varied to obtain desired properties. A mixture of 37% H and 63% L gave the lowest possible freezing point for use in cold weather operations or as a high altitude spray. This HL mixture freezes at -14° C. At 20° C, the mixture has a vapor pressure of 0.248 mm Hg and a volatility of 2,730 mg/m^3. It has a satisfactory storage stability in lacquered steel containers. The LCt_{50} of HL is about 1500 $mg\text{-}min/m^3$ by inhalation and above 10,000 $mg\text{-}min/m^3$ by skin absorption; the ICt_{50} is about 200 $mg\text{-}min/m^3$ (eye injury) and 1500 to 2000 $mg\text{-}min/m^3$ (skin absorption).[8]

b. (C) (b)(1)

(b)(1)

*See Appendix IV.

(b)(1)

5. (C) GB-Phosgene Oxime-Kerosene

(b)(1)

6. (C) GB-VE

(b)(1)

7. (C) GA-Phosgene Oxime

(b)(1)

8. (U) CNS[8]

CNS, containing 23% Chloroacetophenone, 38.4% Chloropicrin, and 38.4% of chloroform; acts as a vomiting agent, a choking agent, and a tear agent. It also may cause nausea, colic, and diarrhea. The lacrimatory effects of CNS are no greater than CN in chloroform. The mixture has a vapor density (compared with air) of about 5.0, a specific gravity of 1.47 at 20° C, and a volatility of 100,000 mg/m at 20° C. CNS has an LCt_{50} of 11,400 mg-min/m^3 and an ICt_{50} of 60 mg-min/m^3.

9. (U) CNB

CNB is a mixture of CN, carbon tetrachloride, and benzene (10:45:45). It has been replaced by CNS. Since this mixture has a lower concentration of CN than CNS, it is a more satisfactory training agent. The mixture has a vapor density (compared with air) of about 4 and a specific gravity of 1.14 at 20° C. It is a powerful lacrimator.[8]

10. (C) Experimental Agent Mixtures

(b)(1)

(b)(1)

b. (U) Thickened Agents. Various polymeric materials, such as the methacrylic resins, have been suggested as thickeners to improve the dissemination characteristics of CW agents.[11]

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Section IX.

PLANT AND ANIMAL POISONS

1. (U) General

a. The study of naturally occurring poisons as possible CW agents has attracted considerable attention since World War II. Among the natural poisons can be found substances with extremely potent lethal and incapacitating properties. Much of the research and development in this field has been devoted to the medical and public health aspects of poisoning. For the same reasons and because of the potential usefulness of natural poisons in a CW-agent program, the military establishments in many countries also have developed a strong interest in these substances.

b. Some natural poisons are far more lethal, by several orders of magnitude, than any of the current array of synthetic CW agents, and some natural poisons can be utilized effectively as incapacitants.

c. Toxins sometimes refer to any poisonous material derived from a living organism. In this text, the toxins will be considered as a specific class of poisons that are distinct by virtue of their proteinaceous nature, high molecular weight, and usually, antigenicity. The products from natural sources will include the toad poisons, bacterial toxins, marine poisons, and plant alkaloids as well as snake and insect venoms. Toxicity data on many natural poisons are given in Appendix II. The term "alkaloid" refers to the large group of organic, basic, and physiologically active components found in plants.

2. (U) Batrachotoxin

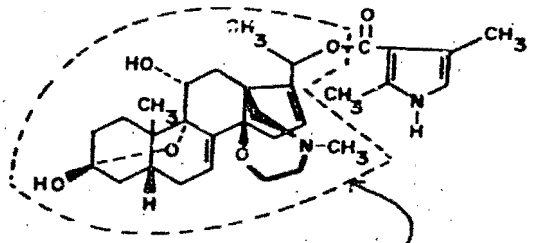
a. Code or Alternate Designations.

- Kokoi'.
- Kokoa' venom.
- Kokei venom.
- Kokŏi venom.

b. Class. Frog venom, steroidal compound.

c. Chemical Name. 20α ester of 3α, 9α-epoxy-14β,8(18-epoxyethano-N-methylimino)-5β-pregna-7, 16-diene-3β, 11α, 20α triol with 2,4-dimethylpyrrole-3-carboxylic acid.

d. Formula. $C_{31}H_{42}N_2O_6$.[93-95]



Apparent Molecular Ion ($C_{24}H_{33}NO_4$)

e. Molecular Weight.

- 399.2 (apparent molecular ion).
- 538.3 (Batrachotoxin).

f. Method of Preparation. The venom is a secretion from the skin of the South American "Kokei" frog, Phyllobates bicolor; it is extracted with methanol. (About 20 µg Batrachotoxin is obtained from each frog.)

g. Physical and Chemical Properties.

- Physical state and color: Colorless, crystalline solid.
- Solubility: Soluble in alcohol, chloroform, and methylene chloride. Slightly soluble in NaCl solution, and CO_2 saturated water. Insoluble in water and ether.

h. Method of Dissemination. Must penetrate the skin to be effective (possibly, flechettes).

i. Use. Lethal agent.

j. Physiological Effects. Venom irreversibly blocks transmission of neuromuscular junctions, acts strongly on the central nervous system, and paralyzes the muscles and heart. Symptoms include violent convulsions, powerful contractions over the entire body, salivation, choking, labored

breathing, collapse, and death. With a high intravenous dose, death occurs within seconds accompanied by complete muscular rigidity. Venom has no effect on intact skin.

k. Therapy. None known.

l. Toxicity. LD_{50} is 2 µg/kg for mice.[95]

m. Historical. First described by Arango in Columbia in 1869. Used by Choco Indians as arrow poison or darts for blowguns; venom was collected on dart tips by impaling the frog alive on a stick and holding it over an open fire until the venom oozed from the skin.

3. (C) Botulinum Toxin

a. (U) Code or Alternate Designations.

- Botulism
- "Sausage Poisoning"
- Referred to by the various types of toxin (A,B,C,D, E, or F)
- XR

b. (U) Class. Lethal high-molecular-weight bacterial exotoxin.

c. (U) Chemical Name and Formula. Botulinum toxins are simple proteins elaborated by Clostridium botulinum. Precisely how the amino acids are arranged to produce such high toxicity to man and animals constitutes one of the most challenging, unsolved problems in molecular biology.

d. (U) Source of Material. The toxin is produced by anaerobic spore-forming bacteria. To date, six types have been identified, each of which produces a distinctive type of toxin with designations A, B, C, D, E, and F.

(1) (U) Type A - Present in home-canned fruit and vegetables, meat, and fish. Principally affects man and chickens and is found in Western United States, Soviet Ukraine, United Kingdom, and Canada.

(2) (U) Type B - Present in prepared meats, especially pork products, salmon eggs, and liver paste. Principally affects man, horses,

cattle, and is found in France, Canada, Norway, Eastern United States, USSR, and Sweden.

(3) (U) Type C - Present in fly larvae, rotting vegetation, ponds and marshes, toxic forage, carrion, and pork liver. Principally affects aquatic wild birds, cattle, horses, mink, and man. Man appears relatively resistant to toxin taken by mouth. Found in Western United States, Canada, South America, South Africa, Australia, Western Europe, and USSR.

(4) (U) Type D - Present in carrion. Principally affects cattle and man. Man appears relatively resistant to toxin taken by mouth. Found in South Africa and Australia.

(5) (U) Type E - Present in uncooked fish and marine mammals, smoked white fish, dried whale blubber, dried seal meat and flippers, and salmon eggs. Also found in canned fish. Principally affects man. Found in Northern Japan, British Columbia, Labrador, Alaska, Great Lakes region of United States and Canada, Sweden, Denmark, USSR, Poland, and Norway.

(6) (U) Type F - Present in homemade liver paste (Denmark), home-processed venison jerky (California), marine sediments (California and Oregon), salmon (Columbia River), crabs (York River, Virginia), river mud (Eastern North Dakota), and fish (Atchafalaya River, Louisiana). Apparently sparsely distributed in nature. Principally affects man.

e. (U) Methods of Preparation and Purification.[96,97]

(1) (U) Preparation. Several factors influence botulinum toxin production in bacterial cultures (temperatures, salt and sugar concentrations, pH, and substrate), and these factors vary with the type of botulinum toxin. Organism types A through E may be cultured in media described in the following respective articles:

- Type A - Duff, J. T., et al., "Studies on Immunity to Toxins of Clostridium botulinum: I. A Simplified Procedure for Isolation of Type A Toxin," J. Bacteriol. 73 (1957), pp 42-47.
- Type B - Duff, J. T., et al., "Studies on Immunity to Toxins of Clostridium botulinum: II. Production and Purification of Type B Toxin and Toxoid," J. Bacteriol., 73 (1957), pp 597-601.

- Type C - Cardella, M. A., et al., "Studies on Immunity to Toxins of Clostridium botulinum: IV. Production and Purification of Type C Toxin for Conversion to Toxoid," J. Bacteriol. 75 (1958), pp 360-365.

- Type D - Cardella, M. A., et al., "Production and Purification of Clostridium botulinum Type D Toxin for Conversion to Toxoid," Bacteriol. Proc. (1957), p 97.

- Type E - Gordon, M., et al., "Studies on Immunity to Toxins of Clostridium botulinum: III. Preparation, Purification, and Detoxification of Type E Toxin," J. Bacteriol. 74 (1957), pp 533-538.

- Type F - Cultured in the same medium as Type E at 30° C.

(2) (U) Purification. After the various toxins are produced, the following general procedures for extraction and purification are used:

- Type A - Precipitation with acid at pH 3.5, extraction of toxin in 0.075 M calcium chloride at pH 5, acid precipitation at pH 3.7, precipitation with 15% ethanol at -5° C, and crystallization from 0.9 M ammonium sulfate.

- Type B - Precipitation with acid at pH 3.5, extraction of toxin at pH 5, reprecipitation with acid at pH 4, reprecipitation with acid at pH 5.

- Type C - Precipitation from culture in 25% ethanol at -5° C, extraction of toxin with 0.005 M $CaCl_2$ at pH 5, reprecipitation with 15% ethanol at -5° C.

- Type D - Precipitation with 25% ethanol at -5° C, extraction of toxin with 0.075 M $CaCl_2$ at pH 6.5, reprecipitation with 10% ethanol at -5° C.

- Type E - Treat culture with 0.1% trypsin at pH 6.0 for 2 hr at 37° C, precipitate toxin with 25% ethanol at -5° C.

- Type F - Culture supernatant centrifuged at 3000 rpm for 30 min at 3° C. Filtered through Sephadex gel G-100 and G-200.

f. (U) Equipment. Standard laboratory equipment.

g. (U) Physical, Chemical, and Immunological Properties. All types of botulinum toxin possess hemagglutinating properties and can be destroyed or detoxified with nitrous acid, strong alkali, many oxidizing agents, formaldehyde, dilute ethanol solution, and by heat (boiling for 5 to 10 min). These toxins are not destroyed by stomach acids, trypsin, or pepsin. In cold stagnant water, they are stable for a week; in food, they may persist for a long time provided air is excluded.[98] The several types of toxin are also chemically and antigenically distinct:

(1) (U) Type A - Simple protein. Crystalline white needles. Molecular weight, approximately 900,000. Produces a specific antibody. Toxicity destroyed by photooxidation in presence of methylene blue and by boiling.

(2) (U) Type B - Simple protein. Amorphous solid. Molecular weight, approximately 60,000. Nonproteolytic. Produces specific antibody.

(3) (U) Type C - Simple protein. Amorphous solid. Molecular weight undetermined. Produces specific antibody. More heat resistant than types A or B.

(4) (U) Type D - Simple protein. Amorphous solid. Molecular weight, approximately 900,000. Strongly proteolytic.

(5) (U) Type E - Simple protein. Amorphous solid. Molecular weight, approximately 19,000. Toxin is resistant to diffused light and destroyed in 40 hr by direct sunlight. More easily destroyed by heat than types A or B. Resistant to cold.

(6) (U) Type F - Simple protein. Molecular weight is approximately 140,000. Partly resembles Type E toxin; not antigenically related to Types A, B, C, or D. Heat labile. Storage at 4° C for 3 months completely inactivates it. Elevated temperatures hasten destruction of toxin. Has marked proteolytic properties. Actively digests forcemeat and egg white, coagulates milk, and liquifies gelatin to release hydrogen sulfide. Possesses saccharolytic properties, forming acid and gas in fermentation of starch, glucose, and other sugars. Toxin formation is greatest in liver broth containing boiled forcemeat. Not activated by trypsin.

h. (U) Method of Dissemination. Aerosol spray, small caliber projectile, ingestion of food or water.

i. (U) Use. Lethal agent.

j. (U) Physiological Effects.

(1) (U) General effects. The botulinum toxin is a neurotoxin that acts principally by paralyzing the cholinergic synapse (junction) of the peripheral nerves leading to muscles; it interferes with the release of acetylcholine, which acts as a chemical mediator of the impulse to the muscle. The inactivation is irreversible. The toxin is distributed throughout the body by the blood stream and acts on the individual motor nerve terminals. Death results from respiratory paralysis. The several types of toxin have similar modes of action on susceptible animal species, but show different patterns of reactivity toward the various animal species. Symptoms generally appear within 12 to 36 hr. Incubation periods may range from 2 hr to 10 days. First signs of poisoning are: malaise, weakness, headache, dizziness, visual disturbances (fogginess, blurred and double vision, dilation of pupils, no reaction to light), disturbances in swallowing and speech (paralysis of tongue, pharynx and soft palate), dry throat and mouth, progressive weakness of muscles of neck, and ataxic gait. Pulse is generally fast, temperature is normal or subnormal. Muscular paresis of stomach and intestines causes constipation. There is progressive respiratory paralysis. Victims generally do not complain of pain. Headache and transient colic normally are observed only at the beginning. Duration of attack varies, but is generally 4 to 6 days. Unless specific treatment is instituted, death can occur as early as the second and third day. In untreated cases that survive, recovery may take months. Before the introduction of the antitoxins, lethality averaged 40% to 50%.

(2) (U) Type-specific effects.

- Type A - Most common type. Very potent with rapid time of onset. Highest mortality rate, with death occurring on second or third day. Abdominal distention also noted.
- Type B - Approximately same toxicity as A. Incubation from 2 to 60 hr. Death may occur on second or third day. Symptoms are: nausea, vomiting, shortness of breath, depressed temperature, and fast pulse; no cramps or diarrhea.
- Type C - Very high toxicity, with death occurring on second or third day. Leg weakness, diarrhea, prostration, and "limberneck" are noted. Type is rare in humans.

- Type D - Least toxic of series. Rare in humans.
- Type E - Highly toxic. Short incubation period. Symptoms appear within 4 to 6 hr and include nausea, vomiting, abdominal distention, fever, and urinary retention. Death may occur within 24 hr.
- Type F - Comparatively rare. Symptoms appear within 24 hr if large amounts are ingested and within 3 days for smaller doses. Symptoms include unsteady gait progressing to severe weakness, palatal paralysis, drooping eyelids, double vision, and impairment of speech.

k. (U) Therapy. Polyvalent antisera (Types A, B, C, D, and E) are available, either for use as a prophylaxis or a therapeutic. Early massive treatment by injection with type-specific botulinum antisera may bring about recovery; the time lag between ingestion and appearance of symptoms (usually 6 to 48 hr) makes diagnosis difficult and delays treatment.

l. (U) Storage. The toxins are relatively unstable in the pure state. A more stable preparation, however, is a partially purified toxin that had been spray-dried and stored in the cold.

m. (C) Toxicities.

(1) (U) LD_{50} intraperitoneally in mice.[96]

Toxin	µg/mouse	Estimated purity of preparation (%)	Form
Type A	2.7×10^{-5}	>98	crystalline
Type B	2.7×10^{-5}	>98	amorphous
Type C	1.4×10^{-4}	?	amorphous
Type D	1.3×10^{-5}	about 90	amorphous
Type E	1.7×10^{-4}	>90	amorphous

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(b)(1)

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n. (U) Historical. The microorganisms were discovered and identified by Van Ermengen in 1895 (Belgium). The various types of botulinum toxin were discovered in the following sequence.

- Type A - Leuchs in 1910 (Germany).
- Type B - Leuchs in 1910 (Germany).
- Type C - Bengston (United States) and Seddon (Australia) in 1922.
- Type D - Thieles and Robinson in 1927 (South Africa).
- Type E - Gunnison, Cummings, and Myer in 1936 (United States); Kusknir in 1934 (USSR).
- Type F - Moeller and Scheibel in 1958 (Denmark).

o. (U) Detection and Identification. "Phagocytic" inhibition test, hemagglutination test, neutralization test using specific antitoxins, and ring precipitation test.

4. (U) Bufotenine

a. Code or Alternate Designations.

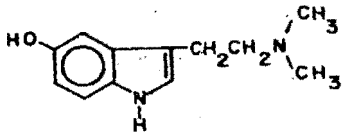
- Nopo.
- Mappine.
- Ch'an Su.
- Cohoba.

b. Chemical Name. 5-Hydroxy-N,N,-dimethyltryptamine.

c. Alternate Chemical Names.

- 3-(2-dimethylaminoethyl)indole-5-ol.
- 3-(2-dimethylaminoethyl)-5-indolol.
- 5-hydroxy-N-dimethyltryptamine.
- N,N-dimethylserotonin.
- 3-(β-dimethylaminoethyl)-5-hydroxyindole.

d. Formula. $C_{12}H_{16}N_2O$



e. Molecular Weight. 204.26.

f. Raw Materials.

(1) Natural sources.

- Toad (Bufo vulgaris Laur).
- Seeds of leguminous shrubs (Piptadenia peregrina and Piptadenia macrocarpa).

- Mushrooms (Amanita mappa, Amanita pantherina and Amanita muscaris).

(2) Synthesis.

- Aluminum chloride ($AlCl_3$).
- 2,5-Dimethoxybenzylcyanide ($C_{10}H_{11}NO_2$).
- N,N-Dimethylaminoethylchloride ($ClCH_2CH_2N(CH_3)_2$).
- Sodamide ($NaNH_2$).
- 5-Benzyloxyindole ($C_{15}H_{13}NO$).
- 5-Ethoxyindole ($C_{10}H_{11}NO$).
- Chloroacetonitrile ($ClCH_2CH$).
- Oxalyl chloride $(COCl)_2$.
- Dimethylamine $[(CH_3)_2NH]$.

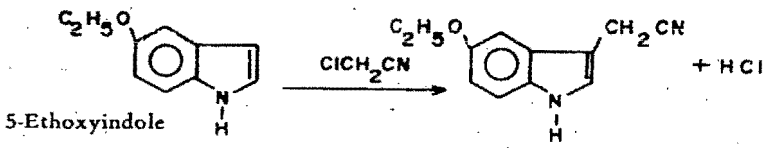
g. Method of Manufacture.

(1) Natural sources.

- Dried preparation of dermal glandular secretion from Bufo vulgaris Laur.
- Ground seeds of Piptadenia peregrina and Piptadenia macrocarpa.
- Extracts from mushrooms Amanita mappa, Amanita pantherina, and Amanita muscaria.

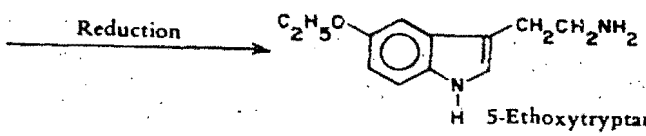
(2) Synthesis.

- Method A.

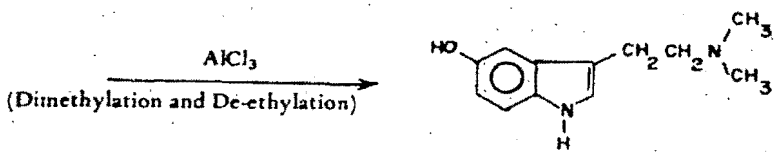


5-Ethoxyindole

5-Ethoxyindole-3-acetonitrile

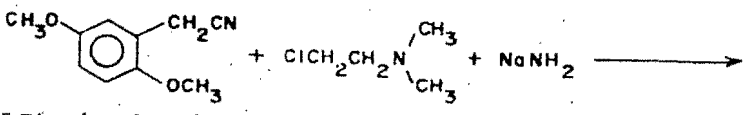


5-Ethoxytryptamine

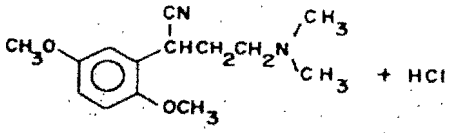


BUFOTENINE

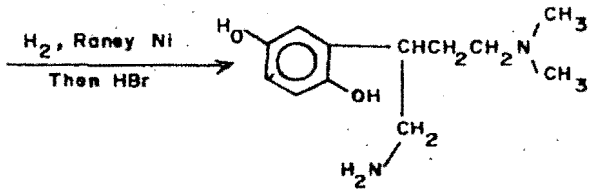
- Method B.



2,5-Dimethoxybenzyl cyanide



1-(2,5-Dimethoxyphenyl)-3-dimethylaminopropylcyanide



1-Dimethylamino-3-(2,5-dihydroxyphenyl)-4-butylamine

Original

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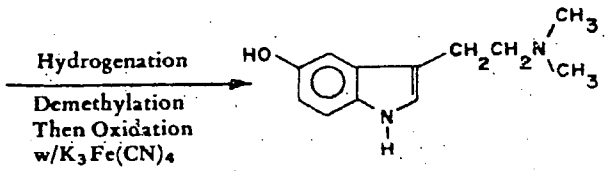
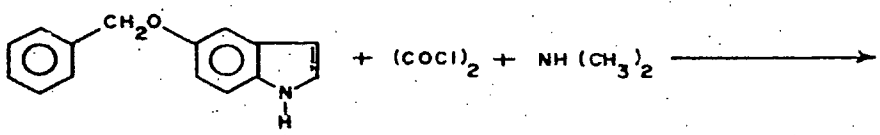
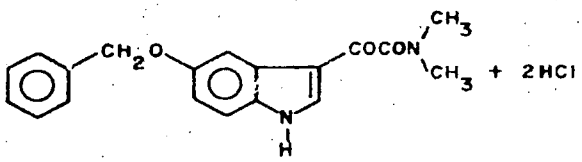


BUFOTENINE

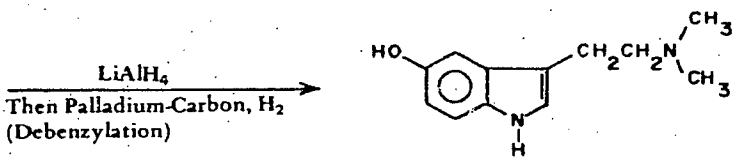
- Method C.



5-Benzyloxyindole



Glyoxyldimethylamide



BUFOTENINE

h. Equipment. Standard chemical processing equipment.

i. Physical and Chemical Properties.

- Physical state and color: Stout prisms.
- Boiling point: 320° C at 0.1 mm Hg.
- Melting point: 146° to 147° C.[3]
- Solubility: Freely soluble in alcohol, soluble in dilute acids and alkali, slightly soluble in ether, insoluble in water.[3]

j. Method of Dissemination. Ingestion.

k. Use. Incapacitant; hallucinogen.

l. Physiological Effects. The face changes to a peculiar shade of purple, the color of eggplant. The compound produces visual hallucinations of both color and shape, and alters time and space perception. A transient rise in blood pressure along with bronchial constriction and chest discomfort results. Bufotenine exerts a central paralytic effect on the motor centers of the nervous system to produce myosis and saliva flow.[11]

m. Therapy. Emetics and atropine; artificial respiration, if necessary.

n. Toxicity. Intravenous injection of 8 to 16 mg of bufotenine in human volunteers produced primary visual disturbances, alteration of time and space perception, and a sensation of intense itching.

o. Historical.

- 1934: Isolated from toads by Wieland in Germany.
- 1935: Synthesized by Hoskins and Shimodaira in Japan.
- 1949: Synthesized by Bovet in Italy.
- 1954: Isolated from toadstools by Wieland and Motzel in Germany.

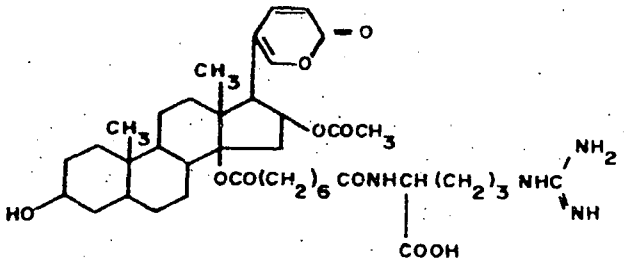
5. (U) Bufotoxin

a. Code or Alternate Designations. Vulgarobufotoxin.

b. Class. Steroidal compound, toad venom.

c. Chemical Name. C_{14} ester of bufotolin with suberylarganine.

d. Formula. $C_{40}H_{60}N_4O_{10}$



e. Molecular Weight. 756.91.

f. Method of Preparation. The principal toxin of the venom of the common European toad, Bufo vulgaris, obtained from the secretions of the granular glands. A steroidal conjugate of suberylarginine.

g. Physical and Chemical Properties.

- Physical state: Needle-like crystals with a bitter, nauseating taste.
- Solubility: Freely soluble in methanol and pyridine; slightly soluble in absolute alcohol; insoluble in water, acetone, chloroform, petroleum, and ether.
- Decomposition temperature: 205° C.

h. Physiological Effects. Bufotoxin has an effect on the central nervous system similar to LSD. The toxin causes hallucinations, respiratory paralysis, muscle tremors, and weakness and has an anesthetic action. The toxin also has actions similar to digitalis and cocaine.

i. Method of Dissemination. Ingestion.

j. Use. Hallucinogen, lethal agent.

k. Toxicity. LD_{50} in cat is 0.39 mg/kg, intravenously.

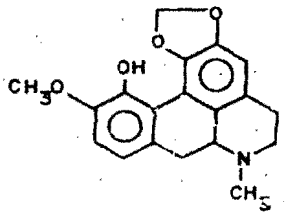
l. Historical. 1922: Isolated and structure determined by Wieland in Germany.

6. (U) Bulbocapnine

a. Code or Alternate Designations. None.

b. Class. Incapacitating agent.

c. Formula. $C_{19}H_{19}NO_4$.



Neg. 513167

d. Molecular Weight. 325.35.

e. Raw Materials.

(1) Natural sources.

- Corydalis cava L. (Bulbous birthwort).
- Corydalis bulboso (Dutchman's breeches).

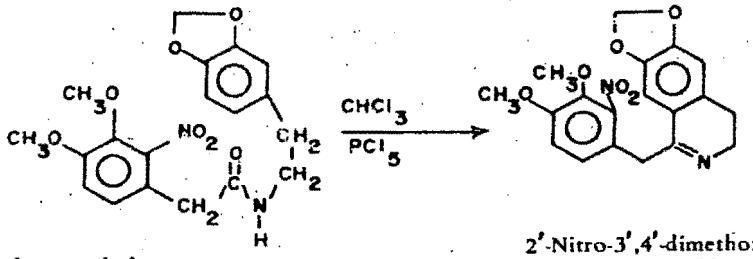
(2) Synthesis.

- 2'-Nitro-3',4'-dimethoxyphenylaceto-B-3,4-dimethylenedioxy-phenylethylamide.
- Methyl iodide (CH_3I).
- Phosphorus pentachloride (PCl_5).
- Chloroform ($CHCl_3$).

f. Method of Manufacture.

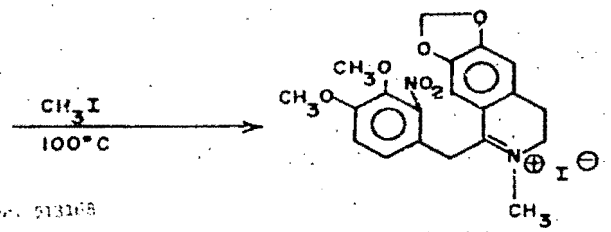
(1) Natural sources. Extraction and crystallization from the tubers of Corydalis cava(L.) and Corydalis bulboso.

(2) Synthesis.

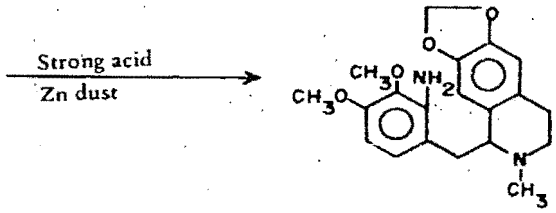


2'-Nitro-3',4'-dimethoxyphenylaceto-β-3, 4-methylenedioxyphenylethylamide

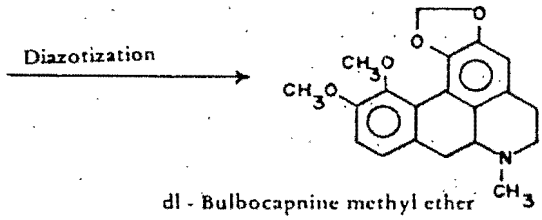
2'-Nitro-3',4'-dimethoxy-6,7-methylenedioxy-l-benzyl-3, 4-dihydroisoquinoline



Methiodide Derivative



2'-Amino-3',4-dimethoxy-6,7-methylenedioxy-l-benzyl-2-methyltetrahydroisoquinoline



dl - Bulbocapnine methyl ether

Hydroxylation → d-Bulbocapnine

g. Equipment. Standard chemical processing equipment.

h. Physical and Chemical Properties.

- Physical state and color: Crystalline powder.
- Melting point: 201-203° C.
- Solubility: Soluble in alcohol and chloroform; insoluble in water.

i. Use. Incapacitating agent; the hydrochloride used medically for muscle tremors.

j. Physiological Effects. Symptoms include catalepsy, negativism, vegetative derangement, hyperkinesis, salivation and vomiting. Intravenous injection produces catatonia. For light doses (1 to 2 mg), drowsiness sets in; for medium doses, catalepsy and negativism; and for large doses, apoplexy and rigidity. Massive doses in man of 200-500 mg produce sluggishness, lack of movement, assumption of abnormal positions with body, mental lassitude, prolonged fixation of relatively unimportant points, and mental catalepsy.

k. Toxicity. LD_{50} for mice 195 mg/kg, subcutaneously. ID for man is 3.0 to 7.0 mg/kg (route of administration unknown).

l. Historical. 1928: Synthesized by Gulland and Haworth in United Kingdom.

7. (U) Curare

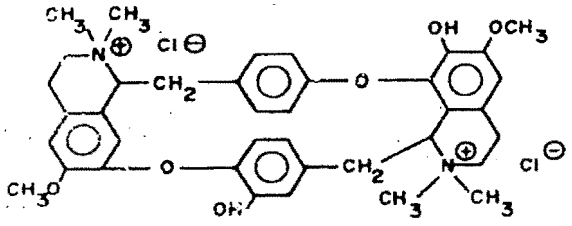
a. Code or Alternate Designations.

- D-Tubocurarine chloride.
- Intocostrin-T.
- Tabadil.
- Delacurarine.
- Durarin "Asta".
- Pariera Brava.
- Tubarine.

b. Class. Neurotropic agent.

c. Chemical Name. Curare is a crude dried extract containing a number of alkaloids which exert curariform effects as well as substances which have a toxic action on the blood vessels and a histamine-like action. The crystallized alkaloid isolated from the crude curare was designated as D-tubocurarine, which has a bis-benzylisoquinoline structure with quaternary nitrogen atoms.

d. Formula. $C_{38}H_{44}Cl_2N_2O_6$.



D-tubocurarine chloride

e. Molecular Weight. 695.67.

f. Raw Materials. From the plant, Chondodendron tomentosum.

g. Method of Manufacture. Tubocurarine is extracted with water from freshly gathered stems and bark of the plant, Chondodendron tomentosum.

The aqueous extract is concentrated to a brownish-black syrupy paste which is autoclaved and then evaporated to dryness. The residue is extracted with an aqueous solution of tartaric acid and the extracts treated with excess lead subacetate. The precipitated lead salts are separated and the filtrate, after removal of soluble lead as its sulfide, is made slightly alkaline and extracted with chloroform to remove other alkaloids. The chloroform-extracted water solution is acidified to pH 3 with H_2SO_4 and then treated with picric acid. The insoluble picrate is separated, purified by recrystallization from a mixture of acetone and ethanol, and then converted to tubocurarine chloride by treatment with dilute HCl in the presence of toluene. Tubocurarine is crystallized from the aqueous acid layer by chilling.

h. Equipment. Standard chemical processing equipment.

i. Physical and Chemical Properties.

- Odor: Odorless.
- Physical state and color: Yellowish white to grayish white, hexagonal and pentagonal microplatelet crystals.
- Decomposition temperature: Anhydrous material decomposes 274° to 275° C.
- Solubility: Soluble in water, forming supersaturated solutions readily; takes up water in moist atmosphere to form pentahydrate. Soluble in alcohol; insoluble in chloroform, ether, and acetone.

j. Methods of Dissemination. Undetermined; possibly flechettes.

k. Use. Lethal, and a possible incapacitating agent; muscle relaxant (effective dose is 10 to 15 mg/man).

l. Physiological Effects. The principal effect of the drug is a total suppression of the skeletal musculature to produce paralysis. The paralysis results from the disturbance of nervous transmissions from the motor nerve. D-tubocurarine chloride increases the threshold of sensitivity of cholino-reactive systems of muscle fibers to acetylcholine and weakens conduction in the autonomic ganglia. Depression effects and bronchospasm also occur due to the release of histamine caused by the agent. Initially, slight dizziness, difficulty in speaking and weakness occur. Later, the fingers and toes become difficult to move--eventually the victim is unable to move at all--and the facial and diaphragmatic muscles tend to relax. Peak effect occurs 3 to 5 min after IV injection,

and the duration of action is about 20 to 40 min.[99] Death is caused by hypoxia as the result of respiratory paralysis. Life usually can be saved by artificial respiration because the duration of action of tubocurarine is relatively brief.

m. Therapy.[99,100] Neostigmine, tensilon (edrophonium bromide), physostigmine, and artificial respiration or oxygen. Paralytic effects of large doses of tubocurarine are enhanced by neostigmine and physostigmine.

n. Decontamination. Decomposed by heat.

o. Storage. Store away from air and moisture.

p. Persistence. Persistent.

q. Toxicity.[99,101] Lethal dose is given as approximately 50 mg/man, evidently by the injection route, since tubocurarine is inactive by the oral route unless taken in massive doses. Total respiratory paralysis takes 7 to 10 min from time of injection. LD_{50} of tubocurarine in rabbits, intravenously, is 0.223 mg/kg; LD_{50} of curare in rabbits, intravenously, is 1.3 mg/kg.

r. Historical.

- 1935: Extracted by King in United States.
- 1946: Isolated from Chondodendron tomentosum by Dutcher.
- 1948: Chemical structure determined by King.
- 1963: Stereochemistry by Hultin.

8. (U) Harmine

a. Code or Alternate Designations.

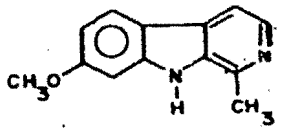
- Ayahausca.
- Banisterine.
- Caapi.
- Leucoharmine.

- Telepathine.
- Yage'.

b. Class. Plant poison—incapacitating agent.

c. Chemical Name. 1-Methyl-7-methoxy-9H-pyrido[3,4-b] indole. 1-Methyl-7-methoxy-B-carboline.

d. Formula. $C_{13}H_{12}N_2O$



e. Molecular Weight. 212.25.

f. Raw Materials.

(1) Natural sources. Seeds and roots of Penganum harmala L. [wild rue, and the wood of Banisteriopsis caapi (ayahausca)].

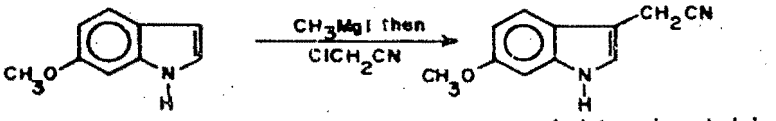
(2) Synthetic.[2]

- 6-Methoxyindole (C_9H_9NO).
- Chloroacetonitrile ($ClCH_2CN$).
- Methyl magnesium iodide (CH_3MgI).
- Sodium (Na).
- Ethanol (C_2H_5OH).
- Sulfuric acid (H_2SO_4).
- Acetic acid (CH_3COOH).
- Maleic acid ($C_4H_4O_4$).
- 6-Methoxytryptamine ($C_{11}H_{14}N_2O$).
- Acetic annydride ($CH_3CO-O-OCCH_3$) or Ac_2O.

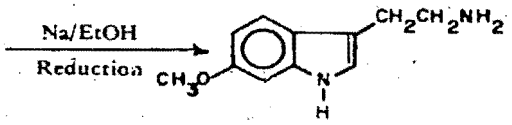
- Phosphorus pentoxide (P_2O_5).
- 6-Methoxytryptophan ($C_{12}H_{14}N_2O_3$).
- Acetaldehyde (C_2H_4O).

g. Method of Manufacture.

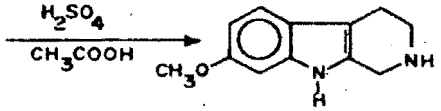
- Method A.



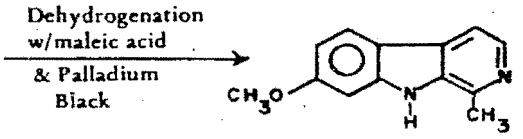
6-Methoxyindole 3-Cyanomethyl-6-methoxyindole



3-Ethylamino-6-methoxyindole

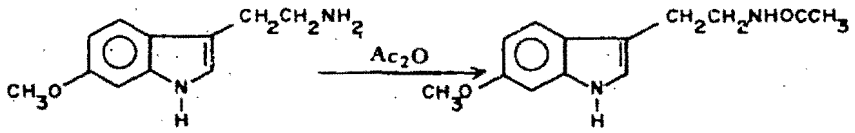


1,2,3,4-Tetrahydroharmine

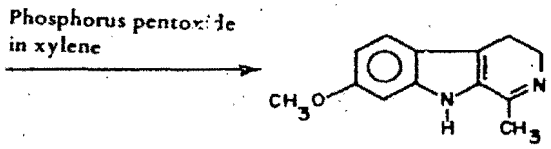


Harmine

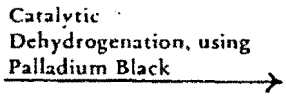
- Method B.



6-Methoxytryptamine

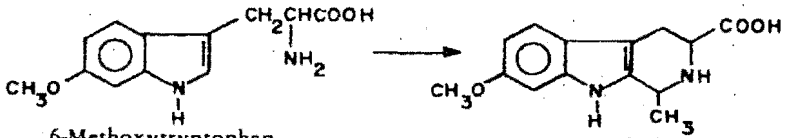


Harmaline



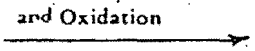
Harmine

- Method C.



6-Methoxytryptophan

1,2,3,4-Tetrahydroharmine-3-carboxylic acid



Harmine

h. Equipment. Standard chemical processing equipment.

i. Physical and Chemical Properties.

- Physical state and color: Slender orthorhombic prisms.
- Boiling point: Sublimes.
- Melting point: 261° C with decomposition.
- Solubility: Soluble in alcohol, ether, chloroform; insoluble in water. Hydrochloride is soluble in hot water.

j. Method of Dissemination. Unknown.

k. Use. Incapacitation.

l. Physiological Effects. Harmine increases arterial pressure, intensifies respiration, lowers bodily temperature and causes shivering. Harmine has central relaxing, hypnotic, spasmolytic, anesthetic and semi-narcosis effects. In large doses, harmine produces hallucinations and other psychotic disorders similar to those produced by Mescaline. An intravenous dose of 0.2 gm produces vomiting, paleness, shivering, ataxia, dizziness, booming in ears, and psychic depression.

m. Toxicity. MLD is 200 mg/kg in rats, subcutaneously. ID for man is 2.9 mg/kg, intravenously.

n. Historical. 1927: Synthesized by Manske, Perkin, Robinson in United Kingdom.

9. (U) Mescaline

a. Code or Alternate Designations.

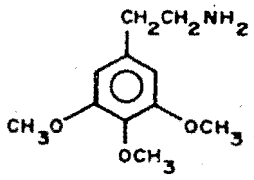
- Mezcaline.
- Mescal Buttons.
- Peyote.
- Peyotl.

- Anhalonium.
- Pellotine.
- Lophophora.

b. Class. Incapacitating agent.

c. Chemical Name. 2(3,4,5-Trimethoxyphenyl)ethylamine.

d. Formula. $C_{11}H_{17}NO_3$.



Nor. 513174

e. Molecular Weight. 211.25.

f. Raw Materials.

(1) Natural sources. Flowering heads of dumpling cactus, Anhalonium lewinii (Lophophora williamsii).

(2) Synthesis.

- 3,4,5-Trimethoxybenzoyl chloride ($C_{10}H_{11}O_4Cl$).
- Nitromethane (CH_3NO_2).
- 3,4,5-Trimethoxybenzoic acid ($C_{10}H_{12}O_5$).
- Acetic acid (AcOH).
- Potassium cyanide (KCN).
- Diazomethane (CH_2N_2).
- Silver nitrate ($AgNO_3$).
- Ammonia (NH_3).

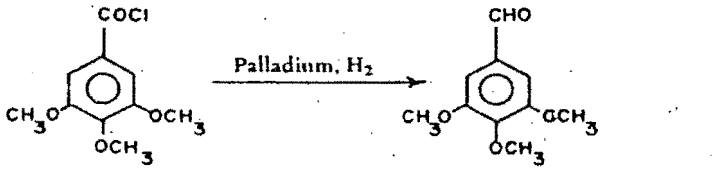
- Silver oxide (Ag_2O).
- Methanol (CH_3OH).
- Potassium hydroxide (KOH).
- Thionyl chloride ($SOCl_2$).

g. Method of Manufacture.

(1) Natural sources. Extraction from flowering heads (mescal buttons) of cactus.

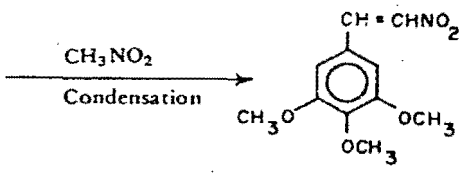
(2) Synthesis.

- Method A.

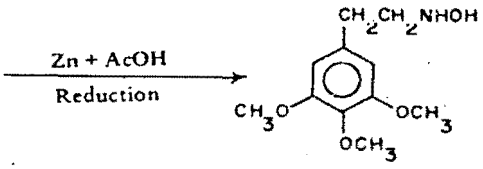


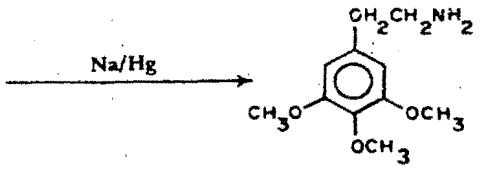
3,4,5-Trimethoxybenzoyl chloride

3,4,5-Trimethoxybenzaldehyde



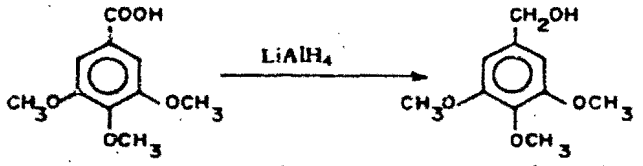
β-Nitro-3,4,5-trimethoxystyrene





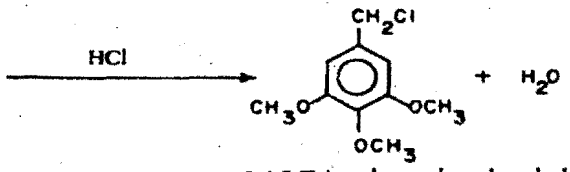
Mescaline

- Method B.

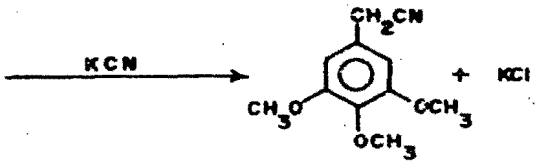


3,4,5-Trimethoxybenzoic acid

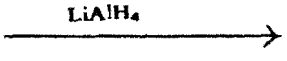
3,4,5-Trimethoxyphenyl-methanol



3,4,5-Trimethoxyphenylmethyl chloride

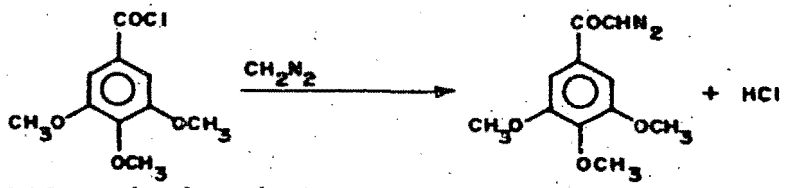


3,4,5-Trimethoxyphenylmethylcyanide



Mescaline

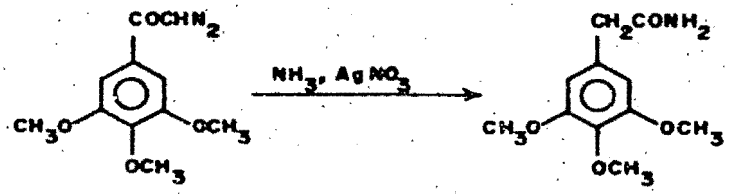
- Method C.



3,4,5-Trimethoxybenzoyl chloride

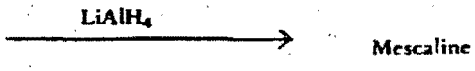
3,4,5-Trimethoxyphenyldiazomethyl-ketone

Route 1:



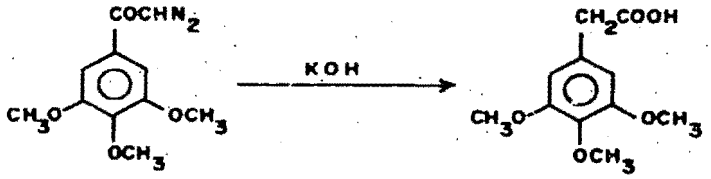
Neg. 513178

3,4,5-Trimethoxyphenylacetamide



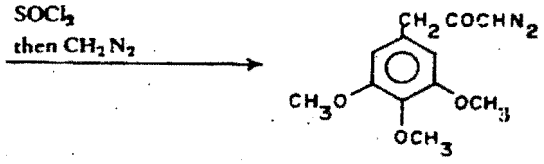
Mescaline

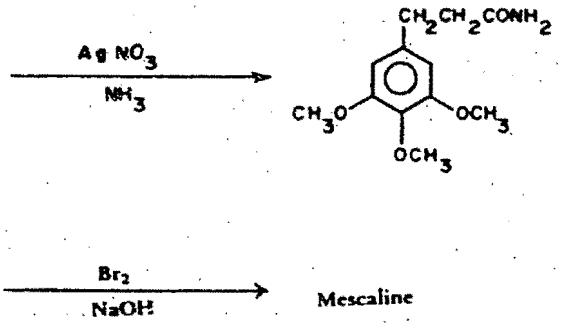
Route 2:



Neg. 513179

3,4,5-Trimethoxyphenylacetic acid





h. Equipment. Standard chemical processing equipment.

i. Physical and Chemical Properties.

- Physical state: Mescaline is crystalline when pure.[11]
- Boiling point: 180° C at 12 mm Hg.
- Melting point: 35° to 36° C. It melts to a colorless oily liquid.[11]
- Solubility: Soluble in alcohol, chloroform and benzene; slightly soluble in water; insoluble in ether.

j. Method of Dissemination. By ingestion with food or water.

k. Use. Incapacitant, hallucinogen.

l. Physiological Effects. Mescaline induces visual and auditory hallucinations, modifies consciousness, disrupts bodily functions, and causes a disappearance of conditioned reflexes. The compound is readily absorbed in the gastrointestinal tract, and the symptoms usually appear within one-half hour. Other symptoms include: mydriasis, difficulty in breathing, nausea, heavy salivation, intense hunger, sharpened hearing and sense of touch, sensitivity to odors, and loss of sense of time and space.

m. Therapy. Chlorpromazine or reserpine, Frenquel (4-piperidyl-benzhydrol derivative).

n. Decontamination. Unknown.

o. Storage. Store away from air.

p. Persistence. Persistent.

q. Toxicity. Oral dose effects appear in 2 to 3 hr and last for 12 or more hr. A 0.1 to 0.2 g dose produces optical phenomena, intense color perception, euphoria, hypomanical conditions; with a 0.3 to 0.5 g dose, euphoria recedes and perception is dulled; a 0.5 g dose shows full clinical effect, hallucinations; more than a 0.5 g dose may be fatal with death resulting from circulatory failure and respiratory paralysis. ID is 1.4 to 7.0 mg/kg, orally, in man.

r. Historical.

- Used by Aztec Indians in religious ceremonies for centuries.
- 1560: Effects first discribed in a book by Francisean Monk Bernardino de Shagun in Spain.
- 1886: Plant described by Lewin in Germany.
- 1896: Active material isolated and structure determined by Heffter in Germany.
- 1919: Synthesized by Späth in Germany.

10. (U) Murexine

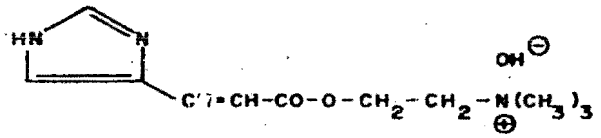
a. Code or Alternate Designations. Purperine.

b. Class. Neurotoxin, snail poison.

c. Chemical Names.

- β(4-Imidazolyl)acrylylcholine.
- Urocanylcholine.

d. Formula. $C_{11}H_{19}N_3O_3$



e. Molecular Weight. 241.29.

f. Method of Preparation. Poison is secreted from the hypobranchial glands of certain gastropods of the family Muricidae (purple snail), Murex trunculus, and other related species of mollusks. The material is extracted with alcohol.

g. Physical and Chemical Properties.

- Melting point: (Hydrochloride) 219° to 221° C with decomposition.
- The compound is unstable in acid and alkaline media. The base is instantly hydrolyzed by water and the chlorides are extremely hygroscopic. Although a choline ester, Murexine is not hydrolyzed by cholinesterase.

h. Physiological Effects. Murexine has an intense nicotinic action. The compound paralyzes skeletal muscles, and death results from asphyxia, followed by fibrillary contractions in nearly all muscles.

i. Toxicity. LD_{100} of oxalate salt in white mice is 300 mg/kg, subcutaneously, and 15 to 30 mg/kg, intravenously.

j. History.

- 1953: Structure determination, Erspamer, Benatr.
- 1960: US pat. 2,956,061, Pascini, Coda, (Societa Farmaceutici).

11. (U) Palytoxin

a. Code or Alternate Designations.

- "Limu make o Hana" (deadly seaweed of Hana).
- EA 3940.

b. Chemical Name. Unknown. Palytoxin contains no repetitive amino acid or sugar units.

c. Formula. Empirical formula $C_{30}H_{53}NO_{14}$.[84]

d. Molecular Weight.[84]

- Determined by ultracentrifuge: 1900 ± 100.
- Determined by mass spectrometry: 2604.

e. Raw Materials. Palytoxin is obtained from the coelenterate, Palythoa sp. (for example, P. vestitus).[102]

f. Method of Preparation. Palytoxin is extracted from Palythoa vestitus with ethanol and purified by chromatography.[84]

g. Physical and Chemical Properties.[84]

- Physical state and color: Clear to pale yellow, amorphous, hygroscopic solid.
- Melting point: No definite melting point, chars when heated to 300° C.
- Solubility: Very soluble in water; insoluble in water-free organic solvents.
- Other properties: Palytoxin is optically active with a specific rotation of +26° ±2° in water.

h. Use. Lethal agent.

i. Physiological Effects.[103] Symptoms occurring in mice in palytoxin poisoning are decreased locomotion, lowering of the anterior trunk, extension of fore limbs, paralysis of hind limbs, diarrhea, severe convulsions, dyspnea, and finally death from cardiac failure or respiratory collapse. Its cardiotoxic effects are due to vasoconstriction.

j. Storage.[84] Palytoxin is stable in aqueous solutions of pH 4.5 to 7.5 and in aqueous ethanol solutions. The toxin is rapidly destroyed in strong base, but less rapidly in strong acid.

k. Toxicity.[84] Except for the polypeptide and protein toxins, Palytoxin is the most toxic substance known. LD in mice is 0.15 µg/kg intravenously, and 0.4 µg/kg intraperitoneally. It is relatively nontoxic when given intragastrically or intrarectally.

l. Historical. Known as "Limu make o Hana" in Hawaiian legends. Used for poison on spear points. 1961: First collected and studied by Moore and Scheuer.

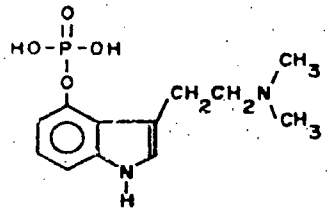
12. (U) Psilocybin

a. Code or Alternate Designations. Teonanacatl.

b. Class. Incapacitating agent.

c. Chemical Name. 3(2-Dimethylaminoethyl)-4-indolyl dihydrogen phosphate.

d. Formula. $C_{12}H_{17}N_2O_4P$.



e. Molecular Weight. 284.3.

f. Alternate Chemical Names.

- 3-[2-(Dimethylamino)ethyl] indole-4-ol dihydrogen phosphate ester.
- O-Phosphoryl-4-hydroxy-N,N-dimethyltryptamine.

g. Raw Material. Psilocybe mexicana (Mexican mushroom) and Strophania cubensis (found in Mexico and Thailand).

h. Method of Manufacture. By extraction of material from natural sources.

i. Physical and Chemical Properties.

- Melting point: Crystals from boiling water, mp 220° to 228° C; crystals from boiling methanol, mp 185° to 195° C.
- Solubility: Slightly soluble in boiling water and boiling methanol; very slightly soluble in ethanol; insoluble in chloroform and benzene.
- Hydrolysis: Conversion to the 4-hydroxyindole derivative (psilocin) by hydrolysis results in a compound slightly more potent than Psilocybin. Psilocin is an isomer of Bufotenine.

Original

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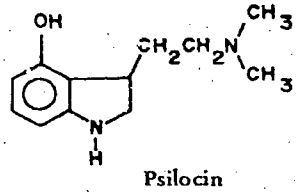


Psilocin

j. Use. Incapacitant.

k. Physiological Effects.[11] Psilocybin is converted to the more potent psilocin in the body. Typical symptoms are: sedative effects, mydriasis, tachycardia, shortness of breath, hyperthemia, hallucinations and a sense of unreality. A dose of 20 mg produces full hallucinogenic effect which lasts for about 5 hr. An oral dose of psilocybin acts within 20 to 30 min; intravenous effects appear within minutes. Psilocybin acts more rapidly than mescaline and is 100 times stronger.

l. Therapy. Psychotic action of psilocybin can be stopped with chlorpromazine.

m. Toxicity. Lethal dose for humans is not known; doses up to 70 mg have been taken without permanent effects. In man, 20 mg (orally) produce hallucinogenic effects.

n. Historical.

- 1953-1955: Plant described by French botanist, (fnu) Heim, and fungus grown under laboratory conditions by associate, (fnu) Wasson.
- 1958: Pure substance isolated and the structure determined by (fnu) Hoffman in Switzerland.
- 1960: German pat. 1,087,321 to Sandoz.
- 1963: US pat. 3,075,992 to Sandoz.

13. (U) Ricin

a. Code or Alternate Designations.

- Palma cristi.
- "W".

b. Class. Phytotoxin, toxic albumin, protoplasmic poison.

c. Chemical Name and Formula. Not determined.

d. Raw Material. Castor beans, Ricinus sanguineus L. or R. communis L. Euphorbiaceae.

e. Method of Preparation. True protein, extracted from oil cake residue after processing castor beans, Ricinus sanguineus L. or Ricinus communis L. Euphorbiaceae. Toxin is not present in the oil. The castor bean is crushed and extracted. The crude extract is then subjected to acid treatment for separating the acid-soluble ricin from insoluble extraneous matter followed by precipitation with sodium sulfate in a neutral solution. These steps are repeated several times and, finally, the purified ricin is skimmed off from a slurry prepared with carbon tetrachloride.[104]

f. Physical and Chemical Properties.

- Physical state and color: White amorphous powder.
- Solubility: Soluble in water.
- Other properties: Stable in aqueous solution only up to 60° to 75° C; in solid form, it is stable up to 100° to 110° C. Toxin is destroyed in digestive tract.

g. Method of Dissemination. Ingestion, inhalation of dust.

h. Use. Lethal agent.

i. Physiological Effects. Ricin acts as a proteolytic enzyme. Temperature greatly affects the action of the toxin: higher temperatures cause relative increases in toxicity. Action is partly local-gastroenteric, and partly central paralysis of respiratory and vasometer centers. Local inflammation may occur, especially if the compound comes in contact with the eyes or the dust enters the respiratory tract. There is no direct action on muscles or nerves. Ricin produces agglutination of red blood cells with embolic obstruction of smaller blood vessels. Symptoms include nausea, persistent vomiting, headache, colic, sometimes bloody diarrhea, thirst, emaciation, weak and rapid pulse, cold sweat, collapse, and convulsions. Symptoms occur about 12 to 18 hr and sometimes several days after poisoning. There may be bleeding from the lungs and mucous membrane. Death may occur in 6 to 8 days either from convulsions or from exhaustion, with a fatality rate of about 6%. Small particles in cuts, eyes, or nose may prove fatal.

j. Therapy. Antitoxin. Treatment is symptomatic.

k. Toxicity. LD_{100} is 0.6 µg/kg for dogs, intramuscularly; LD_{50} is 0.05 µg/kg for rabbits, intravenously; and LD_{100} for man is 150 to 200 mg, orally, and 200 mg, intravenously.[4]

l. Historical.

- 1889: Poisonous action shown by (fnu) Stillmark.
- 1962: Patent 3,060,165, indicating a use as CW agent, issued to US Dept of Army (Craig et al.).
- 1964: Separation and properties of crystalline Ricin D determined by Ishiguro et al. in Japan.

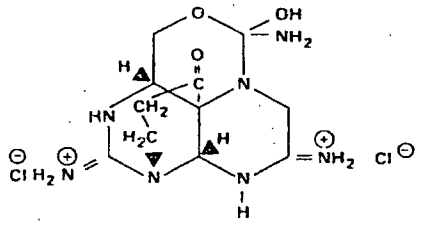
14. (U) Saxitoxin

a. Code or Alternate Designations.

- PSP.
- Parlytic shellfish poison.
- Mussel poison.

b. Class. Neurotoxin.

c. Formula.[105] $C_{10}H_{17}N_7O_4 \cdot 2HCl$



Neg. 51104 Saxitoxin dihydrochloride

d. Molecular Weight. 372.

e. Raw Materials. The sources of this poison are the Alaskan butter clam, Saxidomus giganteus, and the California ocean mussel, Mytilus californianus, both of which feed on toxic plankton such as the dinoflagellate, Gonyaulax catenella. The poison contained in the dinoflagellate

is concentrated in the digestive gland of the mussels; the mussels continue to be toxic to humans for at least 3 weeks after the dinoflagellate is no longer present in the water. The butter clam concentrates this or a similar poison in its siphon, where the toxicity is retained for years.

f. Method of Preparation.

(1) Preparation from shellfish. Minced clam or mussel meat is boiled in 0.1 N hydrochloric acid, cooled, pH adjusted to between 4.0 and 4.5, and distilled water added. Clarified supernatant liquid contains the toxin.

(2) Preparation from Gonyaulax catenella.[106] The organism can be cultured in sterile sea water supplemented with small amounts of salts in 2-liter flasks. After about 17 days at 13° C, the cell count reaches about 30,000/ml. The cells are filtered and lysed with dilute HCl. The extract is then processed through carboxylic acid ion exchange resins and acid-washed alumina.

g. Physical and Chemical Properties.

- Physical state and color: Dihydrochloride salt is a white crystalline solid.
- Solubility: Very soluble in water, methanol, and to some extent in ethanol; insoluble in all lipid solvents.[107] The crystalline material is hygroscopic.

h. Method of Dissemination. Ingestion or injection, aerosolization.

i. Use. Lethal agent.

j. Physiological Effects. Saxitoxin produces widespread effects on the cardiovascular and respiratory systems, blocks nerve conduction, and paralyzes muscular contraction. Fundamental cause of death is respiratory failure. The poison acts directly on the muscle; it also has a central effect in paralyzing the medullary respiratory center. The poison does not have to be digested to be effective. Numbness of lips, tongue, and throat are noted before poisoned material is swallowed. Symptoms also include muscular weakness of limbs, slow and shallow respiration, lowered blood pressure, and brief convulsions. Final breaths are weak and gasping, and heart continues to beat for some time after breathing stops. Tolerance for the poison varies greatly among individuals.

k. Therapy. None known.

l. Storage. Stable for years in dry state or in acid solution; the solution must be refrigerated.

m. Toxicity. LD_{50} is 2 to 7 µg/kg for cats and rabbits, intravenously; 1.0 µg/kg for mice, intraperitoneally; and is 115 to 300 mouse units* for monkeys.

n. Historical.

- 1937: Identified by Sommer et al.
- 1957: Poison isolated by Schantz.
- 1960: Formula proposed by Schantz.

o. Detection. Only current method is death response in mice.

15. (U) Scopolamine Hydrobromide

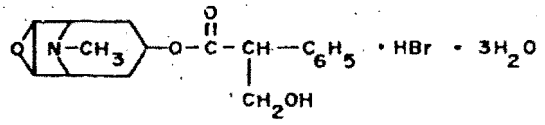
a. Code or Alternate Designations.

- Hyoscine hydrobromide.
- Scopos.

b. Class. Alkaloid, cholinolytic substance, hypnotic, plant poison.

c. Chemical Name. 6,7-Epoxytropine tropate.

d. Formula. $C_{17}H_{21}NO_4 \cdot HBr \cdot 3H_2O$



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*A mouse unit is defined as the amount of poison that will kill a 20 gm white mouse in 15 min when 1 ml of solution is injected intraperitoneally.

e. Molecular Weight. 438.32.

f. Method of Preparation. Extraction of levorotatory isomer from Solanaceae, especially Datura metel and Scopola carniolica, followed by bromination.

g. Physical and Chemical Properties.

- Physical state and color: Colorless, transparent crystals, or fine crystalline powder.
- Melting point: 195° C (anhydrous). Slightly efflorescent in dry air.
- Solubility: Soluble in water and alcohol; slightly soluble in chloroform; insoluble in ether.
- Other properties: Deteriorates if exposed to light.

h. Use. The drug is a hypnotic, sedative, central nervous system depressant, prophylaxis in motion sickness, and enhances the analgesic effects of narcotics.

i. Physiological Effects. The drug may cause mental excitement and delirium. There is a sedative and depressant action on central nervous system. Scopolamine has a stronger (muscarinic) action than atropine on the iris and certain secretory glands, but has a weaker action than atropine on heart, intestine, and bronchial muscles. Therapeutic doses sometimes produce hallucinations or delirium.

j. Dosage. 0.3 to 0.75 mg/man, orally.

k. Toxicity. LD_{50} is 5900 mg/kg for mice subcutaneously.[108]

l. Storage. Store in orange glass containers, away from light.

m. History. 1919: Prepared by King.

16. (U) ~~(U) (FD)~~ Staphylococcal Enterotoxin B

a. (U) Code or Alternate Designations.

- United States - PG (formerly UC)[12]

- Enterotoxin B
- Staphylococcus aureus toxin

b. (U) Class. Incapacitant. It is a non-lethal high-molecular-weight bacterial exotoxin.[98]

c. (U) Chemical Name and Formula.[96,109] Staphylococcal enterotoxin B is a high-molecular-weight protein elaborated by Staphylococcus aureus. This exotoxin contains about 252 amino acid residues and exists as a very compact, unhydrated molecule over a wide pH range. The precise arrangement and sequence of the amino acids have not been determined, but the purification of enterotoxin B has progressed to a stage permitting a complete amino acid analysis and biophysical characterization of the molecule. It has one disulfide bridge, but no free sulfhydryl group. Glutamic acid is its N-terminal residue, and lysine is the C-terminal residue.

d. (U) Molecular Weight. 35,380.[109]

e. (U) Source of Material. Enterotoxin B is one of four types of serologically distinct enterotoxins (Types A, B, C, and D) produced by certain strains of the common bacterial species, Staphylococcus aureus. These toxins are associated with massive outbreaks of acute food poisoning. The two common antigenic types of enterotoxin, Types A and B, produce similar, if not identical, symptomatic manifestations when administered by the oral route, and differ apparently only with respect to the specific antibodies produced by the animal host. Type B has been studied most extensively.[4]

f. (C-NFD) Methods of Preparation.[12,110]

(1) (C-NFD) (b)(1)

(b)(1)

(2) (C-NFD) (b)(1)

(b)(1)

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(b)(1)

g. (U) Equipment Used. 40-gal fermenters.

h. (U) Physical and Chemical Properties.[109,111]

- Color: White fluffy powder.
- Solubility: Hygroscopic; very soluble in water and salt solutions.
- Isoelectric point: about pH 8.6.
- Diffusion coefficient: $(D^{\circ}_{20,w}) = 7.72 \times 10^{-7}$ cm^2.
- Sedimentation coefficient: $(S_{20,w}) = 2.78$ S.
- Extinction coefficient: $(E^{1\%}_{1cm}) = 14.0$.
- Maximum absorption: 277 mμ.
- Other properties; Resistant to heat. Retains activity after heating at 99° C for 87 min and after warming at 60° C, pH 7.3, for 16 hr.

i. (U) Method of Dissemination. Aerosol spray (because of its relative stability, enterotoxin B is easier to disseminate in aerosol form than botulinum toxin), ingestion.

j. (U) Use. Incapacitant.

k. (U) Physiological Effects.

(1) (U) Produces incapacitation at dosages that are far below the lethal dose. Incapacitation may occur with sufficient violence and persistence to immobilize a subject completely for several hours. Death rarely occurs in otherwise normal humans, but a few fatalities have been recorded.[98]

(2) (U) Ingestion of poison causes salivation, followed by nausea, vomiting, retching, abdominal cramps, and watery diarrhea. Fever and respiratory effects are absent. Symptoms appear in 1 to 6 hr following

ingestion of enterotoxin. The incubation period is influenced by dose and resistance of individual. Small amounts of toxin produce illness for about 24 hr; larger doses may produce incapacitation lasting several days. Although enterotoxin is believed to evoke its characteristic response in cats and monkeys by stimulating the vagal and sympathetic nerves, the nature of the inciting stimulus in the gut remains obscure.[4]

(3) (U) Intoxication by respiratory challenge is characterized by high fever, malaise, muscle and chest pains, headache, cough, nausea, and loss of appetite. Vomiting and diarrhea do not result. Onset of illness is abrupt, occurring within 2 to 8 hr after exposure; peak response time is given as 9 to 15 hr. The duration of action is 30 to 56 hr.[4,98]

l. (U) Therapy. Monkeys, repeatedly given enterotoxin B orally, became resistant to 200 times the minimum emetic dose of the toxin. Although no antitoxin was demonstrable in sera, it was believed to be responsible for the animal's resistance to the toxin. The immunizing capacity of enterotoxin B in humans is yet to be fully evaluated. Enterotoxin B has been treated with formalin to produce toxoid for the purpose of inducing active immunization.[98,111]

m. (U) Storage. Freeze-dried enterotoxin B, stored with a dessicant such as silica gel at 4° C for over 1 year, showed no loss in biological activity. The toxin is also stable to pH changes and can withstand temperatures of boiling water for 30 min.[98]

n. (C) Toxicity (in µg/kg).[4]

(b)(1)

(CONFIDENTIAL)

(b)(1)

o. (U) Persistence. Destroyed in soil in less than 2 hr; persists longer on surfaces such as painted wood or aluminum, especially out of sunlight.

p. (U) Detection. The preferred methods for the detection of enterotoxin are Oudin's single diffusion tube and the quantitative precipitin test. Other methods include Ouchterlony diffusion plates, hemagglutination inhibition, reversed passive hemagglutination, microlatex bead agglutination, and immunofluorescence.[111]

17. ~~(C)~~ (U) Tetrahydrocannabinol[4,84,112-114]

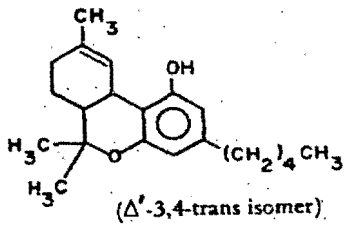
a. (U) Code or Alternate Designations.

- Cannabis.
- EA 1476 (United States).
- Hashish.
- Anasha.
- Karas (charas).
- Bhang.
- Dogga.
- Kif.
- Marijuana.
- THC.
- "Pot".
- Marihuana.

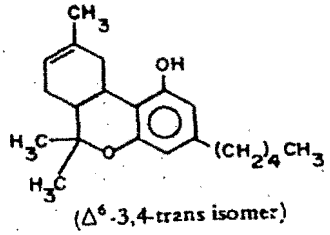
b. (U) Class. Incapacitating agent.

c. (U) Chemical Names. Mixture of Δ^1-3,4-tetrahydrocannabinol and Δ^6-3,4-tetrahydrocannabinol isomers.

d. (U) Formula. $C_{21}H_{30}O_2$

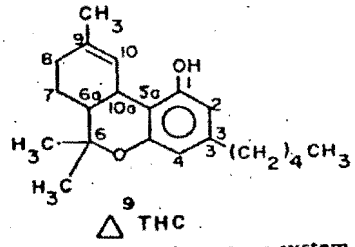


(Δ^1-3,4-trans isomer)



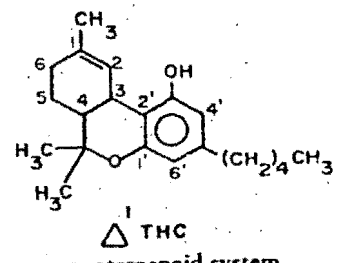
(Δ^6-3,4-trans isomer)

Two numbering systems are commonly used in the literature for naming THC-type compounds—the "pyran-type compound" numbering system and the monoterpenoid numbering system:



Δ^9 THC

pyran-type system



Δ^1 THC

monoterpenoid system

This handbook uses the monoterpenoid system.

e. (U) Molecular Weight. 314.5.

f. (U) Raw Materials.

(1) (U) Natural sources. Active constituents of dried flower tops of Cannabis sativa L. (India hemp). This hemp plant includes old name of C. indica Lam.

(2) (U) Synthesis.

- Citral ($C_{10}H_{16}O$).
- Methyl magnesium iodide (CH_3MgI).
- Lithium derivative olivetol dimethyl ether ($C_{13}H_{20}O_2Li$).

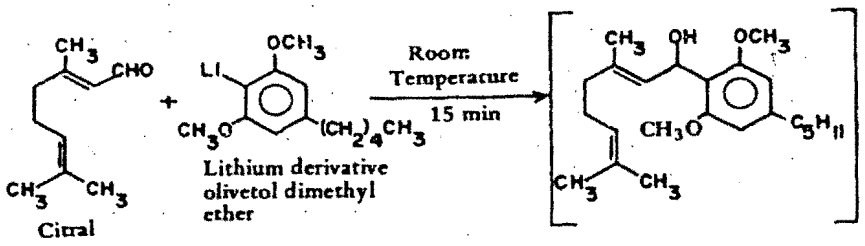
- Olivetol ($C_{11}H_{15}O_2$).
- *p*-Toluenesulfonyl chloride ($C_7H_7ClO_2S$).
- Boron trifluoride etherate [$(C_2H_5)_2O{\cdot}BF_3$].

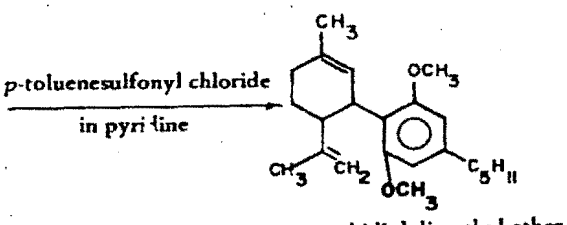
g. (U) Method of Manufacture.

(1) (U) Natural sources. Extraction from dried flower tops of Cannabis sativa L. Derived from "red oil" constant boiling fraction from petroleum ether extract. The major constituent found in nature is the Δ^1 isomer.

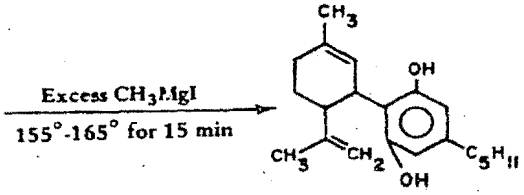
(2) (U) Synthesis.

(a) (U) Δ^1-isomer.[68]

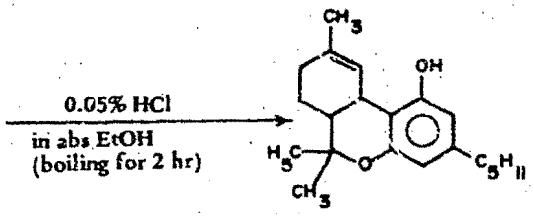




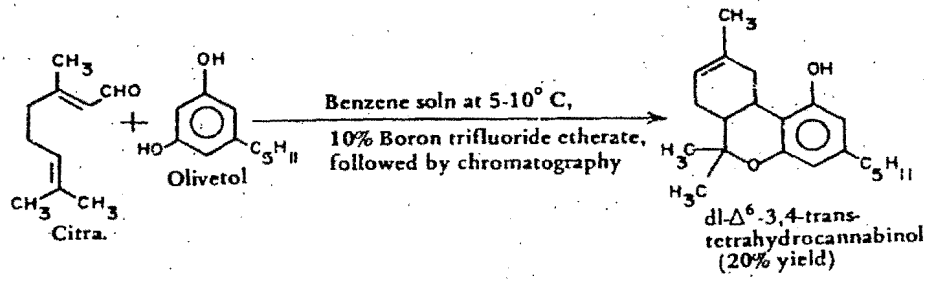
d,l-cannabidiol dimethyl ether



d,l-cannabidiol



(b) (U) Δ⁶-trans isomer.[113]



The product is identical to the natural Δ⁶-trans isomer isolated from hemp in all respects (nmr, ultraviolet, and infrared) except for optical activity. Note: A synthetic Δ³-trans isomer, which is not found in nature, was prepared. This compound possessed the physiological activity of marihuana.

h. (U) Equipment. Standard chemical processing equipment.

i. (U) Physical and Chemical Properties.

- Physical state and color: Colored crystalline or viscous resin oil. Discolored by light and oxygen.
- Boiling point: 185° C at 0.05 mm Hg.
- Melting point: 76° to 77° C.
- Other properties: Heat or acid treatment converts the Δ¹ isomer to the Δ⁶ isomer.

j. (U) Method of Dissemination. Aerosol.

k. (U) Use. Incapacitant.

1. (U) Physiological Effects. Tetrahydrocannabinol induces euphoria, relaxation, colored dreams, hallucinations, and disturbs body functions. Large doses lead to mental confusion, apprehension, and temporary psychoses. The effects of THC last for 6 to 48 hr. Large doses may cause "suspended animation" for as long as 3 days. A dose of 0.5 to 1.0 mg causes fatigue, thirst, and headache. A dose of 1.5 to 3.0 mg causes postural hypotension, loss of vision on standing, weakness, giddiness, and a slowing of motor activity. A dose of 3.5 to 4.0 mg causes marked psychomotor retardation; subject is unwilling or incapable of standing, unable to concentrate, and suffers blurring of vision. For doses greater than 2.8 mg, the subject is incapable of performing regular activities. THC is not habit forming.

m. (U) Therapy. d-Amphetamine (15 mg) counteracts sedation and the indifference induced by the cannabinols.[8]

n. (U) Decontamination. Unknown.

o. (U) Protection Required. Protective mask against aerosols and smoke.

p. (U) Storage. Store away from light and air.

q. (U) Persistence. Persistent.

r. (U) Detection. Unknown.

s. (C) (b)(1)

(b)(1)

(b)(1)

t. (U) Historical.

- Effects of marijuana have been known for 3000 years.
- 1942: A tetrahydrocannabinol isolated in an impure form and a gross structure suggested by H. J. Wollner and associates.
- 1949: (b)(6) and associates studied various analogs of tetrahydrocannabinol.
- 1965: Structure determination and total synthesis by (b)(6) and associates in Israel.
- 1966: Acid isomerization of tetrahydrocannabinol by (b)(6) and associates in the United States.

18. (U) Tetrodotoxin

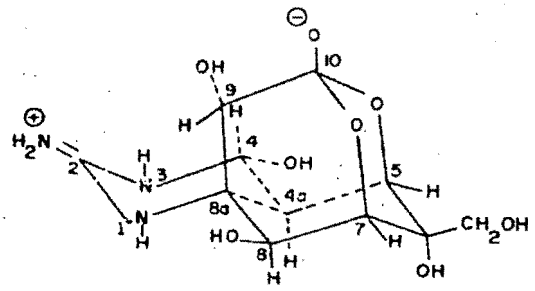
a. Code or Alternate Deisgnations.

- Fugu poison.
- Kai po.
- Puffer fish poison.
- Cutter poison.
- Tetraodon poison.
- Tarichatoxin.

b. Class. Nonprotein neurotoxin, fish poison.

c. Chemical Name. Aminoperhydroquinazoline derivative.

d. Formula. $C_{11}H_{17}N_3O_8$



Tetrodotoxin (zwitterion)

e. Molecular Weight. 319.3.

f. Method of Preparation. Obtained from organs (liver and ovaries) of the Japanese puffer fish, Spheroides rubripes, and from the embryos of the California newt, (salamander) Taricha torosa. The poison is extracted in boiling water.

g. Physical and Chemical Properties.

- Physical state and color: White crystalline solid. Crude material has a yellow color, and is tasteless.

- Solubility: Highly soluble in water and methanol; insoluble in most organic solvents.
- Melting point: Decomposes without melting; also decomposes at a pH less than 3 or greater than 7.[107]

h. Physiological Effects. Tetrodotoxin causes paralysis and blocks nerve impulses. In large doses, it depresses motor centers and blood pressure. First symptoms occur from 30 min to 4½ hr after ingestion. Poisoning is characterized by the rapid onset of symptoms: tingling or prickling sensation in fingers and toes gradually progressing to numbness; eyes do not react to light; pulse is slow; heartbeat faint; temperature drops; weakness; dizziness; pallor; and numbness of lips, tongue, and throat. Nausea, anxiety and vomiting are frequently seen. Heavy perspiration, increased salivation, pain on respiration, muscular weakness, and hypotension are often experienced. In severe poisoning, the victim may complain of "numbness all over," and a feeling of "floating in air." In fatal cases, severe respiratory distress, marked hypotension, cyanosis, paralysis, and small hemmorhages may develop. In most fatal cases, death occurs 6 to 24 hr after ingestion of the toxic fish.

i. Method of Dissemination. By ingestion or injection.

j. Use. Lethal agent.

k. Therapy. No known antidote; treatment is strictly symptomatic. Ingestion of large quantities of sodium bicarbonate is recommended.

l. Toxicity.[107]

(1) Mouse -- LD_{50} is 14 µg/kg, subcutaneously; 11 µg/kg, intraperitoneally; and 10 µg/kg, intravenously.

(2) Rat -- LD_{50} is 14 µg/kg, subcutaneously; 12 µg/kg, intraperitoneally; and 10 µg/kg, intravenously.

(3) Rabbit -- LD_{50} is 10 µg/kg, subcutaneously; and 2 µg/kg, intravenously.

(4) Cat -- MLD is 2 µg/kg, intravenously.

(5) Dog -- MLD is 15 µg/kg, subcutaneously.

m. Historical.

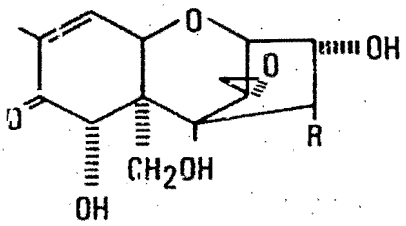
- 1909: Isolated from puffer fish by Tawara (Japan).
- 1964: Structure identified by Tsuda, Goto, Hirata (Japan).

★19. Trichothecenes (U)[192]

a. (U) Code or Alternate Designation (U). Yellow rain.

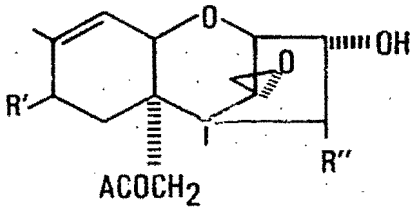
b. (U) Class (U). Nonprotein mycotoxin.

c. (U) Chemical Names and Formulas (U). The trichothecenes are a family of approximately 60 naturally occurring sesquiterpenoids. The basic ring system of the trichothecene mycotoxins is named trichothecane. All of the naturally occurring trichothecenes contain an olefinic bond at carbons 9 and 10, and are known as 12, 13-epoxytrichothecenes. The trichothecenes of most interest are:



NIVALENOL, R = OH

DEOXYNIVALENOL, R = H



T-2 TOXIN : R' = $O\overset{O}{\overset{\|}{C}}CH_2\,CH(CH_3)_2$; R'' = OAc

HT-2 TOXIN : R' = $O\overset{O}{\overset{\|}{C}}CH_2\,CH(CH_3)_2$; R'' = OH

DIACETOXYSCIRPENOL (DAS) : R' = H ; R'' = OAc

d. (U) Method of Preparation (U). The production of the various trichothecenes employs Fusarium species and depends upon the type of substrate, temperature, and duration of cultivation. T-2 toxin production is promoted by incubation at temperatures of 15°C or below. Most of the trichothecene-producing fungi are grown for toxin production at 24°C.

e. (U) Natural Occurrence (U). The main substrates on which trichothecenes are produced are cereals, leguminous crops, sweet potatoes, cabbage, and hay. Naturally occurring levels of trichothecenes are around 2 ppm; the largest quantity found to occur spontaneously was 71.5 ppm.

f. (U) Physical and Chemical Properties (U). The naturally occurring trichothecenes are colorless, crystalline, optically active solids. Impure preparations can be colored. Trichothecenes are generally soluble in alcohol, acetone, ethyl acetate, and chloroform. Only the highly hydroxylated derivatives have significant water solubility. They do not absorb strongly

in the UV, do not fluoresce, and are difficult to separate from complex biological mixtures. The trichothecenes are stable in solution and may be stored as a solid for years at room temperature with no loss of activity. Heating for 1 hour at 100°C also produces no decrease in activity.

g. (U) Physiological Effects (U). They produce headaches, chills, nausea, vomiting, vertigo, and visual disturbances. Trichothecenes cause alimentary toxic aleukia, the symptoms of which include vomiting, skin inflammation, multiple hemorrhaging, diarrhea, and leukopenia. Rapid onset of vomiting along with severe itching and tingling of the skin are characteristics of trichothecene intoxication.

h. (U) Detoxification (U). This can be accomplished with strong mineral acid.

i. (U) Method of Dissemination (U). Dissemination can be by rockets, or by spray tanks, mortars, and/or artillery shells.

j. (U) Use (U). Lethal agent, terrorizing agent.

k. (U) Therapy (U). Opiates help reduce the fluid loss in adults.

l. (U) Toxicity (U). In general, the LD_{50}'s in laboratory animals range from 0.1 mg/kg to > 1000 mg/kg.

(1) (U) LD_{50} intraperitoneally in mice:

Toxin	mg/kg
T-2	5.2
HT-2	9.0
DAS	23.0
Nivalenol	4.1
Deoxynivalenol	70.0

(2) (U) Toxicity of T-2 in cats:

- The LD_{50} is 0.5 mg/kg, subcutaneously
- The ED_{50} for vomiting is 0.1 mg/kg subcutaneously
- The ED_{50} for skin irritation is 0.1 - 0.9 mg/kg

m. (U) Historical (U).

- In 1944, many Soviet citizens were killed by trichothecene-contaminated grain
- In 1946, the first trichothecenes were isolated (Brian and McGowan)

Section X.

SCREENING SMOKES

1. (U) General[5]

a. Screening smokes are used to conceal all types of troop movements and installations in combat zones and rear areas. The obscuring action of the smoke is due to the reflection and refraction of the light rays striking the particles comprising the smoke. The optimum particle size has an equivalent diameter of one micron (10^{-4} cm).

b. There are several factors which affect the life or persistency of a smoke. Water vapor plays an important role by improving the effectiveness of most smokes, either by hydrolysis or by hydrating hygroscopic smoke particles to effective size.[8] Wind, convection currents, and ambient temperature also have strong effects on smoke characteristics.

c. Smoke may be generated by mechanical or thermal techniques, or by a combination of these techniques.

2. (U) Berger Mixture

a. Code or Alternate Designations. None.

b. Class. Smoke agent.

c. Chemical Name. Zinc smoke.

d. Raw Materials and Composition.

- Finely divided metallic zinc (Zn)--25%.
- Kieselguhr (absorbent)--5%.
- Carbon tetrachloride (CCl_4)--50%.
- Zinc oxide (ZnO)--20%.
- Igniting composition (iron dust, potassium permanganate, and match head).

e. Physical and Chemical Properties. The mixture is a smooth dough-like paste. It is chemically inert and entirely harmless until ignited; it could not be fired even if hit by projectiles. Upon ignition, the zinc reacts with carbon tetrachloride to produce zinc chloride, carbon, and heat (1200° C); the heat evaporates the zinc chloride to form a dense cloud of light gray smoke. A disadvantage of this smoke mixture is the high temperature produced by the reaction with resulting spark dispersion that can cause fires.

f. Methods of Dissemination. Smoke candles only, because mixture is too slow in igniting for smoke grenades, artillery shells, or airplane bombs. To prepare the smoke candles, three pounds of the pasty mixture are pressed into a can about the size of a large tomato can, and then covered with a layer of igniting material.

g. Physiological Effect. None.

h. Decontamination. Not necessary.

i. Protection Required. There is no physiological action which requires protection in a normal encounter; however, under prolonged exposure a protective mask should be worn because the zinc chloride may produce toxic effects.

j. Storage. The mixture can be stored for long periods without deterioration; occupies small storage space; and is easy to transport, handle and operate.

k. Toxicity. Lowest irritant concentration is 100 mg-min/m^3.

l. Total Obscuring Power. (See glossary) 256 m^2/kg (1250 ft^2/lb).

m. Historical. Prepared by the French chemist Berger.

3. (U) BM Mixture

a. Code or Alternate Designations. None.

b. Class. Smoke agent.

c. Chemical Name. Zinc smoke.

d. Raw Materials and Composition.

(1) Standard Mixture:

- Sodium chlorate ($NaClO_3$)--9.3%.
- Zinc dust (Zn)--35.4%.
- Ammonium chloride (NH_4Cl)--5.4%.
- Carbon tetrachloride (CCl_4)--41.6%.
- Magnesium carbonate ($MgCO_3$)--8.3%.

(2) Fast Mixture:

- Sodium chlorate ($NaClO_3$)--24.9%.
- Zinc dust (Zn)--30.2%.
- Zinc oxide (ZnO)--9.8%.
- Carbon tetrachloride (CCl_4)--35.1%.

(3) Starter Mixture #1:

- Zinc dust (Zn)--63.1%.
- Zinc oxide (ZnO)--16.2%.
- Powdered sulfur (S)--20.7%.

(4) Starter Mixture #2:

- Powdered iron (Fe)--46.6%.
- Potassium permanganate ($KMnO_4$)--53.4%.

e. Physical and Chemical Properties. The mixture produces a dense white smoke with better handling qualities than Berger Mixture. It is less easily dissipated or disturbed by air currents.

f. Method of Dissemination.

(1) Smoke candles, grenades, floating pots for naval use.

(2) The pastelike Standard and Fast mixtures are packed into the munition and covered with both starter mixtures. Starter mixture #2 receives the flash from the igniting match head, burns through the igniting cup and ignites starter mixture #1, which starts the reaction.

g. Physiological Effect. None.

h. Decontamination. Not necessary.

i. Protection Required. None necessary.

j. Storage. Stable for long periods if container is airtight.

k. Total Obscuring Power. 286 m^2/kg (1400 ft^2/lb).

l. Historical. 1917: US improvement of original Berger Mixture, prepared by Bureau of Mines personnel.

4. (U) British Type S Mixture

a. Code or Alternate Designations. None.

b. Class. Smoke agent.

c. Chemical Name. None.

d. Raw Materials and Composition.

(1) Smoke Torch, Mark I, Type S:

- Potassium nitrate (KNO_3)--45%.
- Borax ($Na_2B_4O_7 \cdot 10H_2O$)--9%.
- Sulfur (S)--12%.
- Glue--4%.
- Pitch--30%.

(2) Smoke Candle, Mark II, Type S-1:

- Potassium nitrate (KNO_3)--40%.
- Borax ($Na_2B_4O_7 \cdot 10H_2O$)--8%.

- Sulfur (S)--14%.
- Coal dust--9%.
- Pitch (hard)--29%.

e. Physical and Chemical Properties. The mixture burns vigorously for about 3 min and generates a large volume of yellowish brown smoke due to incomplete combustion of solid carbon particles in the pitch. Screening properties are unreliable since smoke has a tendency to rise rapidly, break up, and leave gaps in the smoke screen. Nevertheless, the mixture is cheap, easily produced from readily available materials, and stable.

f. Method of Dissemination. Candles were used in large quantities through World War I by both British and American armies.

g. Physiological Effect. None.

h. Decontamination. Not necessary.

i. Protection Required. None necessary.

j. Storage. Stable in storage.

k. Total Obscuring Power. 94 m^2/kg (460 ft^2/lb).

l. Historical. First material used in World War I for the generation of artificial smoke on land.

5. (U) Crude Oil

a. Code or Alternate Designations. United States -- CO; Fog oil SGF1 and SGF2 (MIL-F112070H, screening smoke, Standard A).[12]

b. Class. Smoke agent.

c. Chemical Name. Mixture of paraffin hydrocarbons.

d. Physical and Chemical Properties of SGF2.[8]

- Flash point: 160° C.
- Ignition temperature: 207.2° C.

- Viscosity: 25 sec at 37.7° C. Below 0° C, a mixture of SGF2 oil and paraffin (wax)-free kerosene is used.
- Specific gravity: 0.8.
- Solubility: Soluble in gasoline and benzene.

e. Method of Dissemination. The Crude oil may be vaporized in a generator by heat from a fuel burner. When the vaporized smoke oil enters the cool surrounding air, the oil vapor is cooled so rapidly that only very small liquid droplets are able to form. The final smoke cloud, which appears to be white, is quite stable. However, oil that is partially burned results in the separation of solid particles of carbon which, at first, tend to float in air to produce a dense smoke; later, the carbon particles coagulate into flakes that quickly settle out and drop to the ground. This type of smoke has poor screening value. Other smokes, intermediate in character, are also in use. In these smokes, the solid carbon particles surround the liquid droplets and thus are prevented from coagulating into flakes. It is grayish black in color and is much more stable. Fifty-six grams of crude oil is said to produce 28 m^3 (1000 ft^3) of smoke at a cost of 8 cents.

f. Use. Used by all navies for smoke screens at sea; also used for smoke generation on land.

g. Physiological Effect. Slightly suffocating when dense. No other effects.

h. Decontamination. None necessary.

i. Storage. Very stable. It is not affected by humidity and is non-corrosive to material.

j. Persistence. Summer -- while source is operating and 5 min after.

k. Protection. Protective masks when exposed to high concentrations for prolonged periods.[8]

l. Total Obscuring Power. 41 m^2/kg (200 ft^2/lb).

m. Historical. 1915: First used by Germans in the Battle of Jutland. Produced by incomplete combustion of crude-oil fuel under boilers of naval ships, especially destroyers.

(U)

6. (C-NFD) HC Mixture

a. (U) Code or Alternate Designations. United States -- HC.

b. (U) Class. Smoke agent.

c. (U) Chemical Name. Zinc smoke.

d. (U) Composition.

- Hexachloroethane (Cl_3CCCl_3)--46.7%.
- Grained aluminum--6.7%.
- Zinc oxide (ZnO), absorbent--46.7%.

e. (C-NFD) Reaction.

(b)(1)

(b)(1)

f. (U) Physical and Chemical Properties. HC has a slightly acrid odor. Solid hexachloroethane is substituted for and found to be superior to carbon tetrachloride in Berger's Mixture. By reducing the aluminum content, but keeping the proportions of hexachloroethane and zinc oxide constant, the amount of carbon appearing in the smoke is reduced due to the formation of carbon monoxide. The zinc chloride rapidly absorbs moisture from air to form particles of effective size.

g. (U) Methods of Dissemination.[6]

(1) (U) Smoke candles, grenades, smoke pots, artillery and mortar shells, and aerial bombs.

NO FOREIGN DISSEM

(2) (U) A typical starter mixture is composed of silicon, potassium nitrate, charcoal, iron oxide, grained aluminum, cellulose nitrate, and acetone.

h. (U) Physiological Effect. Smoke has no physiological action, except that high concentrations of $ZnCl_2$, during prolonged exposure, may be toxic.

i. (U) Decontamination.[5] Water or alkaline solutions.

j. (U) Protection Required. Protective masks, when subjected to exceedingly high concentrations of $ZnCl_2$.

k. (U) Storage. Very stable during storage, if it has a total moisture content of 0.6% or less. Stable in steel drums.

l. (U) Historical. Produced in United States as an improvement over Berger Mixture.

7. (C) Radar and Infrared Screening Smokes[9,16]

(b)(1)

8. (U) Soviet Smoke Mixtures[115,116]

a. Anthracene Mixture.

(1) Code or alternate designations. None known.

(2) Class. Smoke agent (screening).

(3) Chemical name. Mixture.

(4) Composition.

- Potassium chlorate ($KClO_3$), an oxidizing agent--41.9%.

NO FOREIGN DISSEM

- Ammonium chloride (NH_4Cl), a coolant--40.2%.
- Crude anthracene [$(C_6H_4CH)_2$], the smoke agent--17.8%.
- Inert material--0.1%.

(5) Physical and chemical properties. The mixture is a yellow-brown to grayish-green solid which is very soluble in water.

(6) Method of dissemination.

(a) Smoke pots (for example: DM-11, DB-11, BDSh-5), smoke barrel (for example: DSh-100).

(b) The mixture is wet loaded into cans or drums in three layers, and will not burn if packed in one solid mass. When ignited, it burns for 6 1/2 to 10 min depending on the size of container and gives off a grayish to white smoke.

(c) The primer in these munitions consists of 41.5% lead thiocyanate, 49.6% potassium chlorate, and 8.9% inert binder. It is contained in a cardboard tube waterproofed with a red lacquer covering. A booster composed of black powder, potassium chlorate, shellac (rosin), and inert material is pressed into a yellow cylindrical pellet with a red cap.

(7) Use. Screening smoke.

(8) Therapy. Soviets have antismoke ampoules, containing a mixture of ethanol, chloroform, ether, and ammonia water, for relieving the effects of smoke irritation.[16]

(9) Storage. Reasonably stable, if kept dry and not subjected to rough handling.

b. Smoke Oil. The principal mixture is made of 70% inexpensive waste products of the petroleum industry and 30% fuel oil. It is disseminated in a generator to produce a stable black smoke with satisfactory screening properties. The smoke is non-irritating to humans, is not corrosive, and does not have storage, handling, and transport problems associated with liquid smoke agents.[16]

c. Miscellaneous Smoke Mixtures.

(1) Code or alternate designations. See below.

(2) Class. Smoke agent (screening).

(3) Chemical name. (Mixtures).

(4) Composition.

	Yershov		Samkov	Gorbev	English
	Mixture I	Mixture II	Mixture	Mixture	Mixture
Ammonium chloride	50%	40%	---	23%	---
Naphthalene	20	20	41%	---	---
Potassium chlorate	20	20	51	67	---
Potassium nitrate	---	10	---	3	40%
Birch charcoal	10	10	8	7	9
Petroleum coal tar	---	---	---	---	29
Sulfur	---	---	---	---	14
Borax	---	---	---	---	8

(5) Physical and chemical properties. The mixtures are dark solids of a rather primitive composition. The smoke produced has a slight concealing power and tends to settle out quickly with loss of effectiveness. Yershov Mixture No. II burns faster than Mixture No. I.

(6) Method of dissemination. Smoke candles.

(7) Storage. No information available, but it is believed to be reasonably stable during storage.

9. (U) Sulfur Trioxide-Chlorosulfonic Acid Mixture

a. Code or Alternate Designations.

- United States -- FS.
- United Kingdom -- CSAM.
- USSR -- S4.
- Germany -- Nebelsaure.

b. Class. Smoke agent.

c. Composition. 55% sulfur trioxide (SO_3) + 45% chlorosulfonic acid (SO_3HCl) solution.

d. Raw Materials.

- Sulfur dioxide (SO_2).
- Gaseous hydrogen chloride (HCl).
- Oxygen (O_2).
- Sponge platinum (Pt).

e. Method of Manufacture of Chlorosulfonic Acid.

$$2SO_2 + O_2 \xrightarrow[Pt]{400\text{-}450^\circ C} 2SO_3$$

$$SO_3 + HCl \longrightarrow SO_3HCl$$

f. Physical and Chemical Properties.

- Odor: Acrid.
- Physical state: Liquid.
- Specific gravity: 1.91 at 20° C.[8]
- Melting point: -30° C.

- Decomposition temperature: about 68° C.[8]
- Solubility: Soluble in strong sulfuric acid; reacts violently with water.
- Hydrolysis: Chlorosulfonic acid hydrolyzes instantaneously to form HCl and H_2SO_4; SO_3 adds water to form H_2SO_4.[8]

g. Method of Dissemination.[5,8] Cylinders under gas pressure, bombs, airplane spray tanks, artillery and mortar shells.

h. Physiological Effect. The liquid burns the skin like strong acid and the smoke causes a prickling sensation on skin. Prolonged exposure may cause severe irritation to eyes and respiratory tract.

i. Decontamination.[5,8] Wipe off liquid with dry cloth, and flush with large amounts of water. Alkali, in solid form or in solution, or hot soapy water may also be used.

j. Protection Required. None for ordinary smoke, protective mask for high concentrations, and rubber gloves for handling liquid.

k. Storage. Stable in steel containers if dry, using steel stoppers and asbestos gaskets; highly corrosive on metals and airplane fabrics.

l. Persistence. Only while container is operating.

m. Total Obscuring Power. 615 m^2/kg (3000 ft^2/lb).

10. (U) Sulfuric Anhydride

a. Code or Alternate Designations. None.

b. Class. Smoke agent.

c. Chemical Name. Sulfur trioxide.

d. Formula. SO_3

e. Raw Materials.

- Sulfur dioxide (SO_2).

- Oxygen (O_2).
- Sponge platinum (Pt) (catalyst).

f. Method of Manufacture.

$$2SO_2 + O_2 \xrightarrow[Pt]{400\text{-}500^\circ C} 2SO_3.$$

g. Physical and Chemical Properties.

- Physical state and color: Colorless liquid, or transparent solid.
- Odor: Acrid suffocating odor.
- Solubility: Soluble in phosphorus oxychloride ($POCl_3$) and in H_2SO_4.
- Boiling point: 45° C.
- Melting point: 16.8° C. Polymerizes spontaneously into an asbestoid crystalline mass of $(SO_3)_2$, which melts at 40° C into liquid commercial product.
- Specific gravity (liq.): 1.92.
- Specific gravity (solid): 2.3.

h. Method of Dissemination. Artillery shells, airplane spray.

i. Use. On contact with air it fumes vigorously and throws off dense white clouds composed of minute droplets of sulfuric and sulfurous acids.

j. Physiological Effect. Irritant effect on respiratory organs and skin. Causes a hacking cough, which is much aggravated in higher concentrations.

k. Decontamination. Cold water.

l. Protection Required. None necessary.

m. Storage. Stable, if dry.

n. Toxicity. Concentration of 0.010 mg/l causes a hacking cough.

o. Persistence. Winter and summer -- While container is operating.

p. Total Obscuring Power. 615 m^2/kg (3000 ft^2/lb).

11. (U) Sulfuryl Chloride

a. Code or Alternate Designations. None.

b. Class. Smoke agent.

c. Chemical Name. Sulfuryl chloride.

d. Formula. SO_2Cl_2

e. Molecular Weight. 134.98.

f. Raw Materials.

- Chlorosulfonic acid (SO_3HCl).
- Mercury salts (catalyst).

g. Method of Manufacture.

$$2SO_3HCl \xrightarrow[70°C]{Hg\ salts} H_2SO_4 + SO_2Cl_2.$$

h. Physical and Chemical Properties.

- Physical state and color: Colorless liquid with extremely pungent odor, turns yellow on prolonged standing.
- Boiling point: 69.1° C.
- Melting point: -54.1° C.
- Solubility: Miscible with benzene, toluene, ether, and glacial acetic acid; decomposes slowly in cold water but rapidly and vigorously in hot water with the formation of sulfuric and hydrochloric acids.

- Specific gravity: 1.67 at 20° C.
- Vapor density: Vapor is 4.6 times heavier than air.

i. Method of Dissemination. Howitzer and mortar shells.

j. Use. As a smoke agent.

k. Toxicity. None.

l. Physiological Effect. Vapors corrosive to skin and mucous membrane.

m. Decontamination. None necessary.

n. Protection Required. Protective mask if vapor concentration is heavy. Avoid contact with liquid.

o. Storage. Stable, if kept air free and dry; slightly corrosive to iron.

p. Historical. 1926: Prepared by Danneel in Germany and Durrans in United Kingdom.

12. (U) Titanium Tetrachloride

a. Code or Alternate Designations.

- United States -- FM.
- Germany -- F-Stoff.

b. Class. Smoke agent.

c. Chemical Name. Titanium tetrachloride.

d. Formula. $TiCl_4$

e. Molecular Weight. 189.71.

f. Raw Materials.

- Rutile (Titanium dioxide, TiO_2).

- 30% Carbon (C).
- Gaseous chlorine (Cl_2).

g. Method of Manufacture.

$$TiO_2 + 2C \xrightarrow{650°C} TiC + CO_2.$$

$$TiC + 2Cl_2 \xrightarrow{heat} TiCl_4 + C.$$

h. Equipment. Electric furnace.

i. Physical and Chemical Properties.

- Physical state and color: Colorless, highly refractive liquid, with acrid odor.
- Boiling point: 136° C.
- Freezing point: -25° C.
- Solubility: Soluble in ethylene dichloride and dilute HCl.
- Specific gravity: 1.7 at 20° C.[8]
- Hydrolysis: Reacts vigorously with moisture in air with the evolution of dense clouds of acrid white smoke. Hydrolysis products are solid $TiOCl_2$, HCl; some $Ti(OH)_4$ if sufficient water is present. The formation of solid products in airplane smoke tanks causes difficulty during dissemination because of orifice clogging.[8]

j. Methods of Dissemination. Artillery and mortar smoke shells, bombs, special munitions.

k. Physiological Effect. Smoke is irritating to the respiratory tract, and may burn skin due to the HCl resulting from hydrolysis.

l. Decontamination. Any alkali solid or solution.

m. Protection Required. Protective masks needed for heavy concentrations.

n. Storage. Stable, if dry and in steel containers.

o. Total Obscuring Power. 390 m^2/kg (1900 ft^2/lb).

p. Historical. Introduced by the Allies near the end of World War I as a substitute for tin and silicon tetrachlorides.

13. (U) White Phosphorus

a. Code or Alternate Designations.

- United States -- WP (MIL-C-215B, Screening smoke, Standard A). PWP is plasticized white phosphorus (MIL-P-337C, Screening smoke, Standard A).
- USSR -- R-4(?), KS (mixed with sulfur).

b. Class. Smoke agent.

c. Chemical Name. Phosphorus. (White or yellow).

d. Formula. P_4 (gas).

e. Molecular Weight. 123.9.

f. Raw Materials.

- Calcium phosphate [$Ca_3(PO_4)_2$].
- Silicon dioxide (SiO_2).
- Carbon.

g. Method of Manufacture.

$$Ca_3(PO_4)_2 + 3SiO_2 + 5C \longrightarrow 3CaSiO_3 + 5CO + 2P$$

h. Equipment. Electric furnace.

i. Physical and Chemical Properties.

- Physical state and color: White, waxy solid, turns yellow on contact with light.
- Odor: Odor of burning matches.
- Boiling point: 280° C.
- Melting point: 44° C.
- Solubility: Soluble in carbon disulfide, benzene, and ether.
- Density of solid: 1.8 g/cc at 20° C.
- Other properties: Chemically, WP is very active and combines readily with oxygen in air to form phosphorus pentoxide (P_2O_5), and in the presence of water, H_3PO_4.[8] The greater the surface exposed to air, the more rapid the reaction. Upon oxidation, phosphorus becomes luminous and in a few minutes bursts into vigorous flames that can only be quenched by complete submersion in water. Phosphorus is a better smoke producer, pound for pound, than any of the other known smokes. In use, it has some disadvantages: difficulties during storage and in handling, the bright flame that is produced upon burning, the need to dissolve WP in highly flammable and dangerous solvents when used as a spray, the tendency for WP to splinter readily into small particles which burn very rapidly, and its tendency to produce a pillaring effect.

j. Method of Dissemination.[6] Grenades (hand and rifle), artillery shells, mortars, aerial bombs, aerial spray, incendiary projectiles, rockets, incendiary flasks.

k. Use. As a smoke agent phosphorus may be used either dissolved in carbon disulfide (CS_2), or mixed with sublimed sulfur. It is effective as an antitank weapon.[12]

l. Physiological Effect. Solid particles burn flesh; vapor is very poisonous, but it oxidizes so rapidly as to be harmless in field concentrations. The smoke is relatively harmless.

m. Decontamination. None needed. $CuSO_4$ as well as dousing with water to stop burning of particles.

n. Protection Required. None needed against smoke; fireproof suits needed against burning particles.

o. Storage. Stable out of contact with oxygen. Stored under water in concrete tanks or in steel drums; should be stored in isolated areas away from the direct rays of the sun. Its low melting point sometimes causes WP to melt in stored munitions. To overcome its poor storage characteristics, plasticized WP was developed; it is formed by mixing WP in water with a viscous solution of synthetic rubber. The rubbery mass of plasticized WP is dispersed by an exploding munition to produce a smoke less prone to the pillaring effect observed with standard WP.[8]

p. Persistence. Winter and summer -- while container is operating.

q. Total Obscuring Power. 940 m^2/kg (4600 ft^2/lb).

Section XI.

FLAME AND INCENDIARY AGENTS[8,12]

1. (U) General

a. Flame agents are considered antipersonnel agents which cause lethal or incapacitating effects on target personnel by means of direct burn wounds, depletion of oxygen, carbon monoxide poisoning, heat, or a combination of these factors. Flame munitions include flamethrowers and firebombs.

b. Incendiary agents are considered antimateriel agents which generate sufficient heat to cause destructive thermal degradation or destructive combustion of target materiel. Incendiary munitions include bullets, mortars, artillery shells, bombs, and grenades.

c. In some cases, it is difficult to differentiate between flame (antipersonnel) and incendiary (antimateriel) agents because the effects may be a combination of both.

2. (U) ~~(U)~~ Flame/Incendiary Agents

(U) These agents are classified according to their composition: i.e., hydrocarbon fuels with or without thickeners, metal fuels, hydrocarbon-metal fuel combinations, and pyrophoric aluminum alkyls with thickeners. White phosphorus, which is primarily a screening smoke (Standard A) but may also be considered a flame and incendiary agent, is placed under pyrophoric fuels. Thickened fuels generally are used in mechanical and portable flamethrowers as well as in incendiary bombs; unthickened or less thickened fuels may be used in portable flamethrowers where thickened fuel is not available or in jungle operations where maximum range is not required.

a. (U) ~~(U)~~ US Standard and Non-standard Fuels.

(1) (U) Hydrocarbon fuels.

(a) (U) Incendiary oil: Iso (Standard A). Composed of gasoline and thickener M4 aluminum soap; it is field mixed. It is used in flamethrowers and firebombs.

(b) (U) Incendiary oil: NP2 (Standard A). Composed of gasoline and thickener M2 aluminum soap; it is field mixed. It is used in flamethrowers and firebombs.

(c) (U) Incendiary oil: NP (Standard B). Composed of gasoline and thickener M1 aluminum soap; it is field mixed. It is used in flamethrowers and firebombs.

(d) (U) Incendiary oil: 1M (Standard B). Polymer AE (isobutyl methacrylate) is added to a mixture of gasoline and other substances to form various 1M incendiary oil mixtures by plant mixing. An example of such a mixture is Type I incendiary oil containing polymer AE, stearic acid, calcium oxide, gasoline, and water (5:3:2:88.75:1.25).

(e) (U) Napalm B (Non-standard). Composed of gasoline (33%) polystyrene (46%), and benzene (21%). It is used in firebombs. It is unsuitable for cold weather employment.

(f) (U) Westco gel (Non-standard). Composed of hydrocarbon fuels thickened by in situ formation of sodium soap by the reaction of polyunsaturated fatty acids with aqueous NaOH. It is used in firebombs.

(2) ~~(C)~~ (U) Metal fuels.

(a) ~~(C)~~ (U) Magnesium incendiaries.

- (U) Magnesium metal. At its ignition temperature (623° C) it burns vigorously in air to produce temperatures of about 2000° C. Magnesium may be used in pure form, either solid or powdered. In massive form, magnesium is difficult to ignite, but this problem may be overcome by packing a hollow core in the bomb with thermate and an easily ignitable mixture.

- (b)(1)

(b)(1)

(b) (U) Thermite and thermate incendiaries.

- Thermite: TH1 (Standard B). Composed of ferric oxide (73%) and granular aluminum (27%). Used in incendiary bombs, particularly as a component in igniting compositions for magnesium bombs; ignites at approximately 1200° C and burns at approximately 2200° C. The fire may be smothered with dry graphite, sodium bicarbonate, sodium chloride, or dolomite mixtures. With various additives, it is used as a component in igniter compositions for magnesium bombs.

- Thermate: TH3 (Standard A). Composed of thermite (68.7%), barium nitrate (29.0%), sulfur (2.0%), and oil binder (0.3%). Used in incendiary bombs. TH3 was found to be superior to TH1 in incendiary magnesium bombs.

- Thermate: TH4 (Standard A). Composed of iron oxide (51%), barium nitrate (22%), aluminum (22%), and polyester resin (5%). Used in incendiary bombs.

(3) ~~(c)~~ Composite hydrocarbon-metal fuels.

(b)(1)

(b) (U) PT1 incendiary mixture (Standard B). A mixture composed of 49% Type C "goop," 3% petroleum oil extract, 10% coarse magnesium, 30% gasoline, 5% sodium nitrate, with 3% isobutyl methacrylate polymer (AE) as thickener. It is a soft, black, and homogeneous mixture that can be disseminated by the use of incendiary bombs. It is stable and flammable. The "goop" is a paste consisting of magneisum dust, magnesium oxide, carbon, some petroleum distillates, and asphalt.

(c) (U) PTV incendiary mixture (Standard A). An improved oil and metal incendiary. It is composed of 5.9% polybutadiene, 28% magnesium powder, 6% sodium nitrate, 60% gasoline, and 0.1% *p*-aminophenol. It can withstand an HE charge in an incendiary bomb whereas other gels have a tendency to break up after an explosion. The components of the mixture can be combined very simply and is adaptable to continuous mixing and loading.

(4) ~~(c)~~ Pyrophoric fuels.

(b)(1)

(b) (U) White phosphorus. See "Screening Smokes," sec X, para 13. The advantage of this agent as an incendiary material is its ability to ignite spontaneously, but it also has a relatively low combustion temperature (1000° C). Also employed for ignition of thickened hydrocarbon fuels in firebombs as in igniter, WP (Standard A).

b. (C) Experimental Flame/Incendiary Agents

(b)(1)

(2) (U) Flamex agent: Flame - explosion couple system--composed of a thickened hydrocarbon fuel containing solid oxidizer explosive (hydrazine nitrate) and a suspended solid explosive primer, which produces a predetermined burn period followed by an explosion.

(3) (U) Nitrile flame agent: A flame agent system--composed of acrylonitrile gelled with a terpolymer containing carboxylic acid groups reactive with an organic crosslinker compound, and produces an improved conductive heat flux.

(4) (U) Hypergolic fuel - oxidizer combinations: A binary flame agent system--consisting of selected thickened fuels and oxidizing agents capable of hypergolic reaction, and producing a high radiant heat flux. Fuels could be hydrazine or alkyl-borane compounds; oxidizers could be nitrogen tetroxide, tetranitromethane, or fuming nitric acid (RFNA, IRFNA, WFNA).

(5) (U) Composite oxygenated compound agent: An incendiary agent based on nitrocellulose - gelled alkoxyethanol compounds, of improved combustion efficiency compared to hydrocarbons, and containing suspended magnesium and aluminum, capable of producing very high temperatures and capable of damaging metal targets.

(6) (U) Composite metal - hydrocarbon slurry agents: Incendiary agents based on gelled hydrocarbon liquids--containing about 50% of metals such as lithium, boron, magnesium, aluminum, and metal hydrides such as LiH, which are especially effective against wooden targets.

(7) (U) Eutectic white phosphorus: Composed of a solution of P_2S_5 (45%) in white phosphorus (55%). Requires a polymeric thickener to improve dissemination efficiency.

c. (U) Molotov Cocktails.[119] Soviet incendiary flasks are filled with various incendiary mixtures including:

(1) (U) "KS mixture" (White Phosphorus in carbon disulfide). It is a viscous, oily, greenish-yellow liquid with the odor of rotten eggs. It is spontaneously flammable so it is often used without a fuze. However, in order to prevent any delayed ignition, pyrotechnic fuzes or chromyl chloride ampules are often added. Its combustion temperature is 800° to 1000° C, and it gives off white smoke.

(2) (U) Mixture No. 1. It is a mixture of mineral oils, and is dark brown in color. It has to be ignited before throwing. Ignition can be accomplished with matches, powder strips, primers, chromyl chloride ampules, or chlorate mixtures. Combustion temperature is 600° to 700° C.

(3) (U) Mixture No. 3. It is a viscous mixture of petroleum and benzene with an added thickener of ozokerite and diatomaceous earth. Concentrated sulfuric acid is often added; in this case, an ampule containing a potassium perchlorate igniter is used. Combustion temperature is 600° to 700° C.

(4) (U) Mixture No. 4. It consists of phosphorus in an organic solvent, such as gasoline. The gasoline is often thickened with OP-2, an aluminum salt of naphthenic acid. This mixture is self-igniting.

3. (U) Thickeners

(U) Thickeners are added to fuels to increase the range of flamethrowers, to impart slower burning properties, to give clinging qualities, and to cause flames to rebound off walls or other surfaces and to go around corners. They are used in all incendiary oil bombs as well as in flame weapons. More thickener is used in the incendiary oil bombs and mechanical flamethrowers than for portable flamethrowers. Peptizers are sometimes added to thickened fuels to facilitate the dispersal of thickener in the fuel at low temperatures.

a. (U) Standard Thickeners.

(1) (U) M1, Napalm aluminum soap (Standard B). Consisting of a mixed aluminum soap coprecipitated from a mixture of coconut oil, oleic, and naphthenic acids (50:25:25). The percentage of thickener used ranges from 2% for very thin fuels to 12% for the highest consistency likely to be required. Peptizer used is cresylic acid. Used in preparation of flamethrower fuels by Service Unit: M4A2.

(2) (U) M2, Napalm aluminum soap (Standard A for Air Force). Consisting of an intimate mixture of 95% M1 thickener and 5% "devolatilized" silica aerogel or other approved antiagglomerant, such as Attasorb clay. Cresylic acid is used as the peptizer. Used in preparation of Incendiary Oil: NP2 as firebomb fuel by continuous mixing in Mixing and Transfer Unit: AN-M3A1.

(3) (U) M3, Aluminum 2-ethylhexanoate. Obsolete; replaced by M4-aluminum isooctanoate.

(4) (U) M4-Aluminum isooctanoate (Standard A). Composed of 98% aluminum isooctanoate and either 2% Attasorb clay or Santocel C as an antiagglomerant. 2-ethylhexanoic acid is used as the peptizer. It is employed for the preparation of Incendiary: ISO by field mixing in Mixing and Transfer Unit: M5 or Service Unit: M4A2. The M4 thickener has a greater density than the M1 or M2 thickeners. For use of M4 at about 0° C, a peptizer is required. The "gels" formed with this thickener are more stable than those formed with the M1 or M2 thickeners.

(5) (U) Polymer AE.[8,12] 5% Polymer AE (isobutyl methacrylate) is used in the preparation of M1 incendiary oil, Type I, and in PT1 incendiary mixture (Standard B).

(6) (U) Metavon. A Dutch napalm thickener prepared according to US specifications.

(7) (U) Northick. A Norwegian fuel thickener made of aluminum soaps of a mixture of whale oil, lauric acid, and tall oil acids (70:15:15).

(8) (U) Octogel. A French fuel thickener consisting of aluminum di-2-ethylhexanoate (similar to M3 thickener) for flamethrowers. "Nagel" incorporates a clay filler that is claimed to be effective in improving storage life of the thickened fuel.[9]

(9) (U) T-55. A Swedish fuel thickener made of aluminum soaps of tall oil acids with Cellosolve added as a stabilizer.

(10) (U) Opalm. A Swiss thickener containing polyisobutylene.

(11) (U) Octal. A Canadian thickener similar to M3 thickener.

b. ~~(C)~~(U) Experimental Thickeners.

(1) (U) E10: Polybutadiene (GRS-XP268). 94% Polybutadiene containing 3% talc and 3% sorbitan palmitate (Span 40). Polymer is not reproducible in large batch production for this application. Tested for field mixing of portable flamethrower fuels. Unsatisfactory for mechanized flamethrower fuels.

(2) (~~C~~) (b)(1)

(b)(1)

Section XII.

ANTIPLANT AGENTS

1. (U) General

a. Chemical antiplant agents have come into use as chemical warfare agents in recent years. These agents are used to destroy the enemy's food supply and to deny him concealment by foliage or vegetation. Numerous statements and accusations in both the foreign and domestic press were concerned with the effect of these chemical agents on the ecology.

b. The antiplant chemicals currently in use can be classified as herbicides, defoliants, and growth suppressants or inhibitors:

(1) Herbicides. These substances are used to kill plants or interrupt their growth. They are divided into two main groups depending on whether they are selective or nonselective as to the types of plants they attack. Selective herbicides kill only certain plant species, and have little or no effect on others. These are generally organic compounds such as derivatives of phenoxyacetic acid (2,4-D and 2,4,5-T), triazines and urea compounds. The nonselective group kills all plant life without regard to species. These are usually inorganic compounds such as sodium arsenite and sodium chlorate. However, some herbicides may be classed as both selective and nonselective, depending on the concentrations and the amounts used per unit area. The herbicides may also be further divided into three additional subgroups based upon the method of application and their mode of entry into the plant. Contact herbicides such as dessicants kill primarily by contact with the plant tissue rather than by translocation or movement within the plant. If the dosage is insufficient, unexposed parts of the plant may sprout new growth. The systemic or translocated herbicides are capable of penetrating the plant fibers, through both leaves and roots, into the "vascular" system where they are rapidly conveyed throughout the entire plant, to cause a change in the water balance, leaf fall, dying of the stems and branches, and possible death of the plant. Finally, soil herbicides also include those compounds which, when applied directly to the soil, penetrate the root system of the plant and destroy it along with any dormant or sprouted seeds.

(2) Defoliating agents. These chemicals cause trees, shrubs, and other plants to shed their leaves prematurely. Contact and systemic herbicides can have a defoliating action; however, a true defoliant is a growth-regulating chemical that causes leaf-fall without killing or seriously affecting the plant. Several chemicals are available that are effective defoliants for cotton and other agricultural crops, but no satisfactory nonherbicidal defoliant has been found for woody vegetation. Defoliation may be of value militarily to prevent ambush along routes of movement through jungles and forests, and to deny the enemy food and concealment.

(3) Growth suppressants or inhibitors. These substances are growth regulating chemicals which retard or inhibit growth and can be used to maintain vegetation at a desired height or stage of growth.

2. (U) Atrazine

a. Code or Alternate Designations.

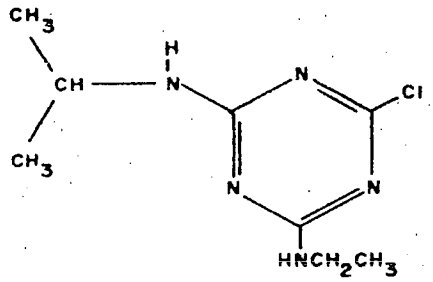
- United States -- Atrazine, F-30027.
- USSR -- Atrazine, ZEAZINE, F-30027.

b. Class. Selective herbicide.

c. Chemical Names.

- 2-Chloro-4-ethylamino-6-isopropylamino-*sym*-triazine
- 2-chloro-4-ethylamino-6-isopropylamino-sym-triazine.

d. Formula. $C_8H_{14}ClN_5$



e. Molecular Weight. 216.06.

f. Method of Preparation. Unknown.

g. Physical and Chemical Properties.

- Physical state and color: White crystalline powder.
- Melting point: 171° to 174° C.
- Solubility: Soluble in ether, chloroform and methanol; slightly soluble in water (70 ppm at 25° C). Wettable; more mobile in soil than simazine and enhances nitrate formation in soil.

h. Use. Selective herbicide for dicotyledonous, monocotyledonous, and grassy plants.

i. Anti-plant Effects. Atrazine enters the plant through both roots and leaves. Material washed off the leaves enters through the roots. The agent affects perennial plants having deep root systems.

j. Physiological Effects. Atrazine causes inhibition of liver and kidney catalase and thyroid dysfunction in animals. These effects have not been observed in man.

k. Therapy. None necessary.

l. Decontamination. None necessary.

m. Protection. None necessary.

n. Storage. No fire hazard; nonpoisonous; does not corrode metals.

o. Persistence. Persists in soil for several years in dry climates.

p. Toxicity. Atrazine is considered nontoxic for man. The oral LD_{50} for rats is 1750 to 3080 mg/kg.

q. Historical.

- 1961: Prepared by (b)(6) in USSR.

- 1962: Hungarian Pat. 149,189, Andriska et al. (Nehezvegyipari Kutato Intezet).
- 1963: French Pat. 1,317,812, Mildner (Radonja Kernijska Industrija).

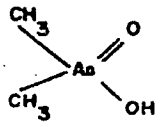
3. (U) BLUE (Cacodylic Acid Mixture)

a. Code or Alternate Designations. Phytar 560G (Ansul Company).

b. Class. Herbicide.

c. Chemical Name and Composition. BLUE is composed of 21% sodium cacodylate plus additional cacodylic acid to make a total dimethylarsinic acid equivalent of not less than 26% on a weight basis. Included in the formulation is 3% to 5% surfactant by volume and 0.5% antifoam agent by volume.[120,121]

d. Formula. $C_2H_7AsO_2$



Neg. 513192 Cacodylic Acid

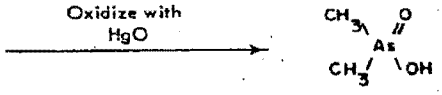
e. Molecular Weight. 137.99.

f. Raw Materials.

- Arsenic trioxide (As_2O_3).
- Potassium acetate ($KC_2H_3O_2$).

g. Method of Manufacture.

Cacodyl oxide



Neg. 513193 Cacodylic Acid

h. Physical and Chemical Properties.[120,121]

- Physical state and color: Cacodylic acid (technical) is a colorless, crystalline solid. BLUE (Phytar 560G) is a free-flowing reddish or brownish liquid.
- Melting point: Cacodylic acid, 200° C.
- Freezing point: BLUE, below -30° C.
- Solubility: Cacodylic acid and BLUE are soluble in water and alcohol, insoluble in diesel fuel and oils.
- Specific gravity: BLUE, 1.31 at 25° C.
- Vapor pressure: BLUE, very low.
- Volatility: BLUE, nonvolatile.
- Viscosity: BLUE, centipoises at

10° C (50° F)----------19.9
23.9° C (75° F)----------11.0
35° C (95° F)---------- 9.0.

i. Method of Dissemination. Helicopter and airplane spray systems, backpack sprayers for small ground operations.

j. Use. Contact herbicide and anticrop agent.

k. Anti-plant Effects. BLUE is a dessicant or contact herbicide and causes rapid browning of foliage. Foliage of broad-leaved plants affected by BLUE may shrivel and remain on the plant. Grasses may show rapid browning and death of top growth with regrowth of resistant perennial species in 1 to 2 months. BLUE has a short term effect on woody vegetation with the maximum effect occurring 2 to 6 weeks after treatment. BLUE is the agent of choice for destruction of cereal or grain crops.[120,121]

l. Physiological Effects. The arsenic in cacodylic acid is in the relatively innocuous pentavalent state rather than in the toxic trivalent form. The toxicity of BLUE to man is considered to be very low, being even less toxic than aspirin.

m. Therapy. BAL for acute and chronic arsenic poisoning.

n. Decontamination. Storage and loading areas can be decontaminated by repeated washings with ammonia water and clear water.

o. Protection Required. Mask to prevent inhalation.

p. Storage. BLUE should be stored in airtight containers. Corrosion tests show that zinc is the least resistant metal while steel undergoes moderate corrosion. Brass, copper, aluminum, or tin corrode only to a slight extent. BLUE has no significant effect on paint, natural or butyl rubber, neoprene, or polyethylene.[117] Light has no effect on BLUE.

q. Persistence. BLUE is nonpersistent. When applied directly to the soil, the chemical is rapidly absorbed and deactivated by soil colloids. New crops can be planted during the same growing season.[121]

r. Toxicity. BLUE may be considered nontoxic to animals and fish. The acute oral toxicity (LD_{50}) of cacodylic acid in rats ranges between 1280 to 1400 mg/kg, and for BLUE, the LD_{50} is 2600 mg/kg. Cattle fed 24.5 mg/kg of cacodylic acid daily in a 60-day feeding test showed no arsenic in the milk or accumulation in the body. Fish were able to withstand 100 ppm for 72 hr.

4. (U) Butyphos

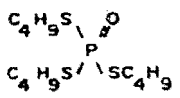
a. Code or Alternate Designations.

- United States -- DEF, Degreen, Fos-Fall "A", E-Z-OFF D.
- USSR -- Butifos.

b. Class. Defoliant.

c. Chemical Name. S,S,S-Tributyl trithiophosphate.

d. Formula. $C_{12}H_{27}OPS_3$

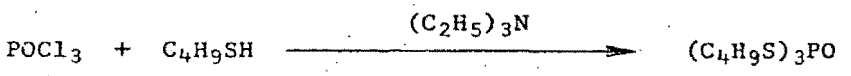


e. Molecular Weight. 314.51.

f. Raw Materials.

- Phosphorus oxychloride ($POCl_3$).
- Butyl mercaptan (C_4H_9SH).
- Triethylamine [$(C_2H_5)_3N$].

g. Method of Manufacture.



Phosphorus oxychloride		Butyl mercaptan	Triethylamine	Butyphos

Used as 70% concentrate in emulsion form or 70% oily solution in diesel fuel. Emulsion can be mixed with water in any proportion.

h. Physical and Chemical Properties.[108]

- Physical state and color: Colorless to pale yellow liquid.
- Melting point: Less than -25° C.
- Boiling point: 154° C at 0.5 mm Hg.
- Specific gravity: 1.057 at 20° C.
- Solubility: Soluble in ethanol, chloroform, benzene, and other organic solvents; insoluble in water.

i. Use. Excellent cotton plant defoliant. Highly effective in small doses. Ineffective against fine-fibered plants.

j. Physiological Effects. Since it is a cholinesterase inhibitor, its symptoms to animals are similar to those of nerve agents.

k. Therapy. Atropine.

l. Decontamination. Alkaline solutions.

m. Protection. Protective mask in areas of high concentration.

n. Storage. Store separately from food products.

o. Toxicity. Butyphos is mildly toxic with cumulative action. LD_{50} is 325 mg/kg, for white rats, orally.

p. Historical. 1957: Prepared by Melnikov in USSR.

5. (U) Calcium Cyanamide

a. Code or Alternate Designations.

- United States -- Cyanamide, Aero, "Lime-nitrogen."
- USSR -- "Free cyanamide."

b. Class. Defoliant.

c. Chemical Names.

- Calcium cyanamide.
- Calcium carbimide.

d. Formula. $CaCN_2$

$N \equiv CN{-}Ca$

e. Molecular Weight. 80.11.

f. Method of Preparation. Passing nitrogen (N_2) over calcium carbide (CaC_2) in an electric furnace at 1200° C.

g. Physical and Chemical Properties.

- Physical state and color: Pure form consists of glistening hexagonal crystals; commercial grade consists of gray-black lumps of powder that may contain as much as a 40% mixture of $Ca(OH)_2$, $CaCO_3$ and carbon.
- Melting point: 1200° C.
- Sublimation temperature: 1150° to 1200° C.
- Solubility: No known solvent will bring about solution without decomposition.
- Specific gravity: 2.3.
- Hydrolysis: Decomposes in water to liberate ammonia.

h. Use. Cotton defoliation in humid climates. Fertilizer.

i. Physiological Effects. Free cyanamide is very irritating and caustic and can produce severe cellulitis and abscesses on moist skin. Ingestion or inhalation will cause transitory intense redness of face, headache, vertigo, increased respiration, tachycardia, hypotension, and possible deep ulcers of the mucous membrane. Excessive amounts may cause profound shock.

j. Therapy. Treatment of the symptoms.

k. Decontamination. None necessary.

l. Protection. Masks are required for high concentrations and the skin should also be protected.

m. Storage. Store in airtight containers, away from moisture.

n. Toxicity. LD_{50}, orally, is 1 g/kg for white rats. LD_{100}, orally, for humans is 40-50 g/man.

o. Historical.

- 1931: Preparation, Franck, Heimann.
- 1951: Preparation, Kastens, McBurney.
- 1961: Owen, Dedman.

6. (U) 2,4-D and Esters and Salts

a. Code or Alternate Designations.

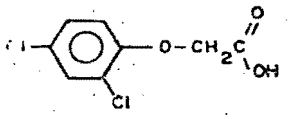
- 2,4-D-Hedonal.
- Sodium Salt -- 2,4-DU, Dikonirt, Dikoteks 30, Dikoteks 80.
- Amine Salt -- 2,4-DA, Agent WHITE.
- Butyl Ester -- Preparation 359, Agent ORANGE, Agent PURPLE.
- Octyl Ester -- Preparation 50, Krotilin, Crotylin.

b. Class. Selective herbicide.

c. Chemical Names.

- 2,4-Dichlorophenoxyacetic acid.
- Sodium salt of 2,4-D.
- Other forms in which 2,4-D is used are the dimethylamine, isopropylamine, triethylamine, diethanolamine, and triethanolamine salts, the butyl ester and the gamma chlorocrotyl ester.

d. Formula of (2,4-D). $C_8H_6Cl_2O_3$

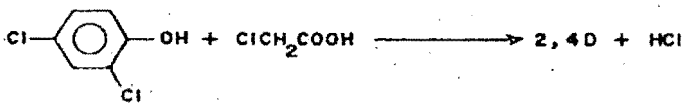


Neg. 513195 2,4-D

e. Molecular Weight. 221.04.

f. Method of Preparation.

(1) 2,4-D.



(2) Esters and salts. Butyl and octyl esters are prepared by esterification of 2,4-D with butyl or octyl alcohol in the presence of sulfuric acid or benzenesulfonic acid. For preparing the octyl ester, hexamethylenetetramine or pyridine can be used as a catalyst. The sodium salt is formed by treating 2,4-D with sodium hydroxide. The amine salts are prepared by treating the acid with the appropriate amine.

g. Physical, Chemical Properties and Antiplant Effects.

(1) 2,4-D.

- Physical state and color: White crystalline powder.
- Melting point: 130° C.
- Boiling point: 168° C at 0.4 mm Hg.
- Solubility: Soluble in organic solvents; insoluble in water.

- Antiplant effects: 2,4-D interferes with the exchange of phosphorus-containing compounds in broad-leafed plants. 2,4-Dichlorophenol, a metabolic product formed in the plant tissue, is 20 times more toxic than the original 2,4-D. 2,4-D retains its toxicity in treated fields for 4 to 6 weeks and is eventually broken down by microorganisms in the soil.

(2) Sodium salt of 2,4-D.

- Physical state and color: Pure state -- white needles; industrial product -- pinkish or grayish crystalline substance.
- Odor: Odor of phenol.
- Solubility: Slightly soluble in water at 20° C (approximately 3.5%).
- Volatility: Low volatility.
- Decomposition temperature: 215° C.
- Antiplant effects: The sodium salt of 2,4-D is effective on dicotyledonous plants. Wetting agents must be added.

(3) Amine salts of 2,4-D.

- Physical state and color: Industrial product is a brown liquid with 40% to 50% active ingredient. The amine salt is more soluble than the sodium salt. The addition of a wetting agent is desirable. A small amount of sequestering agent, such as ethylenediaminetetracetic acid, is generally added to prevent complex formation in hard water.
- Antiplant effects: The amine salts of 2,4-D are effective on dicotyledonous plants. The amine salts penetrate through the leaves within 2 hr after application.

(4) Butyl ester of 2,4-D.

- Physical state and color: Oily, dark brown liquid with 50% to 60% butyl ester plus solvents.
- Solubility: Insoluble in water, but forms stable emulsions.
- Volatility: Highly volatile; may injure other crops.
- Antiplant effects: The butyl ester of 2,4-D is effective against dicotyledonous plants. The ester penetrates plant leaves rapidly and is not affected by rainfall 30 min after application. The granulated form is not retained by dry leaves or grasses.

(5) Octyl ester of 2,4-D.

	Pure Compound	Industrial Product
• Physical state and color:	Colorless crystals	Dark brown liquid
• Odor:		Unpleasant
• Melting point:	33° to 34° C	
• Boiling point:	185° to 188° C	
• Solubility:	Soluble in ether, acetone benzene, alcohol, chloroform; insoluble in water	Soluble in ether and acetone, slightly soluble in alcohol; insoluble in water.
• Specific gravity:		1.397 (liq)
• Vapor pressure:		2 mm at 20° C

h. Methods of Dissemination, (2,4-D). Portable decontamination apparatus; M106 riot control disperser, power-driven decontaminating apparatus, and aerial spray tanks.

i. Use. Selective herbicide. The octyl ester of 2,4-D is sprayed on leaves to kill or defoliate dicotyledonous plants.

j. Physiological Effects.[12]

(1) Derivatives of 2,4-D in concentrations ordinarily used in crop spraying do not accumulate in the bodies of warm blooded animals, but break down and are eliminated within a day. It is nontoxic to man or animals.

(2) The sodium salt leaves a salty taste in the victim's mouth. The butyl ester and amine salt affect the blood and circulatory systems--the number of red blood cells is sharply reduced, the number of white cells are increased, and arterial blood pressures are modified. Humans have been affected for as long as 14 days.

k. Antiplant Effects.[8] Plant responses appear within 1 hr on actively growing sensitive plants. Leaf and stem curvatures are the first discernible effects. Plant injury will usually be evident within 24 hr. It produces injury to all broadleaf plant species such as cotton, beans, soybeans, and sugar beets. Several weeks after treatment, seriously affected plants may develop spongy, enlarged roots. The outer portion of the root may slough off and leave wet, stringy cores that will later dry up or rot. The esters are more effective than the salts in penetrating the leaf cuticle and in killing resistant species.

l. Therapy. A weak bicarbonate of soda solution will relieve irritation of skin, eyes, nose, and throat. In case the herbicides are ingested, the victim should drink copious quantities of water.

m. Decontamination. Loading and storage areas can be decontaminated by repeated washings with diesel fuel and the run-off diverted to settling basins or pits for incorporation into the soil where microbial or photo-decomposition will occur.

n. Protection. The danger to humans working with herbicides is increased by high air temperature and dry weather. It is recommended that work with these chemicals be confined to early morning hours when temperatures are low and humidity is higher. It is also recommended that workers wear protective respirators, goggles and coveralls, and should shower immediately after work.

o. Storage.[3] A small amount of sequestering agent is usually added (for example, ethylenediaminetetraacetic acid) to prevent complex formation in hard water.

p. Toxicity. The oral toxicities of the various 2,4-D derivatives for rats are as follows:

Compound	LD_{50} (mg/kg)
2,4-D	560
Sodium salt	710
Amine salt	1150
Butyl ester	950
Octyl ester	2100

These compounds have teratogenic effects.[12]

q. Detection. Paper chromatography, gas chromatography.

r. Historical.

- 1941: Preparation, Pokorny.
- 1945: British pat. 573,476, Foster.
- 1949: US pat. 2,471,575, Nanske (US Rubber Co.).

7. (U) Endothal

a. Code or Alternate Designations.

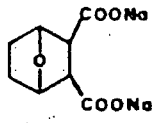
- United States -- Endothal, Aquathiol, Hydrothiol.
- USSR -- Endotal.

b. Class. Defoliant.

c. Chemical Names.

- Disodium salt of 3, 6-endoxohexahydrophthalic acid.
- Disodium salt of 7-oxabicyclo [2.2.1] heptane-2,3-dicarboxylic acid.

d. Formula. $C_8H_8Na_2O_5$



Neg. 513197

e. Molecular Weight. 230.13.

f. Method of Preparation. Diels-Alder addition of maleic anhydride to furan, catalytic hydrogenation of adduct, using furan as a solvent.

g. Physical and Chemical Properties.

- Physical state and color: White crystalline powder.
- Melting point: 116° C.
- Solubility: Very soluble in water.

h. Use. Pre-emergence herbicide, defoliant and dessicant.

i. Physiological Effects. Endothal may be irritating to skin, eyes and mucous membrane. Ingestion may cause vomiting and diarrhea.

j. Therapy. Treatment of symptoms.

k. Decontamination. None necessary.

l. Protection. None necessary.

m. Storage. Store separately, away from food products.

n. Toxicity. LD_{50} orally in rats 35 mg/kg.

o. Historical. 1951: US pat. 2,550,494, Olm (Sharples Chemicals, Inc.).

8. (U) Magnesium Chlorate

a. Alternate Code or Designations.

- United States -- De-Fol-Ate, E-Z-Off, Magron, Ortho MC.
- USSR — "Etalon."

b. Class. Defoliant.

c. Chemical Name. Magnesium chlorate.

d. Formula. $Mg(ClO_3)_2 \cdot 6H_2O$

e. Molecular Weight. 299.33.

f. Method of Manufacture. Chlorine reacts with magnesium hydroxide in the presence of heat to form magnesium chlorate.

g. Physical and Chemical Properties.

- Physical state and color: White crystals or powder; has a bitter taste.
- Melting point: 35° C.
- Solubility: Soluble in water; slightly soluble in alcohol. Very deliquescent.
- Specific gravity (solid): 1.8 at 25° C.
- Decomposition temperature: 120° C.

h. Use. For defoliation. Used in aqueous solution. Magnesium chlorate acts through the green portions of plants and is effective on all vegetation.

i. Physiological Effects. Magnesium chlorate is readily absorbed from the alimentary tract. Ingestion of large amounts of magnesium chlorate produces methemoglobin in blood, destroys red blood cells, causes gastric irritation, nausea, vomiting, and irritation of the kidneys. The compound is also reported to damage heart muscles.

j. Therapy. Emetics, gastric lavage and saline catharsis are required to remove material from stomach. Oxygen should be administered and a blood transfusion performed to counter methemoglobinemia.

k. Decontamination. None necessary.

l. Protection. None required.

m. Storage. The compound is a fire hazard and should be stored in closed containers in a cool, well-ventilated area, away from easily oxidizable materials. The compound may also form explosive mixtures when mixed with combustible materials, such as paper, wood, saltpeter, and ammonium phosphate.

n. Toxicity. LD_{50} in rats is 5250 mg/kg, orally. A dose of 5000 mg in man is generally fatal, although higher doses sometimes are nonfatal.

9. (U) Monuron

a. Code or Alternate Designations.

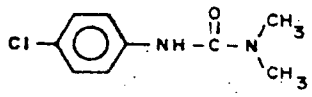
- United States -- Monuron, Telvar.
- USSR -- Monuron, Karmex W, Telar-W, KhMM, Telvar.

b. Class. Selective herbicide.

c. Chemical Names.

- 3-(*p*-Chlorophenyl)-1,1-dimethyl urea.
- N-(4-Chlorophenyl) N,N-dimethyl urea.

d. Formula. $C_9H_{11}ClN_2O$



e. Molecular Weight. 198.65.

f. Method of Preparation. Reaction of *p*-chlorophenyl isocyanate with dimethyl amine.

g. Physical and Chemical Properties.

- Physical state and color: Thin rectangular prisms. Commercial product (80% active ingredients) is a grayish-white powder.
- Melting point: 170.5° to 171.5° C; commercial product, 176° to 177° C.
- Solubility: Very slightly soluble in water and in No. 3 diesel oil; soluble in methanol, ethanol and acetone; insoluble in hydrocarbon solvents.
- Hydrolysis: Hydrolyzes at high temperatures, and in acid or alkaline conditions.

h. Use. General weed control in non-crop areas. Used as water suspension for spraying directly on soil.

i. Physiological Effects. Anemia and methemoglobinemia have been produced in experimental animals.

j. Therapy. None necessary.

k. Decontamination. None required.

l. Protection. None required.

m. Storage. Monuron is stable to oxygen and moisture under ordinary conditions at neutral pH, is not flammable, and does not corrode metals.

n. Toxicity. Monuron is considered to be nontoxic. The oral LD_{50} for white rats is 3600 mg/kg.

o. Persistence. May be retained in the soil 2 to 3 years.

10. (U) ORANGE I

a. Code or Alternate Designations. None.

b. Class. Herbicide and defoliant.

c. Chemical Name and Composition. ORANGE consists of equal parts by volume of n-butyl esters of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T).

d. Physical and Chemical Properties.[120,121]

- Physical state and color: Clear reddish brown to straw-colored liquid at room temperature.
- Melting point: 7° to 8° C.
- Solubility: Soluble in diesel fuel and organic solvents; insoluble in water.
- Specific gravity: 1.28 to 1.30 at 25° C.
- Vapor pressure: less than 1 mm Hq at 35° C.
- Flash point: 146° C.
- Viscosity, centipoise, at:[60]

-17.8° C (0° F)	5,000
-6.7° C (20° F)	940
0.0° C (32° F)	390
10.0° C (50° F)	134
23.9° C (75° F)	43
37.8° C (100° F)	24

e. Method of Dissemination. Backpack sprayers for small ground operations. Helicopter and airplane spray systems - for example, the US Army 80-gal spray tank, the counterinsurgency Air Force A/B23Y-1 dispenser, and the internal herbicide Air Force A/A45Y-1 dispenser.[8]

f. Use. ORANGE is a defoliant for broad-leaved or dicotyledonous plants and is also used as an anticrop agent.

g. Antiplant Effects. ORANGE, consisting of two systemic herbicides, is effective on a wide range of plant species, principally of the broad-leaved or dicotyledonous groups. 2,4-D is effective on broad-leaved herbaceous plants, and 2,4,5-T is effective on a broad array of woody plants. Herbicidal response is caused by disruption of the respiration, metabolic, and cell division processes in plants. Mixed woody vegetation shows a browning and discoloration of the foliage within 1 to 2 weeks after the application of ORANGE. Leaf drop will occur over a period of 1 to 2 months; maximum leaf drop may occur 2 to 3 months after application. Under tropical conditions, application of the agent at a rate of 3 gal/acre is needed for defoliation, particularly in multiple canopy forests. Grasses and bamboos may exhibit browning and partial topfall, but these plants recover rapidly. Under temperate conditions, application rates of 1 to 1.5 gal/acre appear to be adequate for effective defoliation.[120]

h. Therapy. None necessary.

i. Decontamination. Loading and storage areas can be decontaminated by repeated washings with diesel fuel and the run-off diverted to settling basins or pits for incorporation into the soil where microbial or photodecomposition will occur.[121]

j. Protection Required. None necessary.

k. Storage.[12,119] ORANGE is noncorrosive on most metals but is deleterious to some paints, rubber and neoprene. Teflon, polyethylene and Viton are resistant to deterioration by ORANGE.

l. Persistence. The components of ORANGE undergo photodecomposition and microbial decomposition in the soil and will generally disappear in 1 to 2 months.[120]

m. Toxicity. ORANGE is low in toxicity to man, fish, and wildlife. The LD_{50} for acute oral toxicity of ORANGE for rats is 550 mg/kg. The toxicity of 2,4-D and 2,4,5-T for fish varies widely with the

species. Only under conditions of direct application of ORANGE to shallow bodies of water at a rate of 3 gal/acre would it kill the most sensitive species of fish.

11. (U) ORANGE II

a. Code or Alternate Designations. None.

b. Class. Herbicide and defoliant.

c. Chemical Name and Composition. A mixture containing equal parts by volume of n-butyl ester of 2,4-D and isooctyl ester of 2,4,5-T.

d. Physical and Chemical Properties.

- Physical state and color: Reddish brown to straw-colored liquid at room temperature.
- Melting point: 9° C.
- Solubility: Soluble in diesel fuel and organic solvents; insoluble in water.
- Specific gravity: 1.22 to 1.24.
- Vapor pressure: Less than ORANGE.
- Flash point: Not known.
- Viscosity, centipoises, at:[121]

  23.9° C (75° F)---------- 67

  37.8° C (100° F)---------- 27

e. Methods of Dissemination. Same as ORANGE I.

f. Use. Same as ORANGE I.

g. Antiplant Effects. Same as ORANGE I.

h. Therapy. None necessary.

i. Decontamination. Same as ORANGE I.

j. Protection Required. None necessary.

k. Storage. Same as ORANGE I.

l. Persistence. Same as ORANGE I.

m. Toxicity. Same as ORANGE I.

n. Effectiveness. Same as ORANGE I.

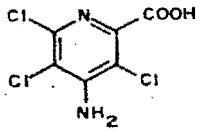
12. (U) Picloram

a. Code or Alternate Designations. United States -- Agent White, M-2993, Tordon.

b. Class. Antiplant agent -- selective herbicide.

c. Chemical Name. 4-Amino-3,5,6-trichloropicolinic acid. See also agent WHITE.

d. Formula. $C_6H_3Cl_3N_2O_2$



Neg. 513199

e. Molecular Weight. 241.48.

f. Method of Preparation. Unknown.

g. Physical and Chemical Properties.

- Physical state and color: Colorless crystalline powder.
- Melting point: 218° to 219° C, with decomposition.

h. Use. Very effective defoliant and herbicide on broadleaf species of trees such as birch, beech, red maple. Other broadleaf trees are resistant to it. Good herbicide for conifers (fir, spruce, hemlock), if applied in high enough concentration (3.4 kg/hectare or 3 lb/acre of active ingredient). See also agent WHITE.

i. Physiological Action. No evidence that its use will create toxicity problems for man or animals.

j. Therapy. None necessary.

k. Decontamination. None necessary.

l. Protection. None necessary.

m. Toxicity. Orally, LD_{50} is 3080 mg/kg for rats, 2000 mg/kg for sheep, and 3163 mg/kg for cattle.

13. (U) Simazine

a. Code or Alternate Designations.

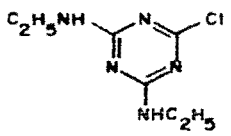
- United States -- Simazine.
- USSR -- Simazine, Sym-triazine, CET, G-27692.

b. Class. Selective herbicide.

c. Chemical Names.

- 2,4-Bis(ethylamino)-6-chloro-*sym*-triazine.
- 2-Chloro-4,6-bis(ethylamino)-1,3,5-triazine.

d. Formula. $C_7H_{12}ClN_5$



e. Molecular Weight. 201.67.

f. Method of Preparation. Reaction of ethylamine with cyanuric chloride.

g. Physical and Chemical Properties.

- Physical state and color: White crystalline powder.
- Melting point: 226° to 227° C.
- Solubility: Slightly soluble in dioxane, ethyl cellosolve; insoluble in water and in most organic solvents.
- Volatility: Slightly volatile.

h. Use. Selective herbicide for monocotyledonous and dicotyledonous plants.

i. Antiplant Effects. Simazine acts as a selective herbicide on monocotyledonous and dicotyledonous plants and is effective on new shoots. The compound enters the plant through the root system and thus, should be sprayed directly on the soil. Simazine is favorable for the development of microorganisms in the soil, especially nitrogen fixing bacteria. The compound also stimulates the action of cellulose-decomposing microorganisms in wet soil.

j. Physiological Effects. No danger to man.

k. Therapy. None required.

l. Decontamination. None required.

m. Protection. None required.

n. Storage. Simazine is stable to action of weak bases and acids. It is also resistant to the action of air and water but should be stored in a cool place. There is no fire hazard or corrosion of metals or rubber by simazine.

o. Toxicity. LD_{50} is 5000 mg/kg for mice, orally.

p. Persistence. Simazine moves slowly through the soil and has a low rate of decomposition. Residual action may last from several months to 8 years.

q. Historical. 1885: Prepared by Hoffman in Germany.

14. (U) Sodium Arsenite

a. Code or Alternate Designations. United States -- Killall, Penite, Chem-Sen.

b. Class. Nonselective herbicide.

c. Chemical Names.

- Sodium arsenite.
- Sodium metaarsenite.

d. Formula. $NaAsO_2$.

e. Molecular Weight. 129.90.

f. Method of Manufacture.

$$As_2O_3 + H_2O + 2NaOH \longrightarrow 2NaAsO_2 + 2H_2O$$

Arsenic trioxide — Sodium arsenite

g. Physical and Chemical Properties.

- Physical state and color: White or grayish white powder. Commercial product is 95% to 98% pure.
- Solubility: Soluble in cold water; slightly soluble in alcohol. It is hygroscopic.

h. Use. Sodium arsenite is used as a nonselective herbicide, insecticide, and aquatic herbicide.

i. Antiplant Effects. The compound kills plant leaves outright, blackening them in a day or two. Small amounts have no perceptible effect for some weeks; then the leaves turn yellow and fall off.

j. Physiological Effects. The arsenic in sodium arsenite is in the toxic trivalent form rather than in the innocuous pentavalent state. Sodium arsenite is a general protoplasmic poison absorbed by the respiratory and gastro-intestinal tract. The compound binds organic sulfhydryl groups found in various enzymes. As a result, sulfhydryl enzyme systems essential to cellular metabolism are inhibited. Acute poisoning, resulting from ingestion of large quantities of arsenic, causes nausea, vomiting, and diarrhea. Chronic poisoning causes loss of appetite, cramps, nausea, constipation, diarrhea, and itching and pigmentation of skin.

k. Therapy. Symptomatic for arsenic poisoning.

l. Decontamination. Intensive use may poison the soil sufficiently to interfere with growth of crops. Applying cryolite to the soil will correct this.

m. Protection. Protective mask.

n. Storage. Store in airtight, moisture-free containers, away from food items.

o. Toxicity. LD_{50} is 10 to 50 mg/kg for white rats, orally. MLD is 10 mg/kg for rats, intraperitoneally.

15. (U) Sodium Chlorate

a. Code or Alternate Designations.

- Altacide.
- Chlorax.
- Drop-Leaf.
- Fall.
- MBC.
- Monoborochlorate.
- Polybor Chlorate.
- Shed-a-Leaf "L."
- Tumbleaf.

b. Class. Nonselective herbicide.

c. Chemical Name. Sodium chlorate.

d. Formula. $NaClO_3$

e. Molecular Weight. 106.45.

f. Method of Preparation. Electrolysis of sodium chloride (NaCl) solution.

g. Physical and Chemical Properties.

- Physical state and color: White crystalline powder or granules.
- Melting point: 248° C. Liberates oxygen at 300° C.
- Specific gravity: 2.5 at 25° C.
- Solubility: Soluble in water, alcohol and glycerine. Very hygroscopic. Addition of sodium chloride diminishes solubility in water.

h. Use. Nonselective, systemic herbicide. It is used in aqueous solutions, or mixed with other herbicides such as simazine for weed control in non-crop area, defoliation of cotton, and for soil sterilization. Sodium chlorate is also used as an oxidizer in explosive and dye industry.

i. Physiological Effects. Considered nontoxic.

j. Therapy. None required.

k. Decontamination. None required.

l. Protection. Fire hazard only.

m. Storage. Must be stored in hermetically sealed containers. Fire hazard in dry weather and must be stored away from combustible materials. Aqueous solutions corrode zinc and soft steel.

n. Toxicity. LD_{50} orally is 12,000 mg/kg for rats.

16. (U) 2,4,5-T

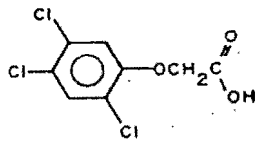
a. Code or Alternate Designations.

- United States -- 2,4,5-T, Agent PINK, Weedone, Inverton-245, TCP, Agents PURPLE and ORANGE.
- USSR -- 2,4,5-T, TKhF.

b. Class. Selective herbicide.

c. Chemical Names. 2,4,5-Trichlorophenoxyacetic acid.

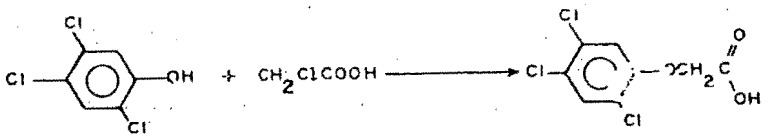
d. Formula.. $C_8H_5Cl_3O_3$



Neg. 513201

e. Molecular Weight. 255.49.

f. Method of Manufacture.



2,4,5-Trichlorophenol 2,4,5-T

g. Physical, Chemical and Biological Properties.

- Physical state and color: White solid or light tan crystals.
- Melting point: 153° to 155° C.
- Solubility: Soluble in alcohol; slightly soluble in benzene; insoluble in water.

h. Use. 2,4,5-T kills woody plants which are resistant to 2,4-D and is also effective for brush and scrub pine control. It burns leaves faster than 2,4-D because of its greater causticity. The compound is also used in the butyl and isobutyl ester forms and is adaptable to year-round spraying.

i. Methods of Dissemination.[8] Portable decontaminating apparatus, M106 riot control disperser, power-driven decontaminating apparatus, and aerial spray tanks.

j. Physiological Effects. It has teratogenic effects.[12]

k. Antiplant Effects. Generally similar to those for 2,4-D. However, it is more effective than 2,4-D on certain woody plants.[8]

l. Therapy. None required.

m. Decontamination. None required. Soil microorganisms that inactivate 2,4,5-T increase when the herbicide is present in the soil.

n. Protection. None required.

o. Storage. No specific precautions.

p. Toxicity.

- 2,4,5-T: LD_{50} is 500 mg/kg for rats, orally.
- Butyl ester: LD_{100} is 1200 mg/kg for mice, orally.
- Isobutyl ester: LD_{100} is 600 mg/kg for mice, orally.

q. Detection. Paper chromatography.

r. Historical. In use in United States since 1945.

17. (U) WHITE[60,61]

a. Code or Alternate Designations. Tordon 101.

b. Class. Defoliant and herbicide.

c. Chemical Name and Composition. Agent WHITE is composed of:

- Picloram (4-amino-3,5,6-trichloropicolinic acid), triisopropanolamine salt ---------- 10.2%

- 2,4-D, triisopanolamine salt ---------- 39.6%
- Water, wetting agent, and inert material ---- 50.2%

d. Physical and Chemical Properties.[60,61]

- Physical state and color: Dark brown viscous liquid.
- Solubility: Miscible in water; soluble in acetone and alcohol; insoluble in diesel fuel and other oils.
- Specific gravity: 1.15.
- Vapor pressure: 6.16×10^{-7} mm Hg at 35° C.
- Volatility: Considered nonvolatile.
- Flash point: 35° C.
- Viscosity, centipoise, at

  10° C (50° F) ---------- 362

  23.9° C (75° F) ---------- 125 to 135

  37.8° C (100° F) ---------- 95

e. Method of Dissemination. Same as ORANGE.

f. Use. WHITE is used as a defoliant for woody and certain broad-leaved plants and is partially more selective than ORANGE.

g. Antiplant Effects. WHITE is partially selective in its defoliant and herbicidal action, acting principally on woody and certain herbaceous plants. WHITE is relatively ineffective on grasses, bamboos and other monocotyledonous plants. Both picloram and 2,4-D are readily absorbed by the foliage.

h. Therapy. None necessary.

i. Decontamination. Loading and storage areas may be partially decontaminated by repeated washings with ammonia water and flushing with clear water. Runoff water from the washing should be diverted to settling basins or restricted areas not subject to overflow on cropland.

j. Protection Required. None necessary.

k. Storage.[12] WHITE is stable, moderately resistant to ultraviolet light, and noncorrosive.

l. Persistence. The picloram component of WHITE is more persistent in soils than ORANGE or BLUE. Losses of WHITE from soil occur principally by leaching and some photodecomposition. Decomposition by microorganisms, sunlight, and ultraviolet radiation is limited. WHITE may persist in soil for a year or more, and for this reason it is not recommended for use as an anti-crop agent.

m. Toxicity. WHITE is considered nontoxic and not hazardous to humans, animals, and fish. WHITE has an acute oral LD_{50} for rats of about 3.1 g/kg, 2 g/kg for sheep, and 3.2 g/kg for cattle. The median tolerance limits of fish ranged from 64 to 240 ppm. Toxicological studies also indicate that a single direct exposure to the spray at the prescribed rates would not constitute a hazard to the skin or a systemic hazard by inhalation.

SECTION XIII

PROPHYLAXIS AND THERAPY (U)

A. INTRODUCTION (U)

1. General (U)

(U) As new chemical warfare agents are developed, prophylactic and therapeutic drugs are also sought to counteract the toxic effects of the agents. Some success in this regard has been achieved in counteracting the poisonous effects of hydrogen cyanide (HCN), Lewisite, LSD, and most of the nerve agents. The effects of poisoning by other CW agents are usually treated symptomatically.[175-179]

2. Mechanisms of Action (U)

a. (U) Hydrogen Cyanide (U). The use of nitrites as antidotes for HCN is based on the fact that the nitrites convert hemoglobin in the red blood cell to methemoglobin, which in turn readily reacts with cyanide ion to form the innocuous cyanomethemoglobin. In this fashion the cyanide ion is prevented from destroying the cytochrome oxidase system and causing death. Actual detoxication can then be achieved by the administration of thiosulfate, which, under the influence of sulfurtransferase, reacts with cyanide to form thiocyanate (SCN^-), a relatively nontoxic substance readily excreted in the urine.

b. (U) Lewisite (U). The Lewisite antidotes, BAL and Unithiol, are effective in protecting sulfhydryl-dependent enzyme systems from arsenical poisons (such as Lewisite) and in reactivating enzyme systems already inhibited by such poisons.

c. Nerve Agents (U).

(1) (U) In the treatment of nerve agent poisoning, atropine is used generally in conjunction with oximes and artificial respiration. Atropine counteracts the muscarinic action of accumulated acetylcholine on cholinergic neurons; oxime compounds are used because their ability to reactivate inhibited cholinesterase can counteract the nicotinic action of the accumulated acetylcholine. Artificial respiration is often necessary because neither atropine nor oximes can fully relieve the paralysis of respiratory muscles resulting from serious nerve agent poisoning. A combination of atropine and artificial respiration was found to be many more times effective than either alone. When used alone, oximes generally do not protect or save, with any measure of certainty, a man who has been exposed to toxic levels of G- or V-type nerve agents. The effectiveness of oximes as adjuncts varies

with the nerve agent involved; they are very effective as prophylactics and therapeutics for GB and VX, less effective for GA and GF, and ineffective against GD after a lapse of time. The difficulty in reactivating the enzyme inhibited by GD and similar refractory agents is due to rapid aging, a process by which the inhibitor becomes more tightly bound to the enzyme with the passage of time. About 50% of the aging process occurs within the first 6 minutes of GD attachment, after which the cholinesterase virtually cannot be liberated with the usual oxime concentrations used for reactivation. For the less refractory nerve agents, such as sarin, 12 to 14 hours are required for 50% of the aging process to occur.[122] Toxic side reactions sometimes are encountered with oxime use, and in some cases a phenomenon of enhanced cholinesterase inhibition is observed as a consequence of a reaction between the nerve agent and the oxime to form an even more toxic product.

(2) (C-NOFORN) (b)(1)

(b)(1)

d. (U) Psychotropic Agents (U). One theoretical explanation of the action of LSD holds that the compound exerts its effect by modifying the actions of endogenous 5HT (serotonin) in the brain. Chlorpromazine, reserpine, and serotonin have been investigated as antagonists because of their actions on this neurotransmitter system.

NOT RELEASABLE TO FOREIGN NATIONALS

B. HYDROGEN CYANIDE ANTIDOTES (U)

3. Amyl Nitrite (U)

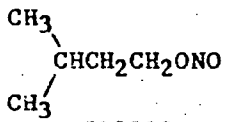
a. (U) Code or Alternate Designations (U). Vaporole, aspiral, nitramyl, isoamyl nitrite.

b. (U) Class (U). Generator of methemoglobin.

c. (U) Chemical Names (U).

- Isoamyl nitrite
- Isopentyl nitrite

d. (U) Formula (U). $C_5H_{11}NO_2$.


Neg. 513203

e. (U) Molecular Weight (U). 117.15.

f. (U) Method of Manufacture (U). Prepared by adding dilute sulfuric acid to a cold mixture of isoamyl alcohol followed by sodium nitrite and water.

g. (U) Physical and Chemical Properties (U).

- Physical state and color: clear, yellowish liquid, pungent aromatic taste
- Odor: penetrating, fragrant, somewhat fruity, stifling odor
- Boiling point: 97° to 99°C
- Solubility: miscible with alcohol, chloroform, benzene, and ether; insoluble in water
- Specific gravity: 0.875
- Volatility: volatilizes readily at low temperatures and is flammable

- Other properties: decomposes slowly on exposure to air, light, or moisture; forms an explosive mixture with air or oxygen

h. (U) Use (U).

- As an antidote and emergency treatment for cyanide poisoning
- A vasodilator of short duration, primarily used for angina pectoris, convulsions, bronchial asthma, and biliary or renal colic

i. (U) Physiological Effects (U). Amyl nitrite converts hemoglobin to methemoglobin; the cyanide ion, having a greater affinity for methemoglobin, is prevented from destroying the cytochrome-oxidase system.

j. (U) Dosage (U). 0.1 to 0.3 mL by inhalation.

k. (U) Toxicity (U). Overdoses may cause flushing, headache, and dizziness. Acute poisoning results in cyanosis, nausea, vomiting, abdominal cramps, mental confusion, convulsions, paralysis, and death. Amyl nitrite vasodilates coronary arteries causing a fall in blood pressure.

l. (U) Contraindications and Precautions (U). Amyl nitrite increases intracranial pressure and thus is contraindicated in cases of head trauma or cerebral hemorrhage.

m. (U) Therapy (U). Methylene blue (orally or intravenously), epinephrine, oxygen inhalation.

n. (U) Storage (U). Must be kept in tightly closed containers in a cool place, protected from light and air.

3.1. Sodium Thiosulfate (U)

a. (U) Code or Alternate Designations (U). Antichlor, sodothiol, sulfothiorine, ametox.

b. (U) Class (U). Sulfur donater.

c. (U) Chemical Name (U). Sodium thiosulfate.

d. (U) Formula (U). $Na_2S_2O_3$.

e. (U) Molecular Weight (U). 158.13.

f. (U) Physical and Chemical Properties (U).

- Odorless crystals or granules
- Pentahydrate
- Melts at 48°C
- Soluble in water, practically insoluble in alcohol
- Effloresces in warm dry air and slightly deliquesces in moist air.

g. (U) Use (U). As an antidote and emergency treatment for cyanide poisoning. It is most effective when following amyl nitrite therapy.

h. (U) Physiological Effects (U). Thiosulfate, under the influence of sulfurtransferase, reacts with cyanide to form thiocyanate (SCN^-), a relatively nontoxic substance readily excreted in the urine.

i. (U) Dosage (U). 12.5 grams in 50 mL administered by slow intravenous injection over a 10-minute period.

j. (U) Toxicity (U). Relatively nontoxic.

k. (U) Contraindications and Precautions (U). The final reaction with thiosulfate is slowly reversible through the action of thiocyanate oxidase. Therefore, if renal function is impaired and signs of poisoning reappear, the amyl nitrite and sodium thiosulfate treatment should be repeated.

l. (U) Storage (U). Thiosulfate slowly decomposes in aqueous solution at normal temperature; this reaction rate is increased by heating.

3.2. Glyceraldehyde (U)

a. (U) Code or Alternate Designations (U). Glyceric aldehyde.

b. (U) Class (U). Antidote for cyanide poisoning.

c. (U) Chemical Name (U).

- 2,3-dihydroxypropanal
- α-β dihydroxypropionaldehyde

d. (U) Formula (U). $C_3H_6O_3$.

$HOCH_2CHOHCHO$

e. (U) Molecular Weight (U). 90.08.

f. (U) Method of Manufacture (U). Obtained from glycerol by mild oxidation with hydrogen peroxide and ferrous salts as catalysts.

g. (U) Physical and Chemical Properties (U).

- DL form: tasteless crystals
- Melting point: 145°C
- Soluble in water; insoluble in benzene, petroleum ether, pentane.

h. (U) Use (U). As an antidote and emergency treatment for cyanide poisoning.

3.3. Aquocobalamine (U)

a. (U) Code or Alternate Designations (U). Vitamin $B12_b$, aquocobamide.

b. (U) Class (U). Direct cyanide binder.

c. (U) Chemical Name (U). α-(5,6-dimethylbenzimidazolyl) aquocobamide.

d. (U) Formula (U). $C_{62}H_{89}CoN_{13}O_{15}P \cdot H_2O$

e. (U) Molecular Weight (U). 1364.

f. (U) Physiological Effects (U). Aquocobalamine is converted to Vitamin B12 in the presence of cyanide. This reaction occurs very rapidly and is useful in the removal of the toxic cyanide molecule from the body.

g. (U) Toxicity (U). Relatively nontoxic.

3.4. Paradimethylaminophenol (U)

a. (U) Code or Alternate Designation (U). DMAP.

b. (U) Class (U). Generator of methemoglobin.

c. (U) Formula (U). $(CH_3)_2NC_6H_4OH$.

d. (U) Molecular Weight (U). 137.

e. (U) Physiological Effects (U). DMAP converts hemoglobin to methemoglobin, which binds cyanide.

f. (U) Dosage (U). The 250-mg dose recommended for humans generates 30% methemoglobin. Subsequent applications are contraindicated because of the massive loss of hemoglobin involved.

g. (U) Contraindications and Precautions (U). Generation of methemoglobin may result in headaches and fatigue. DMAP given in conjunction with certain antimalarial drugs (e.g., primaquine) may result in hemolysis; Negroes are especially susceptible to this effect.

C. LEWISITE ANTIDOTES (U)

4. Dimercaprol (U)

a. (U) Code or Alternate Designations (U).

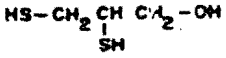
- British Anti-Lewisite
- Antoxol
- BAL
- Dicaptol
- 1,2-dithioglycerol
- Sulphactin

b. Class. Antidote for arsenicals.

c. Chemical Names.

- 2,3-Dimercapto-1-propanol.
- 1,2-Dithioglycerol.

d. Formula. $C_3H_8OS_2$



e. Molecular Weight. 124.21.

f. Method of Manufacture.

- Method A: Prepared by the bromination of allyl alcohol to glycerol dibromohydrin followed by reaction with sodium hydrosulfide under pressure.
- Method B: Hydrogenation of hydroxypropylene trisulfide.

g. Physical and Chemical Properties.

- Physical state and color: Colorless, viscous, oily liquid.
- Odor: Pungent offensive odor of mercaptans.
- Boiling point: 120°C at 15 mm Hg, 130°C at 25 mm Hg, 140°C at 40 mm Hg.[3]
- Solubility: Soluble in vegetable oils, ethanol, methanol, benzyl benzoate and water.
- Specific gravity: 1.24 at 25°C.

h. Use. Developed as protection against arsenical CW agents, especially Lewisite. BAL stops the agent's toxic effect upon the pyruvate oxidase system in the brain. BAL is also used in the treatment of chronic poisoning by arsenic, mercury, gold; it is less effective for bismuth, antimony, cobalt, and nickel.

i. Physiological Effects. BAL removes arsenic rapidly from the body by forming a complex with the metal. The antidote is generally effective even in advanced stages of poisoning. Doses of 4 mg/kg or more in humans may cause: nausea; vomiting; headache; burning sensation of mouth, throat, lips, and eyes; lacrimation; salivation; dental pain; burning and tingling sensation of extremities; substernal pressure; and hypertension. Symptoms appear a few minutes after injection, but are transient in nature. Smaller doses may produce mild symptoms. Contact with skin may cause local swelling and reddening at the area of application. When ingested, BAL may produce ulceration of gastric and respiratory tracts.

j. Dosage. A 3 mg/kg dose, intramuscularly (10% solution in peanut oil for arsenicals).

k. Toxicity. LD_{50} for rats is 105 mg/kg, intramuscularly.

l. Therapy. Epinephrine or ephedrine. Antihistamines may be used for prophylaxis.

m. Storage. Stored in airtight containers at temperatures not above 5°C. Benzyl benzoate is added as a stabilizer.

n. History.

- 1945: Developed by Peters, Stocken and Thompson in United Kingdom.
- 1946: US pat. 2,402,665 (E. I. du Pont de Nemour & Co.).

5. (U) Unithiol

a. Code or Alternate Designation. USSR—Unitiol.

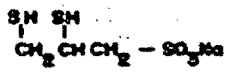
b. Class. Antidote for heavy metal poisoning.

c. Chemical Names.

- 2,3-Dimercaptopropanesulfonic acid sodium salt.
- 1-Propanesulfonic acid -2,3-dimercapto sodium salt.
- Sodium 2,3-dimercaptopropanesulfonate.

Original ST-HB-03-18-74

d. Formula. $C_3H_7O_3S_3$



Reg. 513205

e. Molecular Weight. 213.31.

f. Method of Manufacture. Reaction of BAL with sodium sulfite.

g. Physical and Chemical Properties.

- Physical state and color: Fine crystalline white powder; non-hygroscopic.
- Odor: Mild mercaptan odor.
- Solubility: Soluble in water.

h. Use. Therapy in heavy metal poisoning, especially arsenic (Lewisite) and mercury. For treatment of eye contamination, a salve of 40% unithiol in lanolin is used.

i. Physiological Effects. Unithiol forms a stable compound with arsenic in vivo, which is rapidly removed from the body. The antidote restores the level of blood pressure, prevents collapse, restores activity of enzymes and has no cardiovascular effects. Therapeutic doses of unithiol are well tolerated and have no cumulative properties. Side effects which may occur include nausea, vomiting and constriction in the chest.

j. Toxicity. Low toxicity with a broad range of therapeutic action. Fatal dose is 20 to 40 times greater than the therapeutic dose of 5 mg/kg—intravenously, subcutaneously, or orally. LD_{100}, intravenously, is 1000 mg/kg for rabbits and LD_{100}, subcutaneously, is 1500 mg/kg for rats, 2400 mg/kg for mice, and 500 mg/kg for dogs and cats.

k. Historical. 1950: Developed in Kiev, USSR.

D. NERVE AGENT PROPHYLAXIS AND THERAPY
D.1 CHOLINOLYTICS

6. (U) Atropine

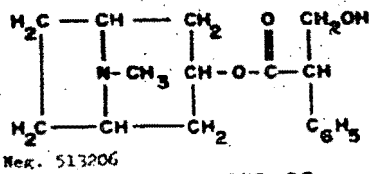
a. Code or Alternate Designations.

- dl-Hyoscyamine.
- dl-Tropyl tropine.
- Tropine tropate.

b. Class. Functional antidote, cholinolytic drug.

c. Chemical Names. Ester of tropine (2,3-dihydro-3-hydroxy-8-methyl-nortropidine) and tropic (2-phenyl-β-hydroxypropionic) acid.

d. Formula. $C_{17}H_{23}NO_3$



Neg. 513206

e. Molecular Weight. 289.38.

f. Method of Preparation. Extraction of Atropa belladonna L., Datura stramonium L. and other Solanaceae. During extraction, partial racemization of the l-hyoscyamine takes place. Dilute alkali or heating in chloroform solution completes the process. It is purified by recrystallization of the oxalate salt.

g. Physical and Chemical Properties.

(1) Atropine.

- Physical state and color: White, needlelike crystals or powder; optically inactive.
- Melting point: 114° to 116°C.
- Sublimation temperature: 93° to 110°C in high vacuum.

- Solubility: Very soluble in alcohol and chloroform, soluble in ether, glycerol, benzene, and dilute acids; slightly soluble in water.

- Hydrolysis: Hydrolyzes to form tropine and tropic acid.

(2) Atropine sulfate. Atropine forms the sulfate salt with H_2SO_4, molecular weight of 694.82. Atropine sulfate consists of colorless crystals or white crystalline granules; effloresces in dry air, melts at 190° to 194°C; is odorless, almost inactive optically, and readily soluble in hot or cold water, glycerol, and alcohol. An aqueous solution has a pH of approximately 5.4.

h. Use.[9 124] Standard antidote for organophosphorus nerve agent poisoning. It is contained in syrettes and automatic injectors. Atropine is also used in the treatment of Parkinson's Disease and to dilate the pupil of the eye.

i. Physiological Effects.

(1) Atropine blocks responses to certain types of parasympathetic stimulation, that is, it antagonizes the muscarinic action of acetylcholine by preventing acetylcholine from acting on receptor sites of effector organs.

(2) Symptoms of atropinization are depressed respiration, dryness of mouth and throat, dilation of pupil of the eye, intolerance toward light, flushed face, nausea, giddiness, numbness of limbs, staggering gait, drowsiness, and stupor. With larger doses, central excitation becomes more prominent, leading to restlessness, disorientation, and hallucinations. With still larger doses, stimulation gives way to depression and medullary paralysis causing death.

(3) In the treatment of nerve agent poisoning, atropine nullifies the muscarine-like effects of accumulated acetylcholine (i.e., miosis, blurred vision, excessive bronchial secretions, nausea, abdominal cramps, tightness in chest, and other symptoms) due to inhibition of the enzyme, cholinesterase. Atropine has no effect on the nicotine-like manifestations of a cholinesterase inhibitor (i.e., muscular twitching, weakness of respiratory muscles, and convulsions).

j. Dosage.[57 124]

(1) In nerve agent poisoning, 2 mg of atropine sulfate is administered intramuscularly, by means of a syrette or an automatic self-injector. Repeat every 10 min until atropinization symptoms appear (dry mouth and a pulse rate of 90 to 100/min). In severe poisoning, as much as 24 mg of atropine may be administered in a single day without producing more than transient, mild symptoms attributable to atropine. A large total dose of 200 mg may be required in severe poisoning. Atropine is one of the basic ingredients of present-day therapy, and is generally used as the first step of treatment because it works rapidly and allows time for ancillary treatment. Atropine tartrate may be substituted for atropine sulfate.

(2) A combination of atropine and artificial respiration is many times more effective than either alone. The use of oximes in conjunction with atropine-artificial respiration therapy is generally even more effective in counteracting the effects of nerve agent poisoning. The combined use of atropine with an oxime mixture of pralidoxime chloride and TMB-4 was found to be superior to atropine in combination with either pralidoxime chloride or TMB-4 individually.

k. Toxicity. LD_{50}, orally, for mice is 794 mg/kg, and for rats, 750 mg/kg. LD_{50}, intravenously, for mice is 90 mg/kg. LD_{50}, subcutaneously, for mice is 750 mg/kg, and for rats, 2000 mg/kg.

l. Therapy. Pilocarpine, physostigmine, or artificial respiration.

m. Storage. In airtight containers, protect from light.

n. History.

- 1927: Extracted by Chemmitrius.
- 1961: Commercial production, Woodward.

Original

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7. (U) Caramiphen Hydrochloride

a. Code or Alternate Designations.

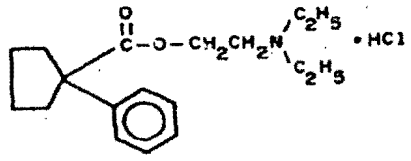
- Parpanite.
- Panparnit.
- Pentaphen.
- Geigy 2747.
- Parpanit.

b. Class. Atropinoid spasmolytic, cholinolytic drug.

c. Chemical Names.

- 1-Phenylcyclopentanecarboxylic acid 2-diethylamino-ethyl ester hydrochloride.
- Diethylamino-ethyl-1-phenylcyclopentane-1-carboxylate hydrochloride.

d. Formula. $C_{18}H_{27}NO_2 \cdot HCl$



Neg. 513207

e. Molecular Weight. 325.87.

f. Method of Preparation. Prepared from 1-phenylcyclopentane-carboxylic acid chloride and diethylaminoethanol.[3]

g. Physical and Chemical Properties.

- Physical state and color: Crystalline solid.
- Melting point: 145° to 146°C.
- Boiling point: Free ester, 110° to 115°C.

- Solubility: Soluble in methanol, ethanol, physiological saline; slightly soluble in water; insoluble in ether.

h. Use. Antidote for massive organophosphorus poisoning when atropine is contraindicated (extreme oxygen starvation, hypoxemia of heart); also for treatment of Parkinson's disease and bronchial asthma.

i. Physiological Effects. Caramiphen is a powerful cholinolytic preparation with both peripheral and central nervous system actions. This therapeutic has antispasmodic, antihistaminic, ganglio-blocking and local anesthetic properties. The prophylactic action is increased considerably if combined with scopolamine. Caramiphen inhibits gastric motility, raises blood pressure, and in large doses has curare-like action. There are very few side effects. In combination with oxime, it is only slightly more effective than atropine.

j. Dosage. The dosage must be individualized. Effective dose for rabbits in parathion poisoning is 5 mg/kg, intravenously, and 12.5 to 100 mg total dose, orally.

k. Toxicity. It is less toxic than Trasentine. LD_{50} for rats is 209 mg/kg, intraperitoneally. LD_{50} for mice is 67 mg/kg, intravenously.

l. Therapy. Not known.

m. Storage. Normal precautions, as for most drugs.

n. History.

- 1945: Swiss pat. 234 452 (Geigy).
- 1946: Prepared by Martin and Häflinger at Geigy in United States.
- 1952: Synthesized by A. I. Briskin in USSR.

8. (U) Trasentine

a. Code or Alternate Designations.

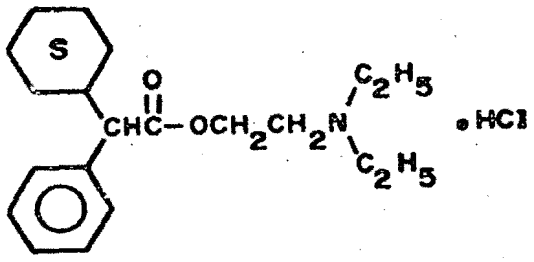
- Trasentine hydrochloride.
- Spasmolytin.
- Diphacil.

- Difatsil
- Patrovina
- Adiphenine hydrochloride

b. (U) Class (U). Atropinoid antispasmodic, cholinolytic drug.

c. (U) Chemical Name (U). 2-diethylaminoethyl α-cyclohexyl-α-phenylacetate hydrochloride.

d. (U) Formula (U). $C_{20}H_{25}NO_2 \cdot HCl$.



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e. (U) Molecular Weight (U). 353.92.

f. (U) Method of Manufacture (U). Prepared by controlled hydrogenation of 2-diethylaminoethyl diphenylacetate.

g. (U) Physical and Chemical Properties (U).

- Physical state and color: Needle-like crystals
- Melting point: 145° to 147°C (crystallized from alcohol and petroleum ether)
- Solubility: Soluble in water; slightly soluble in alcohol and ether. (A 5% aqueous solution is neutral to litmus.)

h. (U) Use (U). Trasentine can be used as an antidote for organophosphorus poisoning, a synthetic substitute for atropine in spasms of involuntary muscles, and a local anesthetic.

i. (U) Physiological Effects (U). Trasentine is a potent antispasmodic agent that acts like papaverine on smooth muscles and like atropine in the parasympathetic nerves. If taken in prescribed doses there are fewer side effects than most antispasmodics, and the effects on the eyes and cardiovascular system are insignificant. Trasentine is centrally active and predominantly nicotinic.

j. (U) Dosage (U). 75 to 100 mg.

k. (U) Toxicity (U). It is much less toxic than atropine and requires very large doses to obtain similar side effects. Should not be used with morphine. LD_{50} for mice is 690 mg/kg, orally, and 380 mg/kg intramuscularly (i.m.).

l. (U) Contraindications and Precautions (U). Trasentine should be used with great caution in patients receiving morphine.

m. (U) Therapy (U). Not known.

n. (U) Storage (U). Normal precautions, as for most drugs.

o. (U) History (U).

- 1936: First introduced
- 1941: Swiss patent 215 775
- 1942: Swiss patent 217 225
- 1942: Swiss patent 219 301 (Ciba).

9. Tropacine (U)

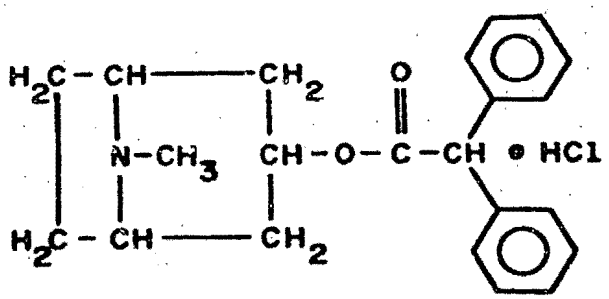
a. (U) Code or Alternate Designations (U). Tropazine, tropasin, tropatsin.

b. (U) Class (U). Cholinolytic drug.

c. (U) Chemical Names (U).

- Tropine ester of diphenylacetic acid hydrochloride
- 3-tropanyl diphenylacetate hydrochloride
- Tropine diphenylacetate hydrochloride

d. (U) Formula (U). $C_{22}H_{25}NO_2 \cdot HCl$.



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e. (U) Molecular Weight (U). 371.91.

f. (U) Method of Preparation (U). Prepared from tropine and diphenylacetyl chloride.

g. (U) Physical and Chemical Properties (U).

- Physical state and color: White crystalline powder
- Melting point: 217° to 218°C (crystallized from chloroform and ether)
- Solubility: soluble in water, alcohol, and chloroform; insoluble in ether and benzene.

★ h. (U) Use (U). Tropacine is used as a therapeutic for organophosphorus poisoning and for the treatment of Parkinson's Disease, traumatic brain diseases, disorders of the central nervous system, and epidemic encephalitis. The Soviets produce 5-, 10-, and 15-mg tablets. Maximum daily dose is 100 mg.

i. (U) Physiological Effects (U). Tropacine has gangliolytic and spasmolytic effects. This therapeutic blocks both muscarinic and nicotinic-cholinoreactive systems. Tropacine causes dryness of mouth and dilation of the pupils (of short duration). It has greater central and weaker peripheral action than atropine.

j. (U) Effectiveness (U). An i.v. dose of 1 mg/kg removes the lethal effect from an LD_{50} dose of parathion in rabbits.

k. (U) Toxicity (U). Doses over 0.3 gram may be fatal.

l. (U) Therapy (U). Not known.

m. (U) Storage (U). Store in well-stoppered containers away from light.

n. (U) History (U).

- 1939: Swiss patent 202 181 (Ciba)
- 1953: Prepared by M. D. Mashkovskiy in USSR.

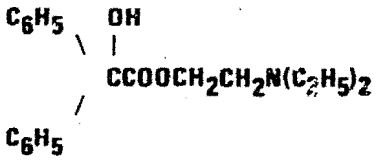
9.1. Benactyzine (U)

a. (U) Code or Alternate Designations (U). Amizil (WP), amisil (WP), nervatil (RO), amisyl (WP), nervacton, arcadine, actozine, cedad, parasan, cafron, lucidil, parpon, cevanol, nutinal, phobex, tranquillin, fobex, ibiotyzil, neuroleptone, suavitil, and AY 5406-1.

b. (U) Class (U). Cholinolytic, tranquilizer.

c. (U) Chemical Name (U). Benzylic acid β-diethylaminoethyl ester, β-diethylaminoethyl benzilate, 2-diethylaminoethyl diphenylglycolate.

d. (U) Formula (U). $C_{20}H_{25}NO_3$.



e. (U) Molecular Weight (U). 327.41.

f. (U) Physical and Chemical Properties (U).

- Crystals
- Melting point: 177° to 178°C
- Soluble in water; practically insoluble in ether.

g. (U) Use (U). Antidote for organophosphorus poisoning, usually administered in combination with an oxime. Also used as a tranquilizer.

h. (U) Physiological Effects (U). Benactyzine is a mild antidepressant and anticholinergic agent that, in animals, has been shown to reduce the autonomic response to stress. In combination with oximes it is only slightly more effective than atropine. Centrally acting.

i. (U) Dosage (U). The Soviets produce 1 mg and 2 mg tablets and recommend a daily dose of 3 to 10 mg. They also produce a 1% to 2% solution for eye drops.

j. (U) Toxicity (U). Overdosage leads to CNS depression and coma. In mice LD_{50} = 100 mg/kg i.m.

k. (U) Contraindications and Precautions (U). In high dosage, benactyzine may produce dizziness, thought-blocking, a sense of depersonalization, aggravation of anxiety, or disturbance of sleep patterns.

l. (U) Therapy (U). Supportive therapy in general.

m. (U) Storage (U). Fairly stable; normal precautions should be taken.

n. (U) History (U).

- 1938: prepared by Horenstein and Pahlicke.
- 1946: US Patent No. 2 394 770.

9.2. Aprophen (U)

a. (U) Code or Alternate Designation (U). Aprofen (WP).

b. (U) Chemical Names (U).

- 2,2-diphenylpropionic acid
  2-diethylaminoethyl ester
- α, α-diphenylpropionic acid
  β-diethylaminoethyl ester
- 2-diethylaminoethyl
  2,2-diphenylpropionate

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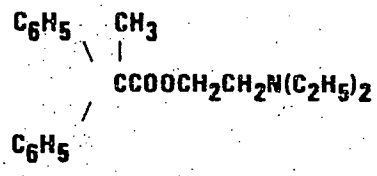
c. (U) Formula (U). $C_{21}H_{27}NO_2$.



d. (U) Molecular Weight (U). 325.

e. (U) Physiological Effects (U). Analgesic, antispasmodic, central and peripheral m- and n-cholinolytic (predominantly blocking nicotinic sites).

★ f. (U) Use (U). Aprophen is used in the Soviet Union as supportive therapy to treat nerve agent poisoning. One mL of a 1% solution or 25-mg tablets are recommended two or three times per day (para 9.6).

9.3. G3063 (U)

a. (~~C-NOFORN~~) Chemical Name (U). (b)(1) (b)(1)

b. (~~C-NOFORN~~) Physiological Effects (U). (b)(1) (b)(1)

9.4. PMCG (U)

a. (~~C-NOFORN~~) Chemical Name (U). (b)(1) (b)(1)

b. (~~C-NOFORN~~) Physiological Effects (U). (b)(1) (b)(1)

9.5. Arpenal (U)

a. (U) Chemical Name (U). Diphenylacetic acid diethylaminopropylamide.

b. (U) Formula (U). $(C_6H_5)_2CHC(O)NH(CH_2)_3N(CH_2CH_3)_2$.

c. (U) Molecular Weight (U). 324.

d. (U) Use (U). Arpenal is used in the Soviet Union to supplement the cholinolytic activity of atropine.

e. (U) Physiological Effects (U). Arpenal exhibits pronounced central n-cholinolytic effects. Cholinolytic action at peripheral and central muscarinic sites is weaker.

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9.6. Taren (U)

a. (C) Chemical Name (U). (b)(1)

(b)(1)

b. (U) Physiological Effects (U). Taren been reported to exhibit cholinclytic activity. One to two tablets can cause dryness of the mouth, increased heart rate, expansion of the pupils, disturbance of near vision, dryness, and sometimes a state resembling alcoholic euphoria.

c. (U) Use (U). Taren is a civil defense nerve agent prophylactic used in the Soviet Union. It is issued in the form of 200-mg tablets (believed to be the weight of active components and filler) and 1-mL ampoules. One tablet is taken every 5 or 6 hours prior to a nerve agent attack or two tablets immediately after exposure to the agent. A taren solution is used to treat mildly intoxicated victims upon the appearance of symptoms or is used in conjunction with the oximes TMB-4 (1 mL of a 15% solution) or isonitrosine (3 mL of a 40% solution) for more seriously intoxicated victims.

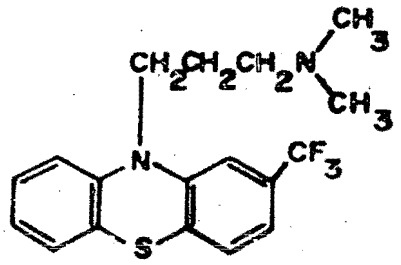
9.7. Triflupromazine Hydrochloride (U)

a. (U) Alternate Designations (U). TFP, vetane, vesprin.

b. (U) Class (U). Antipsychotic, phenothiazine derivative.

c. (U) Chemical Name (U). 10-[3-(dimethylamino)propyl]-2-trifluorom ethylpheno thiazine.

d. (U) Formula (U). $C_{18}H_{20}ClF_3N_2S$.



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e. (U) Molecular Weight (U). 388.9.

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f. (U) Physical and Chemical Properties (U).

- Crystals
- Decomposition point: 173° to 174°C
- Soluble in water, ethanol, acetone

g. (C-NOFORN) Use (U). (b)(1)

(b)(1)

h. (U) Physiological Effects (U). TFP has gangliolytic, adrenolytic, antifibrillatory, antiedema, antipyretic, antishock, anticonvulsant, and antiemetic properties.

i. (U) Dosage (U). Dosage should be titrated to the individual case. Ranges include 50-400 mg orally or 20 to 50 mg i.m. daily.

j. (U) Toxicity (U). Side effects include sedative effects, nonvoluntary effects, and hypotensive effects.

k. (U) Contraindications and Precautions (U). TFP is contraindicated in comatose or greatly depressed states due to various central nervous system depressants. TFP, a member of the phenothiazine group, markedly affects the actions of many other drugs. It may block the action of guanethidine, an antihypertensive. TFP enhances the effects of alcohol and morphine and markedly enhances the respiratory depression produced by meperidine. Combinations of these drugs must be avoided. Phenothiazines interfere with a number of laboratory tests, notably the glucose tolerance test.

l. (U) Therapy (U). A clear airway must be maintained in overdose therapy.

m. (U) Storage (U). Protect from light, store in tinted glass.

n. (U) History (U).

- 1957: Prepared by Yale and coworkers
- 1959: British Patent No. 813 861

9.8. Methylbenactyzine (U)

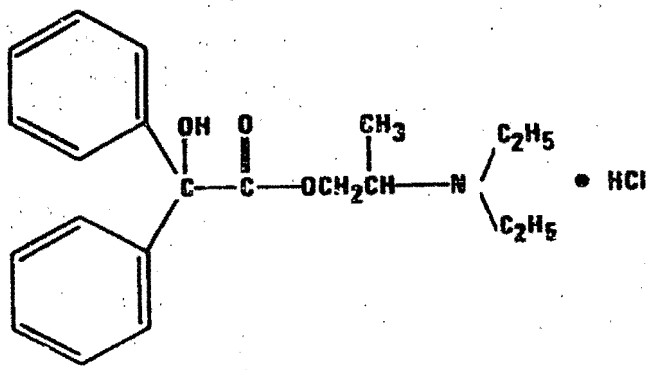
a. (U) Code or Alternate Designations (U). Metamizl (UR), metamizilum (UR), methyldiazil.

b. (U) Class (U). Cholinolytic.

c. (U) Chemical Names (U).

- 2-diethylaminopropyl diphenylglycolate
- Benzilic acid 2-diethyl-aminopropylester

d. (U) Formula (U). $(C_6H_5)_2COHCOOCH_2CH(CH_3)N(CH_2CH_3)_2$



e. (U) Molecular Weight (U). 341.

f. (U) Physiological Effects (U). Predominantly m-cholinolytic effects. Both central and peripheral effects are more pronounced than those of benactyzine.

★ g. (U) Use (U). The Soviet Union produces 1-mg tablets and ampules containing 1 mL of 0.25% solution. One to two mg can be taken two to three times per day.

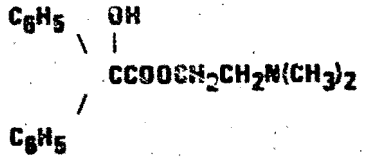
9.9. 2-dimethylaminoethyl Benzilate (U)

a. (U) Code or Alternate Designations (U). Benzacine (USSR), diphemin, labotropin.

b. (U) Chemical Names (U).

- Benzilic acid 2-dimethyl-aminoethyl ester
- 2-dimethylaminoethyl diphenylglycolate

c. (U) Formula (U). $C_{18}H_{21}NO_3$.



d. (U) Molecular Weight (U). 299.

e. (U) Physiological Effects (U). It exhibits m-cholinolytic action half the strength of atropine. Its effects on the brain approximate benactyzine.

f. (U) Use (U). The Soviet Union produces 2-mg tablets and ampoules containing 1 mL of 0.1% solution. A dose of 2 mg can be given two to three times per day.

9.10. Scopolamine (U)

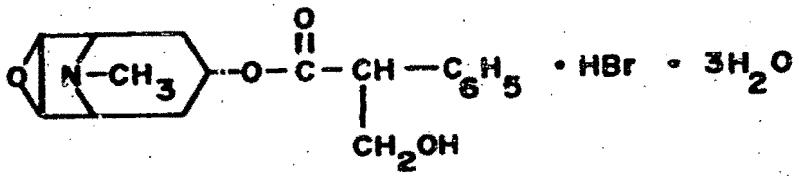
a. (U) Code or Alternate Designations (U). Scopine tropate, tropic acid ester with scopine, hyoscine, l-scopolamine.

b. (U) Class (U). Cholinolytic.

c. (U) Chemical Names (U).

- 6β, 7β-epoxy-3α-tropanyl S-(-)-tropate.
- 6, 7-epoxytropine tropate.

d. (U) Formula (U). $C_{17}H_{21}NO_4$.



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e. (U) Molecular Weight (U). 303.35.

f. (U) Method of Preparation (U). Extracted from the shrub Hyoscymus niger (henbane) and Scopolia carniolica.

g. (U) Physical and Chemical Properties (U).

- Viscous liquid
- Freely soluble in hot water, alcohol, ether, chloroform, and acetone
- Sparingly soluble in benzene and petroleum ether
- Easily hydrolyzed by acids or alkalies
- Decomposes on standing

★ h. (U) Use (U). The Soviets produce ampules containing 1 mL of 0.05% solution. Internal dose is 0.5 mg two to three times per day.

i. (U) Dosages (U). Oral, 0.6 mg in the United States.

j. (U) Toxicity (U). Side effects include dryness of mouth, palpitation, dilated pupils, blurring of vision, headache, restlessness, and fatigue. In mice LD_{50} = 670 mg/kg i.m.

k. (U) Contraindications and Precautions (U). Given alone in the presence of pain or severe anxiety, scopolamine may induce outbursts of uncontrolled behavior. It may cause blindness if administered to patients suffering from narrow angle glaucoma.

l. (U) Therapy (U). In overdose: physostigmine and supportive therapy.

m. (U) Storage (U). Decomposes on standing.

n. (U) History (U). 1928 extracted and purified by Chemnitius.

o. (U) Physiological Effects (U). Its peripheral effects are not as prolonged as the effects of atropine but are more pronounced on the pupil, the ciliary muscle, and the salivary, bronchial, and sweat glands. Scopolamine can also tranquilize the central nervous system.

9.11. 3-oxyquinuclidine Diphenylpropionate (U)

a. (U) Code or Alternate Designation (U). Aprolidine.

b. (U) Physiological Effects (U). It has been found to be more effective than atropine when given to mice either before or after exposure to phosphacol or armin.

9.12. Hexamethonium Chloride (U)

a. (U) Code or Alternate Designations (U). Hexathonide chloride, bistrium chloride, hexone chloride.

b. (U) Class (U). Ganglionic blocking agent, antihypertensive.

c. (U) Chemical Name (U). Hexamethylenebis(trimethyl-ammonium chloride).

d. (U) Formula (U). $C_{12}H_{30}Cl_2N_2$.

$$[(CH_3)_3\overset{+}{N}-(CH_2)_6-\overset{+}{N}(CH_3)_3]2Cl-$$

e. (U) Molecular Weight (U). 273.29.

f. (U) Method of Preparation (U). There are several methods of preparation, e.g., from hexamethylene dichloride and trimethylamine.

g. (U) Physical and Chemical Properties (U).

- Hygroscopic crystals
- Decomposes at 289°-292°C
- Freely soluble in water; soluble in 95% ethanol; practically insoluble in chloroform and ether.

h. (U) Use (U). Used in management of hypertensive cardiovascular disease.

i. (U) Toxicity (U). Side effects include hypotension, tachycardia, mydriasis, constipation, dry mouth, and nausea. In mice LD_{50} = 100 mg/kg i.m.

j. (U) Contraindications and Precautions (U). Hexamethonium chloride causes histamine release and should be used with extreme caution in patients who have a history of allergy.

9.13. Anisodamine (U)

a. (U) Code or Alternate Designations (U). 654 (China).

b. (U) Class (U). Cholinolytic.

c. (U) Chemical Name (U). Benzeneacetic acid γ-(hydroxymethyl)-6-hydroxy-8-methyl-8-azabicyclo (3.2.1)-oct-3-yl ester.

d. (U) Molecular Weight (U). 305.

e. (U) Method of Preparation (U). Extracted from Scopolia tangutica or Anisodus tanguticus.

f. (U) Physiological Effects (U). Similar to atropine but with fewer side effects and lower toxicity. Side effects usually disappear within 3 hours. Greater penetration into central nervous system.

g. (U) Physical Properties (U).

- Colorless, needle-shaped crystals in benzene
- Dissolves in water and alcohol
- Melting point: 62°-64°C.

9.14. Anisodine (U)

a. (U) Code or Alternate Designations. 703 (China).

b. (U) Class (U). Cholinolytic.

c. (U) Method of Preparation (U). Extracted from Scopolia tangutica or Anisodus tanguticus.

d. (U) Physiological Effects (U). Similar to scopolamine in pharmacology.

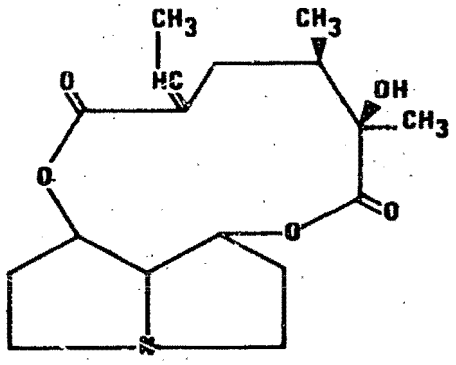
9.15. Platyphylline (U)

a. (U) Code or Additional Names (U). Platifillin.

b. (U) Class (U). Spasmolytic.

c. (U) Chemical Name (U). 1,2-dihydro-12 hydroxysenecionan-11-16 dione.

d. (U) Formula (U). $C_{18}H_{27}NO_5$.



e. (U) Molecular Weight (U). 337.

f. (U) Physical and Chemical Properties (U).

- Crystals
- Melting point: 129°C
- Practically insoluble in water; soluble in alcohol, chloroform, ether, dilute acids

g. (U) Method of Preparation (U). Extracted from Senecia platyphyllus.

★ h. (U) Use (U). Platyphylline is used in the Soviet Union as a spasmolytic and mydriatic. Mentioned by the Soviets as a possible cholinolytic for nerve agent poisoning. It is available in 5-mg tablets and ampules containing 1 mL of a 0.2% solution.

i. (U) Physiological Effects (U). Platyphylline is milder than atropine in action and can be used in doses that do not produce atropine-like side effects.

D.2. CHOLINESTERASE REACTIVATORS

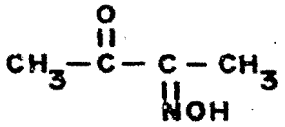
10. Diacetylmonoxime (U)

a. (U) Code or Alternate Designation (U). DAM.

b. (U) Class (U). Oxime.

c. (U) Chemical Name (U). 2,3-butanedione monoxime.

d. (U) Formula (U). $C_4H_7NO_2$.



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e. (U) Molecular Weight (U). 101.04.

f. (U) Method of Preparation (U). Prepared by the interaction of diacetyl with hydroxylamine in an almost neutral alcoholic or aqueous solution.

g. (U) Physical and Chemical Properties (U).

- Physical state: Crystalline solid
- Solubility: Soluble in water, physiological saline, and alcohol
- Half-life: 7.2 hours

h. (U) Use (U). DAM is a cholinesterase reactivator and is used prophylactically and therapeutically as an antidote for anticholinesterase poisoning. DAM is more effective as a prophylactic.

i. (U) Physiological Effects (U). DAM has a pronounced central effect and can penetrate the blood-brain barrier. Although DAM eliminates symptoms of organophosphorus poisoning, it is ineffective against GD (soman). Side reactions of DAM may include sensation of heat at point of injection, blurred vision, dizziness, sleepiness, rapid heartbeat, low blood pressure, bitter taste in mouth, diffused tingling of skin, and temporary anxiety. Large doses may result in nausea, convulsions, and death.

j. (U) Dosage (U). (b)(1)

(b)(1)

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k. (U) Toxicity. LD_{50} for mice is 900 mg/kg. (Route of administration unknown).

l. (U) Storage. Not known.

11. (U) Monoisonitrosoacetone

a. Code or Alternate Designations. MINA.

b. Class. Oxime.

c. Chemical Name. Monoisonitrosoacetone.

d. Formula. $C_3H_5NO_2$

e. Molecular Weight. 87.03.

f. Method of Preparation. Prepared by the reaction of ethyl acetoacetate with potassium hydroxide, then adding sodium nitrite and sulfuric acid.

g. Physical and Chemical Properties.

- Physical state and color: Pale brown needles, vacuum sublimation gives colorless plates.
- Melting point: Pure material, 64° to 66°C; crude material, 45° to 50°C.
- Solubility: Soluble in water and physiological saline solution.

h. Use. MINA is a cholinesterase reactivator and acts both as a prophylactic and antidote for nerve agent poisoning.

i. Physiological Effects. MINA has a pronounced effect on the central nervous system and can penetrate the blood-brain barrier. Side reactions from MINA may include blurred vision, dizziness, rapid heartbeat, and low blood pressure. Large doses may result in convulsions and death. It is more active in CNS than 2-PAM.

j. Dosage. Prophylactic dose for mice against GB is 75 mg/kg, intravenously. MINA is effective only in amounts that are close to their lethal doses.

k. Therapy. Not known.

l. Storage. Not known.

12. (U) Pralidoxime Chloride

a. Code or Alternate Designations.

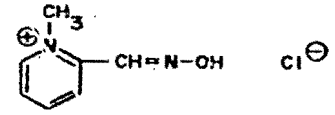
- EA 2170.
- 2-PAM.
- PAM.
- 2-PAM-Cl.
- 2-PAM chloride.
- Protopam chloride.

b. Class. Oxime (pyridine quaternary oxime).

c. Chemical Names.

- Pralidoxime chloride.
- Pyridine 2-aldoxime methochloride.
- 2-Formyl-1-methylpyridinium chloride oxime.

d. Formula. $C_7H_9ClN_2O$



Neg. 513211

e. Molecular Weight. 172.63.

f. Method of Preparation. Prepared from 2-pyridinecarboxaldehyde with hydroxylamine hydrochloride, followed by addition of chloromethane.

g. Physical and Chemical Properties.

- Physical state and color: White crystalline powder; non-hygroscopic.

- Odor: Odorless.
- Melting point: 235° to 238°C with decomposition (crystallized from alcohol and ether).
- Solubility: Freely soluble in water and physiological saline; soluble in chloroform and fats; more soluble in water than pralidoxime iodide.

h. Use. 2-PAM chloride is a cholinesterase reactivator and acts as a prophylactic and therapeutic for poisoning by some anticholinesterases. The therapeutic effectiveness is increased when combined with atropine.

i. Physiological Effects. The action of 2-PAM chloride is slightly stronger than the iodide as a cholinesterase reactivator. When used alone 2-PAM chloride raises the LD_{50} of GA for rats 1.2 times; in conjunction with atropine, the LD_{50} increases 1.6 times. When used with atropine, the LD_{50} of GB for rats is raised 10 to 20 times. 2-PAM chloride is ineffective against GD. 2-PAM chloride relieves such symptoms as muscle tightening, spasms, shaking, and breathing difficulties. Overdoses of 2-PAM chloride may cause dizziness, double image, headache, rapid heartbeat, and unconsciousness.

j. Dosage. Usual dosage is 10 to 20 mg/kg, intravenously. See also 2-PAM iodide. The use of a PAM salt in conjunction with atropine is considered satisfactory in most cases of nerve poisoning. PAM generally is administered intravenously by current techniques, but this procedure is being studied further for use under combat conditions. 2-PAM chloride is preferable to 2-PAM iodide because of the greater water-solubility of 2-PAM in the chloride form. The combined use of PAM and diacetylmonoxime was found to have a synergistic effect, and the combination of atropine, PAM, and TMB-4 (sec XIII, para 15) was superior to mixtures of atropine and PAM, or of atropine and TMB-4 separately.

k. Toxicity. LD_{50} for mice is 115 mg/kg, intravenously, and 410 mg/kg, orally. Oral toxicity to man is 2000 to 10 000 mg/70 kg for man.

l. Therapy. Not known.

m. Storage. It is not as stable as bispyridinium compounds, such as TMB-4, but is more stable than PAM iodide. Stable in solutions with pH between 3.5 and 4.5. The powder is stored in small glass vials.

n. History.

- 1964: US pat 3 140 289, Ellin et al. (US Army).
- 1964: US pat 3 155 674, McDowell (Olin Mathieson).

13. (U) Pralidoxime Iodide

a. Code or Alternate Designations.

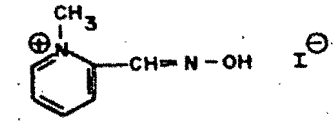
- PAM.
- EA 1821.
- 2-PAM.
- "Chick-ling-ting" (PRC).
- 2-PAM iodide.

b. Class. Oxime (pyridine quaternary oxime).

c. Chemical Names.

- Pralidoxime iodide.
- Pyridine 2-aldoxime methiodide.
- 2-Formyl-1-methylpyridinium iodide oxime.

d. Formula. $C_7H_9IN_2O$



Neg. 513212

e. Molecular Weight. 264.08.

f. Method of Preparation. Prepared from 2-pyridine aldehyde by treatment with hydroxylamine, followed by methyl iodide addition.

g. Physical and Chemical Properties.

- Physical state and color: Yellow crystals.
- Melting point: 225° to 226°C.[125]
- Solubility: Slightly soluble in water giving a yellowish solution.

h. Use. Same as for PAM chloride.

i. Physiological Effects. 2-PAM iodide is a cholinesterase reactivator and is used as a therapeutic for relief of nerve agent symptoms such as: muscle tightening, spasms, and breathing difficulties. 2-PAM iodide is ineffective against GD. Doses of 15 to 30 mg/kg of 2-PAM iodide may cause dizziness, double image, headache, and rapid heartbeat. It is rapidly destroyed in body by the liver.

j. Dosage. The dose depends upon the severity of poisoning. A dose of 15 to 30 mg/kg intravenously in aqueous solution is given initially. A dose of 500 to 1000 mg in 25 ml of sterile water can be repeated after 30 min if no improvement is observed. No more than 2000 mg should be given. Dosage may be increased if given with atropine. A combination of PAM and DAM exert a synergistic effect on cholinesterase reactivation.

k. Toxicity. Same as for PAM chloride.

l. Therapy. Not known.

m. Storage. Aqueous solutions at pH 4.5 at 25°C have a half-life of over 3 years.

n. History.

- 1953: Synthesized by Wilson in the United States.
- 1957: US pat 2 816 113 (US Sec. of the Army).

14. (U) Pralidoxime Methanesulfonate

a. (U) Code or Alternate Designations.

- 7676 RP.
- P2S.

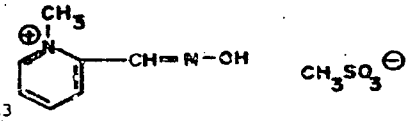
- 2-PAM methanesulfonate.
- Contrathion.
- Pralidoxime mesylate.
- AMP.

b. (U) Class. Oxime (pyridine quaternary oxime).

c. (U) Chemical Names.

- Pyridine-2-aldoxime methanesulfonate.
- 2-Hydroxyiminomethyl-N-methylpyridinium methanesulfonate.

d. (U) Formula. $C_9H_{12}N_2O_4S$



Reg. 513213

e. (U) Molecular Weight. 232.2.

f. (U) Method of Preparation. Prepared from pyridine-2-aldehyde with hydroxylamine hydrochloride in aqueous sodium carbonate, followed by addition of methyl methanesulfonate in benzene.

g. (U) Physical and Chemical Properties.

- Physical state and color: White needles.
- Melting point: 155° to 157°C (crystallized from alcohol).
- Solubility: Highly soluble in water and physiological saline solution.

h. (C) Use. 9 57 (b)(1)

(b)(1)

i. (U) Physiological Effects. P2S is a cholinesterase reactivator. As a therapeutic, P2S relieves muscle tightening, spasm, and difficulty in breathing. Blood pressure is also increased along with a reversal of the tendency of recurrent periphery respiratory failure. P2S is ineffective against GD and cannot penetrate the

blood-brain barrier. Toxic doses cause restlessness, fast respiration, drowsiness, tremor, and finally collapse. Oral preparations of P2S have been used prophylactically and therapeutically. Because of the relatively slow rate of absorption into the body via the intestinal tract, the oral route is generally recommended only under circumstances when poisoning is mild, when the cholinesterase inhibitor undergoes transformation to a more toxic substance in the body (for example, parathion to paraoxon), or when the oxime is given as a prophylactic. A mixture of P2S with diacetylmonoxime, used prophylactically, was twice as effective as diacetylmonoxime alone against GB poisoning. A combination of P2S and monoisonitrosoacetone produced a prophylactic effect eight times greater than P2S alone.

j. (U) Dosage. Safe dose is 30 mg/kg intramuscularly for man.

k. (U) Toxicity. More toxic than PAM; acute oral toxicity to rats is 6.9 g/kg.

l. (U) Therapy. Piperoxan.

m. (U) Storage. Stable in aqueous solutions at pH 4.0. The solid form is stable indefinitely.

n. (U) History.

- 1958: Described by Poziomek et al.
- 1958: US pat. 2 996 510, Green (National Research and Development Co.).

15. (U) TMB-4

a. Code or Alternate Designations.

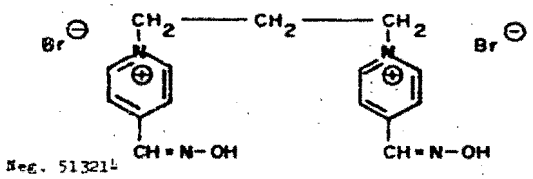
- US ——— EA 1814.[122]
- E. Germany ——— Trimedoxime.
- USSR ——— Dipyroxime.

b. Class. Oxime (pyridine quaternary oxime).

c. Chemical Names.

- 1,1'-Trimethylene-bis (4-formyl-pyridinium bromide) dioxime.
- N,N'Trimethylene-bis(pyridinium-4-aldoxime)dibromide.

d. Formula. $C_{15}H_{18}Br_2N_4O_2$



Neg. 513214

e. Molecular Weight. 446.21.

f. Method of Preparation. Prepared by refluxing 1,3 Dibromopropane with 4-pyridinium aldoxime in absolute alcohol.

g. Physical and Chemical Properties.

- Physical state and color: Crystals.
- Melting point: 241°C with decomposition.
- Solubility: Soluble in water and physiological saline; insoluble in chloroform and fats.

h. Use. TMB-4 is a prophylactic and therapeutic for nerve agent poisoning and can be used alone or combined with atropine. The effectiveness varies with the species of animals.

i. Physiological Effects. TMB-4 is an effective cholinesterase reactivator. In terms of therapeutic effectiveness it is 15 to 20 times stronger than PAM, but it reportedly has more toxic side effects. Deleterious effects have been observed on administration to GD-intoxicated animals. TMB-4 does not readily penetrate the blood-brain barrier.

j. Dosage. A 10 mg/kg dose reverses the Sarin effect in rabbits. A 25 to 50 mg/kg dose of TMB-4, intraperitoneally, counteracts the lethal dose in mice. A 7 mg/kg dose, intravenously, reactivates 40% to 60% of GA-inhibited cholinesterase within 4 hours.

k. (U) Toxicity (U). It is 3.5 times more toxic for man than PAM, but less toxic than P2S. Lethal dose is 1000 mg/70 kg for man. LD_{50}, intravenously, for mice is 53 mg/kg. LD_{50}, intraperitoneally, for mice is 6.38 mg/kg; for guinea pigs, 87 mg/kg; and for rats, 137 mg/kg.

l. (U) Therapy (U). Not known.

m. (U) Storage (U). Ten times more stable than PAM; normal drug storage procedures should be used.

n. (U) History (U). 1957: Prepared by Poziomek et al.

15.1. Dialkob (U)

a. (U) Code or Alternate Designations (U). Cobalt (+3) chelate.

b. (U) Class (U). Non-oxime reactivator.

c. (U) Chemical Name (U). Bis (N-allyldiethanolamine) cobalt chloride.

d. (U) Formula (U). $C_{14}H_{30}O_4N_2CoCl_3$

$$Co\,[C_3H_5N(C_2H_4OH)_2]_2\,Cl_3$$

e. (U) Synthesis (U). An aqueous solution containing 0.01 mole of $[Co(NH_3)_5Cl]\,Cl_2$ is heated for 5 hours at 60°C with 0.025 mole of allyldiethanolamine and 0.1 mole of NaOH. The red-violet crystals that are formed are filtered and recrystallized. The alkaline solution of the reaction deprotonates the four ethanolic OH groups, resulting in the incorporation of Na (+1) as a counterion.

f. (U) Physical Properties (U).

- Crystalline
- Water soluble

g. (U) Use (U). Cholinesterase reactivator. The mechanism of action is currently not known but is believed to be analogous to transition-metal-ion-catalyzed hydrolysis of organophosphorus esters.

h. (U) Physiological Effects (U). Dialkob is claimed by the Soviets to show a marked therapeutic effect in rats poisoned with the organophosphorus pesticide DDVP. The therapeutic index (TI), which is the factor by which the lethal dose is raised, for a 5 mg/kg dose of dialkob was 3.1. The TIs for 5 mg/kg of TMB-4 and 20 mg/kg of 2-PAM were 3.2 and 2.7, respectively. In

combination with atropine, the ratio for dialkob was raised to 8.2 versus 7.6 and 6.2 for TMB-4 and 2-PAM, respectively. The effectiveness of dialkob has not been verified in Western laboratories.

i. (U) Dosage (U). Experimental, 5-25 mg/kg in rats.

j. (U) Toxicity (U). LD_{50} is 1000 mg/kg.

k. (U) Stability (U). Low pH increases the rate of hydrolysis in aqueous solution.

l. (U) Historical (U).

- 1974--Soviet patent, Evreev et al., USSR 449 720
- 1979--Soviet clinical trials

16. Toxogonin (U)

a. (U) Code or Alternate Designations (U).

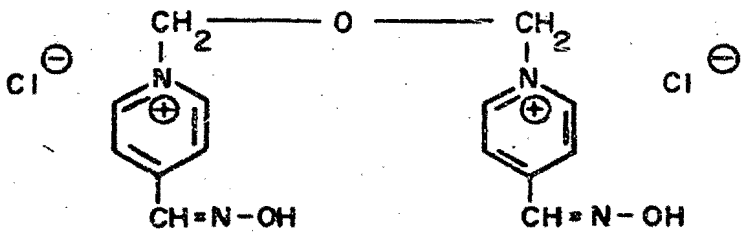
- Obidoxim
- LuH6
- BH6
- S100
- Toxogenin

b. (U) Class (U). Oxime (pyridine quaternary oxime).

c. (U) Chemical Names (U).

- Bis(4-hydroxyiminomethyl-pyridinium-1-methyl) ether dichloride
- Dimethyl-bis-(4-hydroxyiminomethyl-pyridine) ether dichloride

d. (U) Formula (U). $C_{14}H_{16}N_4O_3Cl_2$



Neg. 513215

e. (U) Molecular Weight (U). 359.22.

f. (U) Method of Preparation (U). Most effective method is the conversion of pyridine-4-aldoxime with α, α' dichlorodimethyl ether.

g. (U) Physical and Chemical Properties (U).

- Physical state and color: Fine white powder; turns yellow on standing; slight bitter taste
- Odor: Odorless
- Solubility: Freely soluble in water
- Decomposition temperature: 225°C

h. Use (U).

(1) (U) As a therapeutic, Toxogonin is effective for 1.25 to 2 hours after administration, the effectiveness increasing when used in conjunction with atropine. Toxogonin is an effective prophylactic when injected intramuscularly 1 hour prior to exposure. It is not effective orally.

(2) (U) (b)(1)

(b)(1)

i. (U) Physiological Effect (U). (b)(1)

(b)(1)

j. Dosage (U).

(1) (~~X~~) (b)(1)

(b)(1)

(2) (U) Atropine-Toxogonin antidote mixtures, consisting of 2 mg of atropine sulfate and 150 mg Toxogonin in 1.5 mL of water (preserved with 0.065% methyl paraben and 0.035% propyl paraben), are available in ampoules for use with the Swedish "Astra" autoinjector.[126]

k. (U) Toxicity (U). Less toxic than TMB-4. Orally, its toxicity is approximately 250 g/man. LD_{50} for mice is approximately 2.2 g/kg.

l. (U) Therapy (U). Not known.

m. (U) Storage (U). Stable for months in 1% to 10% solutions. Shelf life is at least 2 years in powder form.

n. (U) History (U). 1960: developed by Merck in West Germany; developed independently in East Germany at approximately the same time.

16.1. DINA (U)

a. (U) Code or Alternate Designations (U). Diisonitrosoacetone.

b. (U) Class (U). Oxime.

c. (U) Chemical Formula (U). $C_3H_4O_3N_2$.

HON=CHC(O)CH=NOH

d. (U) Use (U). DINA is more active in CNS than 2-PAM, but it is effective only in amounts close to the LD.

16.2. Isonitrosine (U)

a. (U) Code or Alternate Designation (U). Isonitrosin.

b. (U) Chemical Name (U). 1-dimethylamino-2-isonitroso-3-butanone.

c. (U) Formula (U). $C_6H_{12}O_2N_2$.

$(CH_3)_2NCH_2C(NOH)C(O)CH_3$

d. (U) Molecular Weight (U). 144.

e. (U) Use (U). Used by the Soviets as an enzyme reactivator having primarily central effects.

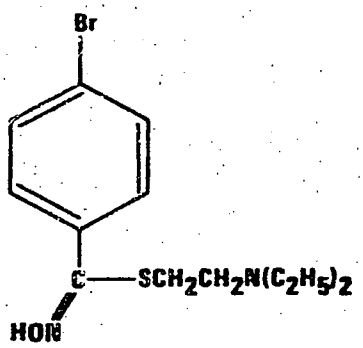
f. (U) Dosage (U). Humans, 3 mL of a 40% solution every 1 to 2 hours.

g. (U) Toxicity (U). LD_{50} > 920 mg/kg i.m. in mice.

16.3. P-bromobenzothio-hydroxime-S-diethylaminoethylate (U)

a. (U) Code or Alternate Designations (U). LA-54 (WP), diethyxime (WP).

b. (U) Formula (U). $C_{13}H_{19}ON_2BrS$.



c. (U) Use (U). This compound is being tested clinically in the USSR.

d. (U) Physiological Effects (U). The Soviets claim that LA-54 is an effective centrally acting oxime. Other countries have not been able to reproduce the optimistic Soviet results.

e. (U) Toxicity (U). LD_{50} > 600 mg/kg i.m. in mice.

16.4. (4-hydroxyiminomethyl-pyridinium-1-ethyl) Sulfoxide Dichloride (U)

a. ~~(C)~~ Code or Alternate Designation (U). (b)(1)

b. ~~(C)~~ Formula (U). (b)(1)

(b)(1)

c. (c) Use (U). (b)(1) [redacted]

16.5. Trimethylene-1-(4-hydroxyiminomethyl-pyridinium)-3-N-methyl morphorinium Dibromide (U)

a. (U) Code or Alternate Designation (U). TPMM.

b. (FOUO) Use (U). (b)(1) [redacted]

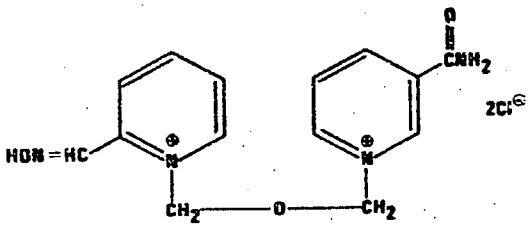
(b)(1) [redacted]

16.6. HI and HS Series (U)

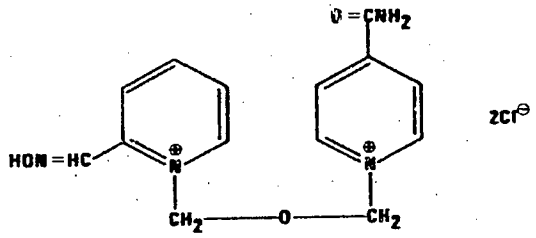
a. (U) Class (U). Bispyridinium oximes.

b. (U) Formula (U). $C_{14}H_{16}O_3N_4Cl_2$.

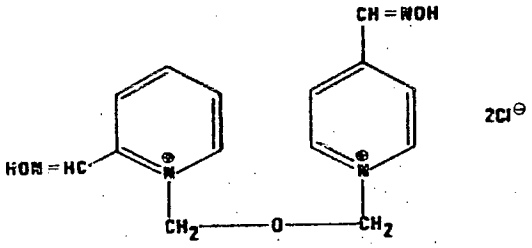
HS - 6



HI - 6



HS - 3



c. (U) Chemical Names (U).

- HS-6 1-(2-hydroxyiminomethylpyridinium)-1-(3-carboxy amido-pyridinium)-dimethyl ether
- HI-6 1-(2-hydroxyiminomethylpyridinium)-1-(4-carboxy amido-pyridinium)-dimethyl ether
- HS-3 1-(2-hydroxyiminomethylpyridinium)-1-(4-hydroxy imino-methylpyridinium)-dimethyl ether

d. (U) Use (U). Potential therapeutic agents for soman intoxication.

e. (U) Toxicity (U). HS-6 has an i.p. LD_{50} in the mouse of 232 mg/kg. HI-6 has an i.p. LD_{50} in the mouse of 295 mg/kg.

16.7. 3-diethylaminopropyl 1-formylacetate Oxime (U)

a. (U) Code or Alternate Designation (U). OA3.

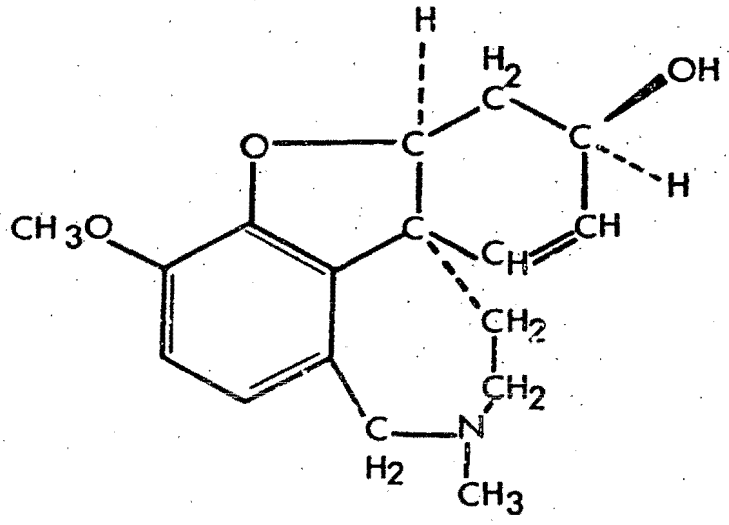
b. (U) Use (U). OA3 has been found to be a very effective centrally active oxime.

D.3 ANTICHOLINESTERASES (U)

16.8. Galanthamine (U)

a. (U) Code or Alternate Designations (U). Lycoremine, Jilkon, Nivalin (hydrobromide).

b. (U) Formula (U). $C_{17}H_{21}NO_3$.



Neg. 517703

c. (U) Molecular Weight (U). 287.

d. (U) Toxicity (U). LD_{50} in mice is 8.0 mg/kg i.v. and 18.7 mg/kg orally.

e. (U) Physical and Chemical Properties (U).

- Fairly soluble in hot water; freely soluble in alcohol, acetone, chloroform
- The hydrochloride is soluble in hot water but very sparingly soluble in alcohol and acetone.

f. (U) Use (U). The Soviet Union has 1-mL ampules containing 0.25%, 0.5%, or 1.0% solutions. One mL of a 0.5% solution can be given twice a day.

g. (U) Physiological Effects (U). Galanthamine penetrates the blood-brain barrier and facilitates the transmission of impulses in the synapses of the central nervous system.

16.9. Carbamates (U)

a. (U) Constituents (U). Pyridostigmine (16.10), physostigmine (16.12), and neostigmine (16.13).

b. (U) Molecular Weights (U). 261, 275, and 303, respectively.

c. (U) Use (U). Carbamates are considered to have excellent potential for use as prophylactics against organophosphorus poisoning. The Soviet Union has neostigmine in 15-mg tablets and in ampules containing 1 mL of a 0.05% solution. The maximum internal single dose in the Soviet Union is 15 mg. Fifty mg may be given daily. Carbamates are useful for treating myasthenia gravis and for reversing poisoning caused by cholinolytic agents.

d. (U) Physiological Effects (U). Carbamates inhibit the destruction of acetylcholine by AChE, thus facilitating transmission of impulses across the myoneural junction (see fig in sec I, para 1). Side effects include nausea, abdominal cramps, diarrhea, increased bronchial secretions, miosis, diaphoresis, muscle cramps, and weakness. The side effects are least severe with pyridostigmine, more severe with physostigmine, and most severe with neostigmine.

e. (U) Dosage (U). US recommended doses are 60 to 180 mg of pyridostigmine bromide three to six times a day orally, 0.5 to 2.0 mg i.m. or i.v. of physostigmine salicylate, and 15 to 30 mg of neostigmine bromide three to six times a day orally.

f. (U) Contraindications and Precautions (U). All of the carbamates are contraindicated in cases of mechanical intestinal or urinary obstruction. In addition, pyridostigmine should not be used in the presence of asthma; physostigmine should not be used in the presence of gangrene or asthma and should not be administered with neuromuscular blocking agents such as decamethonium or succinylcholine; neostigmine is contraindicated in the presence of halothane or cyclopropane and requires adjustments of the dosage of certain antibiotics (neomycin, streptomycin, and kanamycin) that can accentuate neuromuscular block.

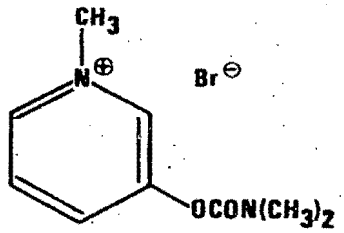
16.10. Pyridostigmine (U)

a. (U) Code or Alternate Designations (U). Mestinon bromide, balymin, RO 1-5130.

b. (U) Chemical Names (U).

- 3-hydroxy-1-methylpyridinium bromide dimethylcarbamate
- 1-methyl-3-hydroxypyridinium bromide dimethylcarbamate
- 3-(dimethylcarbamyloxy)-1-methylpyridinium bromide

c. (U) Formula (U). $C_9H_{13}BrN_2O_2$.



16.12. (C-NOFORN) (b)(1)

(b)(1)

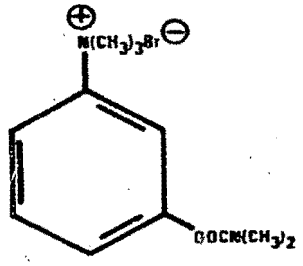
16.13. (U) Neostigmine Bromide

a. Code or Alternate Designations. Proserine bromide (USSR), synstigmin bromide, eustigmine bromide, neoserine, stigmosan, vasostigmine bromide, philostigmin bromide, prostigmin bromide.

b. Chemical Names.

- (m-hydroxyphenyl)trimethyl-ammonium bromide dimethylcarbamate.
- (3-dimethylcarbamoxyphenyl)trimethylammonium bromide.

c. Formula. $C_{12}H_{19}BrN_2O_2$



d. Use. Reports indicate that its effectiveness is greatly increased when it is used with atropine.

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D.4 TRANQUILIZERS

15.14. (C) (b)(1)

(b)(1)

16.15. (C-NOFORN) (b)(1)

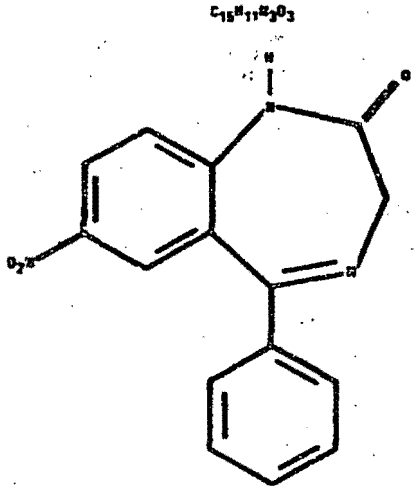
(b)(1)

16.16. (U) Nitrazepam

a. Code or Alternate Designations. Nitrenpax, mogadan, nogadon, sonebon.

b. Chemical Name. 1,3-dihydro-7-nitro-5-phenyl-2H-1,4-benzodiazepin-2-one.

c. Formula.



16.17. (C) (b)(1)

(b)(1)

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16.18. (U) Mydocalm

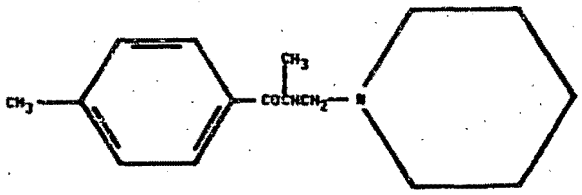
a. Code or Alternate Designations. Mydetron (USSR), mydetone.

b. Chemical Names.

- 2,4'-dimethyl-3-piperidino-propiophenone.
- 1-piperidino-2-methyl-3-(p-tolyl)-3-propanone.

c. Formula.

$C_{16}H_{23}NO$



16.19. (C-NOFORN) (b)(1)

(b)(1)

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d. (C-NOFORN) Use (U). (b)(1)

(b)(1)

D.5. SYMPATHOMIMETICS (U)

16.20 Amfepramone (U)

a. (U) Code or Additional Names (U). Anorex, Danglen, Dobesin, Frekentine, Kermik, Kermin, Magrene, Modulor, Parabolin, Prefamone, Regenone, Tenuate, Tenuate Dospan, Tepanil, Tylinal.

b. (U) Class (U). Sympathomimetic agent, anorexic agent.

c. (U) Chemical Names (U).

- 2-diethylamino-1-phenyl-1-propanone
- 2-diethylaminopropiophenone
- d-benzoyltriethylamine
- diethylpropion

d. (U) Formula (U). $C_{13}H_{19}NO$.

$$C_6H_5COCHN(C_2H_5)_2$$
$$|$$
$$CH_3$$

e. (U) Molecular Weight (U). 205.30.

f. (U) Physical and Chemical Properties (U).

- Crystals (hydrochloride)
- Decomposes at 168°C

g. (U) Method of Preparation (U). Chemically synthesized by method of Hyde, 1928.

h. (C-NOFORN) Use (U). (b)(1)

(b)(1)

i. (U) Physiological Effects (U). Amfepramone is a sympathomimetic amine with pharmacological activity similar to that of the amphetamines. Actions include CNS stimulation and elevation of blood pressure.

j. (U) Toxicity (U). Adverse reactions are an extension of the pharmacological action and include tachycardia, elevated blood pressure, insomnia, dizziness, anxiety, euphoria, and psychotic episodes.

k. (U) Contraindications and Precautions (U). Tolerance to the actions of the drug develops with repeated use and there is potential for drug abuse. The drug is contraindicated in hyperthyroidism or advanced arteriosclerosis. Amfepramone should not be administered during or within 14 days following the administration of monoamine oxidase inhibitors, since a hypertensive crisis may result. Insulin dosages must be adjusted.

l. (U) Therapy (U). Largely symptomatic and includes sedation with a barbiturate.

m. (U) Storage (U). Very stable; store with usual precautions.

m. (U) History (U). 1961: US patent 3 001 910.

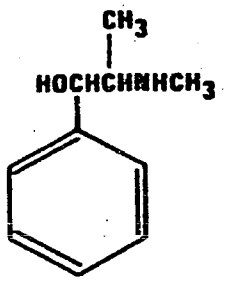
16.21 Ephedrine (U)

a. (U) Code or Additional Names (U). Ephetonin, Racephedrine Hydrochloride, Biophedrin, Ephedral, Ephedrosat, Sanedrine.

b. (U) Chemical Names (U).

- α-[1-(methylamino) ethyl] benzenemethanol
- 2-methylamino-1-phenyl-1-propanol

c. (U) Formula (U). $C_{10}H_{15}NO$.



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d. (U) Molecular Weight (U). 165.

e. (U) Physical and Chemical Properties (U).

- Crystals; melts at 79°C
- Soluble in water, alcohol, ether, chloroform, and oils

f. (U) Use (U). The Soviet Union produces powder, 25-mg tablets, and ampules containing 1 mL of a 5% solution of ephedrine hydrochloride. It is used for collapse, shock, and poisonings.

g. (U) Physiological Effects (U). Causes constriction of blood vessels and an increase in arterial blood pressure. Stimulates the heart and dilates the pupils. Although less potent than adrenalin, it is effective longer and produces a pronounced stimulating effect on the central nervous system.

h. (U) Dosage (U). Twenty-five to fifty milligrams two to three times per day internally; 0.5 to 1 mL of 5% solution one to two times per day intramuscularly (USSR).

i. (U) Side Effects (U). Nausea, vomiting, mild tremor, heart pain, nervousness, and headache.

D.6. NERVE AGENT ANTIDOTES IN USE (U)

16.22. Military Nerve Agent Antidotes (U)

(C-NOFORN)	(b)(1)
(b)(1)	

16.23. Civil Defense Nerve Agent Antidotes (U)

(U) Most countries have atropine available for use by the civilian population. The Soviet Union also has prophylactic taren tablets and substitutes for taren, such as tablets of benactyzine, amedine, aprophen, and spasmolytin.

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★(U) Military Nerve Agent Antidotes

(CONFIDENTIAL)

(b)(1)

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CONFIDENTIAL

(U) Military Nerve Agent Antidotes (Continued)

(CONFIDENTIAL)

(b)(1)

(b)(1)

(CONFIDENTIAL)

D.7. EXPERIMENTAL ANTIDOTE MIXTURES (U)

16.24. ASP-3 (Bulgaria) (U)

a. (U) Components (U). Unknown combination of cholinolytics and oximes.

b. (U) Effectiveness (U). ASP-3 is claimed to be more effective than the Nemikols (para 16.27).

16.25. AV-72 (Bulgaria) (U)

a. (U) Components (U). This mixture is an unknown combination of cholinolytics and oximes.

b. (U) Status (U). AV-72 appears to be the successor to ASP-3 and may be the mixture listed in paragraph 16.26.

c. (U) Effectiveness (U). The Bulgarians believe AV-72 is effective against VX.

16.26. Unnamed (Bulgaria) (U)

a. (U) Components (U). One mg atropine sulfate, 100 mg Toxogonin, 5 mg ethylbenztropine hydrochloride, and 5 mg ephedrine hydrochloride.

b. (U) Status (U). A West German patent was obtained by the Bulgarians in 1978 on this organophosphorus antidote, which may be AV-72.

c. (U) Effectiveness (U). This mixture is effective against light poisoning and in the initial stages of heavier poisoning. Higher concentrations of the constituents are recommended for use in hospitals.

16.27. Nemikols (Bulgaria)[169] (U)

a. (C) Components (U). (b)(1)

(b)(1)

b. (C) Status (U). (b)(1)

(b)(1)

c. (U) Effectiveness (U). Nemikol 4 has been claimed to be effective prophylactically against GD; Nemikol 5 has been shown by Bulgarian researchers to be effective both prophylactically and therapeutically against GD.

16.28. TAB (Probably Bulgaria)[170] (~~C~~)

a. (~~C~~-NOFORN) Components (U). (b)(1)

(b)(1)

b. (~~C~~-NOFORN) Status. (b) (1) Per NSA

(b)(1)

c. (~~C~~-NOFORN) Effectiveness (U). (b)(1)

(b)(1)

16.29 Unnamed (Yugoslavia)[171] (U)

a. (U) Components (U). Two mg atropine sulfate, 3 mg benactyzine hydrochloride, and 1000 mg 2-PAM.

b. (U) Status (U). An experimental mixture used in field trials and reported to have excessive side effects.

16.30 Morsafen (Soviet Union)[172] (U)

a. (~~C~~) Components (U). (b)(1)

(b)(1)

b. (~~C~~) Status (U). (b)(1)

(b)(1)

16.31 Unnamed (United Kingdom) (U)

a. (U) Components (U). Two mg atropine sulfate and 500 mg P2S.

b. (U) Status (U). Will become the standard fill for the British autoject.

E. HALLUCINOGEN ANTIDOTES (U)

17. Chlorpromazine (U)

a. (U) Code or Alternate Designations (U).

- United States--SKF 2601A, Thorazine

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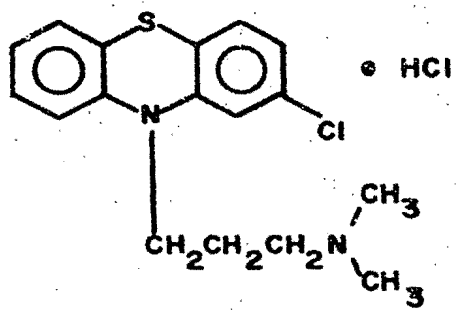
- Canada--Largactil
- Japan--Wintermin
- Sweden--Megaphen Hibernal
- Brazil--Amplictin
- Norway--Largactil, Hibanyl
- Hungary--Plegomazine
- East Germany--Megaphen, Largactil
- USSR--Aminazin

b. (U) Class (U). Therapeutic for LSD.

c. (U) Chemical Name (U). 2-chloro-10-(3-dimethylaminopropyl) phenothiazine hydrochloride.

d. (U) Formula (U). $C_{17}H_{19}ClN_2S \cdot ECl$.



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e. (U) Molecular Weight (U). 355.4.

f. (U) Method of Manufacture (U). Prepared form 2-chloro-diphenylamine, sulfur, sodamide and 3-dimethylaminopropyl chloride. US patent 2 645 640 to Rhone-Poulenc in 1953 for preparation.

g. (U) Equipment (U). Standard chemical processing equipment.

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h. (U) Physical and Chemical Properties (U).

- Physical state and color: Free base is an oily liquid; hydrochloride is a white or yellow crystalline powder; turns black on exposure to light.
- Boiling point: Free base is a liquid boiling at 200° to 205°C at 107 Pa.
- Melting point: Hydrochloride--179° to 180°C by capillary (decomposes); 194° to 196°C on microblock.
- Solubility: Hydrochloride is freely soluble in water, alcohol, and chloroform; insoluble in ether and benzene; and is hygroscopic.

i. (U) Use (U). Antidote for LSD, and possibly for mescaline. Also, a tranquilizer.

j. (U) Physiological Effects (U). Chlorpromazine depresses conditioned reflexes, brings about a condition of indifference toward environment, causes sleepiness, eliminates anxiety and tension, and decreases body temperature without slowing down metabolism. The compound is neither a hypnotic nor an anesthetic, but it does enhance and prolong the effects of drugs with this action. Chlorpromazine has no effect on the peripheral nervous system but frequently causes dizziness, general weakness, fainting, headache, dryness of mouth, goose pimples, and nausea.

k. Therapy. Physostigmine (an anticholinesterase).

l. Storage. Store in dark, well-stoppered glass containers in a dry place and protected from light.

m. Toxicity. Doses of 200 mg cause convulsions similar to epilepsy. Fatal poisonings are rare.

n. Historical. 1952: US pat. 2,645,640 (prepared by Charpentier et al., in France).

18. (U) Reserpine

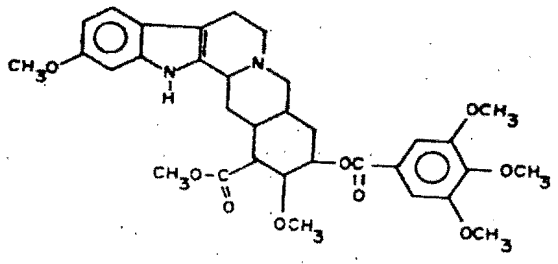
a. Code or Alternate Designations.

- Serpasil in United States, United Kingdom, USSR, Poland, Canada, France, Sweden, Italy, Austria, Belgium.
- Japan — Apoplon.
- Also known as Serfin, Race-sed, Serpanray, Sandril, and Reserpex.

b. Class. Therapeutic for LSD.

c. Chemical Name. 3,4,5-Trimethoxybenzoyl methyl reserpate.

d. Formula. $C_{33}H_{40}N_2O_9$



e. Molecular Weight. 608.70.

f. Method of Manufacture. Extraction from crude oleorum from the roots of Rauwolfia serpentina, L. Benth and R. Vomitoria. Difficulties arise because it is accompanied by at least six other alkaloids which have somewhat similar structures and physical properties. Synthesis developed by Woodward et al., in 1956.

g. Equipment. Standard chemical processing equipment.

h. Physical and Chemical Properties.

- Physical state and color: White crystalline powder.
- Melting point: Melts 250° to 260°C.
- Decomposition temperature: 264° to 265°C.[4]
- Solubility: Freely soluble in chloroform, methylene chloride; soluble in benzene, ethyl acetate; slightly soluble in water, acetone, methanol, and ether.

i. Use. Tranquilizer, antidote for LSD and possibly for mescaline.

j. Physiological Effects. Reserpine has a tranquilizing effect on the central nervous system. The drug reduces high blood pressure, reduces motor activity, causes drowsiness, excessive salivation, diarrhea, and mental depression. In large doses, Parkinsonism may occur.

k. Therapy. Effects removed by inhibitors of monoamino oxidase.

l. Toxicity. Relatively nontoxic.

m. Historical.

- 1954: Isolated and structure identified by Dorfman et al. in Switzerland.
- 1956: Synthesized by Woodward et al. in United States.
- 1958: US pat. 2,833,771, Mueller, Schwyzer (Ciba).

19. (U) Serotonin

a. Code or Alternate Designations.

- Enteramine.
- Thrombocytin.

- Thrombotonin.
- Antenovis.

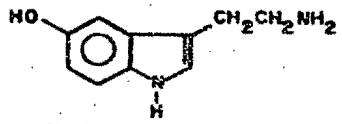
b. Class. Vasoconstrictor, neural function regulator.

c. Chemical Name. 5-Hydroxytryptamine.

d. Alternate Chemical Names.

- 3-(2-Aminoethyl)5-indolol.
- 3-(β-Aminoethyl)-5-hydroxy indole.

e. Formula. $C_{10}H_{12}N_2O$



Neg. 513218

f. Molecular Weight. 176.21.

g. Method of Preparation. Serotonin is present in the blood stream of all mammals and has been isolated from beef serum and ox blood in crystalline form. The best source is from poisonous organs and secretions of invertebrates (posterior salivary gland of Octopus vulgaris). It is extracted with acetone. The compound is absent in cephalopods. Serotonin has been synthesized from 5-benzyloxyindole.

h. Physical and Chemical Properties.[3]

- Physical state: Crystalline material.
- Melting point: Hydrochloride, 167° to 168°C.
- Solubility: Soluble in water, glacial acetic acid; slightly soluble in methanol, 95% ethanol; insoluble in absolute ethanol, acetone, pyridine, chloroform, ethyl acetate, ether, benzene.

i. Use. Vasoconstrictor and as an antagonist of LSD, indoles, atropine, novacaine, and antihistamines.

j. Storage. Aqueous solutions of hydrochloride are stable at pH 2.0 to 6.4. Serotonin is heat stable.

k. Physiological Effects.[100] Serotonin stimulates a variety of smooth muscles and nerves. The wide spectrum of responses to the chemical include the cardiovascular, respiratory, and gastrointestinal systems. Serotonin is a potent vasoconstrictor and produces bradycardia and electrocardiographic disturbances. The compound also stimulates intestinal motility, respiratory rate, and causes bronchoconstriction.

1. History.

- 1951: Synthesis, Speeter, Heinzelmann, Weisblat.
- 1955: US pat. 2 715 129, Hamlin (Abbott Labs).
- 1960: US pat. 2 947 757, Justoni, Pessina (Vismara).

19.1. (U) Thiopropazate and Chlorphencyclan

a. Code or Alternate Designation. Vestian.

b. Use.

- Effective in treatment of hallucinatory paranoid psychosis.
- May be useful as antidote for LSD.

19.2. (C) Physostigmine Salicylate

(b)(1)

19.3. Galanthamine (U)

a. (U) Code or Alternate Designations (U). (b)(1)

(b)(1)

b. (U) Formula (U). (b)(1)

c. (U) Use (U). (b)(1)

(b)(1)

F. ANTIDOTES FOR INCAPACITANTS AND RESPIRATORY TRACT IRRITANTS (U)

20. 1, 2, 3, 4-tetrahydro-9-aminoacridine (U)

a. (U) Code or Alternate Designation (U). Tacrin.

b. (U) Use (U). It is a possible antidote for BZ.

21. Undesignated (U)

a. (U) Components (U). (b)(1)

b. (U) Status (U). (b)(1)

(b)(1)

22. Haloperidol (U)

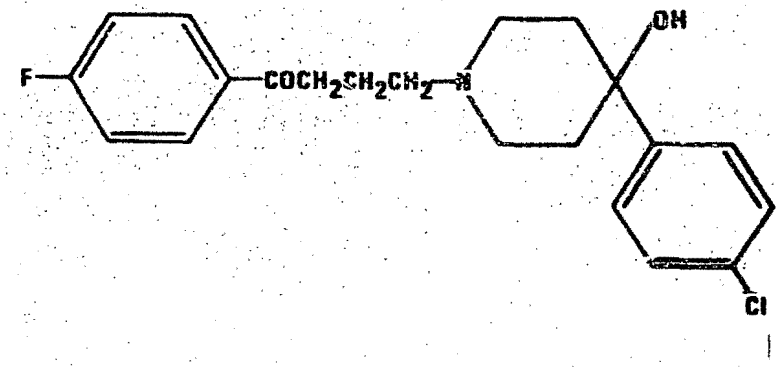
a. (U) Code or Additional Names (U). R1625; Aloperidine; Haldol; Keselan; Serenace; Serenase.

b. (U) Class (U). Tranquilizer, butyrophenone.

c. (U) Chemical Names (U).

- 4-[4-(4-Chlorophenyl)-4 hydroxy-1-piperidinyl]-1-(4-Fluorophenyl)-1-butanone
- 4-[4-(p-chlorophenyl)-4-hydroxypiperidino]-4'-fluorobutyrophenone

d. (U) Formula (U). $C_{21}H_{23}ClFNO_2$



e. (U) Molecular Weight (U). 375.88.

f. (U) Physical and Chemical Properties (U).

- Crystals
- Melting point: 148.0°-149.4°C
- Soluble in water; freely soluble in chloroform, methanol, acetone, benzene, dilute acids

g. (U) Method of Preparation (U). Chemically synthesized by the method of Janssen, 1959.

h. (U) Use (U). Haloperidol is used in management of psychotic disorders and also to control tics and involuntary vocal utterances of Gilles de la Tourette's syndrome. Used for treating BZ intoxication in the Soviet Union.

i. (U) Physiological Effects (U). The precise mechanism of action has not been established, but haloperidol's actions resemble those of the piperazine phenothiazines. It has prominent effects on the CNS, but has little anticholinergic activity. It blocks the activation of receptors by sympathomimetic amines but is less potent than chlorpromazine in this action.

j. (U) Dosage (U). There is considerable variation from patient to patient in the amount of medication required for therapy. Typical doses range from 0.5 mg to 5.0 mg total internal dose.

k. (U) Toxicity (U). The LD_{50} in the rat is 165 mg/kg orally and 63 mg/kg subcutaneously.

l. (U) Contraindications and Precautions (U). Haloperidol is contraindicated in patients who are comatose or have severe CNS depression. The drug will impair the mental and physical abilities required for the performance of tasks such as operating machinery. Because haloperidol lowers the convulsive threshold, adequate anticonvulsant therapy may be needed in special cases. Lithium and methyldopa increase the toxicity of haloperidol.

m. (U) Therapy (U). Supportive treatment. Epinephrine should not be used.

n. (U) History (U).

- 1958: synthesized by Janssen
- 1967: marketed in United States by McNeil Laboratories

23. Bemegride (U)

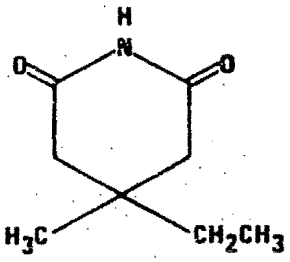
a. (U) Code or Additional Names (U). NP13; Mikedimide (Panray); Eukraton; Malysol, Megimide.

b. (U) Class (U). Analeptic, antidote for incapacitants.

c. (U) Chemical Names (U).

- 4 ethyl-4 methyl 2-6-piperidinedione
- 3 ethyl-3-methylglutarimide

d. (U) Formula (U). $C_8H_{13}NO_2$.



e. (U) Molecular Weight (U). 155.19.

f. (U) Physical and Chemical Properties (U).

- Platelets from water
- Melting point: 127°C
- Soluble in water, acetone

g. (U) Method of Preparation (U). Chemically synthesized.

h. (U) Use (U). Bemegride is an analeptic and CNS stimulant and is used to counteract barbiturate poisoning. Used in the treatment of BZ incapacitation in the Soviet Union.

i. (U) Physiological Effects (U). Bemegride decreases neuronal recovery time so that a single stimulus produces repetitive discharge.

j. (U) Toxicity (U). LD_{50} in mice and rats are 18.8 and 17.0 mg/kg i.v., respectively.

k. (U) Contraindications and Precautions (U). In high doses may cause convulsions.

l. (U) Therapy (U). Antagonized by barbiturates.

24. Methotrimeprazine (U)

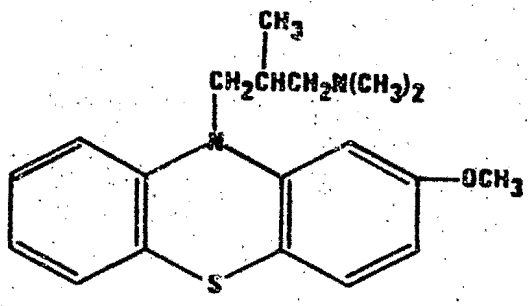
a. (U) Code or Additional Names (U). Levoprome, levomepromazine, levomeprazine, 2-methoxytrimeprazine, RP Levoprome, Sinogan-Debil, Tiscerin, Neozine, Nirvan.

b. (U) Class (U). Analgesic; phenothiazine.

c. (U) Chemical Names (U).

- 2-Methoxy-N, N, B-trimethyl-10H-phenothiazine-10-propanamine
- 10-(3-dimethylamino-2-methylpropyl)-2-methoxyphenothiazine

d. (U) Formula (U). $C_{19}H_{24}N_2OS$.



e. (U) Molecular Weight (U). 328.24.

f. (U) Physical and Chemical Properties (U).

- Normally produced as a salt
- Maleate salt; crystals, darkened by light
- Decomposes at 190°C
- Levorotary
- Sparingly soluble in water and in ethanol

g. (U) Method of Preparation (U). Chemically synthesized by the method of Courvoisier (1957).

h. (U) Use (U). Methotrimeprazine is used to relieve severe pain in nonambulatory patients. It is also used as a preanesthetic medication for producing sedation, somnolence, and relief of apprehension and anxiety. Used in the Soviet Union for treating BZ intoxication.

i. (U) Physiological Effects (U). Methotrimeprazine is a potent CNS depressant with sites of action postulated in the thalamus, hypothalamus, reticular, and limbic systems. It produces suppression of sensory impulses, reduction of motor activity, sedation, and tranquilization. It raises the pain threshold and produces amnesia. The drug also has an antihistaminic, anticholinergic, and antiadrenalin effect.

j. (U) Dosage (U). Ten to twenty mg administered deeply into a large muscle every 4 to 6 hours, as required.

k. (U) Toxicity (U). The LD_{50} in the rat is 1100 mg/kg orally and 45 mg/kg subcutaneously.

l. (U) Contraindications and Precautions (U).

(1) (U) Following administration of this drug, fainting and dizziness probably will occur; ambulation should be avoided or carefully supervised.

(2) (U) Use with great caution in conjunction with atropine, scopolamine and succinylcholine, because tachycardia and a fall in blood pressure may occur. Undesirable CNS effects, such as stimulation, delirium, and extrapyramidal symptoms, may be aggravated.

(3) (U) Do not use concurrently with antihypertensive drugs, including monoamine oxidase inhibitors.

(4) (U) Do not use in presence of comatose states or overdose of CNS depressants.

(5) (U) Do not use in the presence of severe myocardial, renal, or hepatic disease.

(6) (U) Dosage should be reduced and critically adjusted when used concomitantly with, or when sequence of use results in overlapping of effects of, the following: narcotics, barbiturates, general anesthetics, acetylsalicyclic acid, meprobamate, and reserpine.

m. (U) Therapy (U). Supportive measures.

APPENDIX I.

COLOR MARKINGS ON CHEMICAL WARFARE MUNITIONS
AND STORAGE CONTAINERS[5] 127-129

(U) Munitions are painted for the purpose of protection against corrosion and identification. Background paint of a specific color is ordinarily applied to the entire surface of the projectile with the exception of the rotating bands and the fuze. Colored bands or rings with appropriate lettering or stencil serve to identify the contents of the munitions, its use, code number, caliber, charging, date of manufacture, and to give other pertinent data.

(b)(1)

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REVIEW ON: 4 MARCH 2011

(C-NOFORN) (b)(1)

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(C) Toxic Agents and Munitions.

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APPENDIX II.

TOXICITIES OF VARIOUS NATURAL POISONS

AMPHIBIAN TOXINS

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Batrachotoxin	Kokoi frog	Steroid ester, $C_{31}H_{42}N_2O_6$ (538 MW)	LD_{50}: 0.002	NR	mouse[130]
Bufotenine	Bufo vulgaris Laur (toad). Also, Amanita Muscaria (Mushroom)	N,N-Dimethylserotonin $C_{12}H_{16}N_2O$ (204 MW)	Hallucinogen ID: 0.11 to 0.22	p.o.	man[130]
Bufotoxin	Bufo vulgaris (toad)	Nicotine-like $C_{40}H_{60}N_4O_{10}$ (757 MW)	LD_{50}: 0.39	i.v.	cat[131]

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ARTHROPOD TOXINS

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Beetle Larvae Poison	Diamphidia Beetle	High MW Protein	LD: 0.025	i.v.	rabbits[132]
Neurotoxin I	Androctonus australis scorpion venom	Protein (6822 MW)	LD_{50}: 0.019	NR	mouse[133]
Neurotoxin II	Androctonus australis scorpion venom	Protein (7249 MW)	LD_{50}: 0.01	NR	mouse[133]
Scorpion venom	Leiurus quinquestriatus scorpion	Mixture, mostly protein	MLD: 0.3 MLD: 0.1 MLD: 0.6	i.m. i.m. i.m.	mice[134] rats[134] dog[134]
Spider venom	Phoneutria fera spider	Mixture, mostly protein	LD_{50}: 0.76	NR	mice[135]

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BACTERIAL TOXINS

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Botulinum:					
Type A	Clostridium botulinum	Protein (12,000-1,000,000 MW)	LD_{50}: 2.7×10^{-8} LD: 1.25×10^{-6}	i.p. NR	mouse[96] mouse[108]
Type B	C. botulinum	Protein (60,000-500,000 MW)	LD_{50}: 2.7×10^{-8} LD: 1.25×10^{-6}	i.p. NR	mouse[96] mouse[111]
Type C	C. botulinum	Protein with an undetermined MW	LD_{50}: 1.4×10^{-7}	i.p.	mouse[96]
Type D	C. botulinum	Protein (1,000,000 MW)	LD_{50}: 1.3×10^{-8} LD: 4.0×10^{-7}	i.p. NR	mouse[96] mouse[111]
Type E	C. botulinum	Protein (18,000-200,000 MW)	LD_{50}: 1.7×10^{-7}	i.p.	mouse[96]
Diphtheria	Corynebacterium diptheriae	Protein (72,000 MW)	LD: 1.9×10^{-4}	NR	guinea pig[111]
Dysentery neurotoxin	Shigella sonnei	Protein (82,000 MW)	MLD: 1.0×10^{-6}	NR	rabbit[111]
Histolyticum alpha-toxin	Clostridium histolyticum	Protein	MLD: 0.0013	NR	mouse[136]

BACTERIAL TOXINS (Continued)

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Murine toxin	Pasteurella pestis	Protein	LD_{50}: 0.05	i.p.	mouse[111]
Perfringens toxin	Clostridium perfringens	Protein (40,500 MW)	LD: 0.004	NR	mouse[111]
Plague toxin	Pasteurella pestis	Protein	LD_{50}: 0.083	NR	rat[137,138]
Staphylococcal alpha-toxin	Staphylococcus aureus	Protein (44,000 MW)	LD: 0.002	NR	rabbit[111]
			LD_{50}: 0.05	NR	mouse[111]
Staphylococcal enterotoxin B	S. aureus	Protein (30,000 MW)	ED_{50}: $6x10^{-4}$	r.t.	dog[130]
			ED_{50}: 0.98	p.o.	dog[130]
			LD_{50}: 1.5	i.v.	dog[130]
			LD_{50}: 0.05	r.t.	dog[130]
			ED_{50}: $2.5x10^{-5}$	r.t.	man[130]
			LD_{50}: 0.039	r.t.	man[130]
Tetanus	Clostridium tetani	Protein (67,000 MW)	LD: $2x10^{-6}$	NR	mouse[111]
			LD: 0.003 to 0.004	NR	man[11]

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MARINE POISONS

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Amberjack Toxin	Seriola aureovittata (amberjack)	Similar to ciguatoxin	LD: 1.0	NR	mouse[139]
Crab toxin	Zosimus aenus (Xanthid crab)	Closely related to saxitoxin	LD: 0.0095	NR	mouse[140]
Eledoisin	Eledone moschatz (octopi)	Peptide	LD: 0.15-0.30	NR	dog[141]
Erabutoxin b	Laticauda semi-fasciata (sea snake)	Peptide (7,000 MW)	LD_{50}: 0.07	i.m.	rat[141]
Goby toxin	Gobius criniger (Ryukyu goby)	Similar to tetrodotoxin	LD: 0.22	NR	mouse[142]
Holothurin A	Actinopyga agassiy (sea cucumber)	Saponin	LD: 5-15	i.v.	mouse[141]
Laticotoxin a	Laticauda semifasciata (sea snake)	Peptide (7,000 MW)	LD_{50}: 0.13	i.m.	mouse[141]
Murexine	Murex trunculus (purple snail)	β-(4-imidazolyl) acrylylcholine	LD_{100}: 300 LD_{100}: 15 to 30	s.c. i.v.	mouse[130] mouse[130]

MARINE POISONS (Continued)

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Nereistoxin	Lumbreconeris heteropoda Marenz (marine annelid)	4-N,N-Dimethyl-amino-1, 2-dithiolane (149 MW)	MLD: 38 MLD: 1.8	NR NR	rat[143] rabbit[143]
Oyster toxin	Oyster	Probably impure saxitoxin	LD_{50}: 1.34	i.p.	mouse[144]
Pahutoxin	Pahu (Hawaiian box fish)	NR	MLD: 0.2	NR	mouse[141]
Palytoxin	Palythoa sp.	NR	LD_{50}: 1.5×10^{-4} LD_{50}: 4.0×10^{-4}	i.v. i.p.	mouse[130] mouse[130]
Prymnesin	Prymnesium parvum (yellow-green algae)	Glycolipid	LD_{50}: 1.4	i.p.	mouse[141]
Saxitoxin	Saxidomus giganteus (Alaskan clam)	$C_{10}H_{17}N_7O_4 \cdot 2HCl$ (372 MW)	LD_{50}: 0.001 LD_{50}: 0.002-0.007	i.p. i.v.	mouse[145] cat[130] rabbit[130]
Tetrodotoxin	Puffer fish	$C_{11}H_{17}N_3O_8$ (319 MW)	LD_{50}: 0.014 LD_{50}: 0.011 LD_{50}: 0.010 LD_{50}: 0.002	s.c. i.p. i.v. i.v.	mouse[107] mouse[107] mouse[107] rabbit[107]

PLANT TOXINS

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Abrin	Abrus precatorius	Protein (65,000 MW)	LD: 0.007	NR	man[2]
Aconite	Aconitum chasmanthum	Alkaloid	LD_{50}: 0.03 to 0.07	NR	mouse[146]
			LD_{100}: 0.06 to 0.11	NR	mouse[146]
Anisatine	Illicium anisatum L.	$C_{15}H_{20}O_8$	LD_{50}: 0.7	i.v.	mouse[11]
Bulbocapnine	Corydalis cava (herb)	Heterocyclic,	ID: 3.0 to 7.0	NR	man[130]
		$C_{19}H_{19}NO_4$ (325 MW)	LD_{50}: 195	s.c.	mouse[130]
Curare	Chondodendron tomentosum	Heterocyclic	LD_{50}: 0.20	i.v.	rabbit[130]
Dimorphandra	Dimorphandra mollis benth	Curare-like	LD_{50}: 20	NR	mouse[147]
Harmine	Penganum harmala L. (wild rue)	Indole $C_{13}H_{12}N_2O$	ID: 2.9	i.v.	man[130]
			MLD: 200	s.c.	rat[130]
Mescaline	Anhalonium lewinii (cactus)	3,4,5-Trimethoxy-phenylethylamine $C_{11}H_{17}NO_3$	Hallucinogen ID: 1.4 to 7.0	p.o.	man[130]

PLANT TOXINS (Continued)

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Muscarine	Amanita muscaria (mushroom)	Alkaloid $C_9H_{20}O_2N$ (158 MW)	LD: 3.4	s.c.	cat[101]
Muscimol	A. muscaria	Alkaloid $C_4H_6O_2N_2$ (98 MW)	LD: 2.8	i.p.	mouse[148]
			LD: 4.5	i.p.	rat[148]
Phalline B	A. phalloides	Peptide	LD_{50}: 15	NR	mouse[149]
Psilocybin	Psilocybe mexicana (Mexican mushroom)	An indolyl phosphate.	Hallucinogen		
			ID: 0.1-0.3	p.o.	man[130,150]
Ricin	Ricinus sanquineus L. (castor bean)	Albumin	LD_{100}: $6x10^{-4}$	i.m.	dog[130]
			LD_{100}: 150-200	p.o.	man[130]
			LD_{50}: $5x10^{-5}$	i.v.	rabbit[130]
Scopolamine hydrobromide	Scopola carniolica	6,7-Epoxytropine tropate $C_{17}H_{21}NO_4 \cdot HBr \cdot 3H_2O$	LD_{50}: 5900	s.c.	mouse[130]
			ID: 0.005 to 0.010	p.o.	man[130]

PLANT TOXINS (Continued)

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Tetrahydro-cannabinol (Marijuana)	Cannabis sativa L. (India hemp)	Heterocyclic, $C_{21}H_{30}O_2$ (314 MW)	ID: 0.06	p.o.	man[130]
D-Tubocurarine chloride	Chondodendron tomentosum	Alkaloid $C_{38}H_{44}O_6N_2Cl_2$ (696 MW)	LD_{50}: 0.223 LD: about 0.7	i.v. NR	rabbit[130] man[99]
Vincarine	Vinca genus	$C_{21}H_{24}N_2O_3$	ID: 10	NR	mouse[151]

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SNAKE VENOMS

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Alpha-toxin	Naja haje haje	Protein (7000 MW)	LD_{50}: 0.10	s.c.	mouse[152]
Alpha-toxin	N. nigricollis	Protein	LD_{50}: 2.5	s.c.	mouse[107]
			LD_{50}: 3.0	i.p.	mouse[107]
			LD_{50}: 0.6	i.v.	mouse[107]
Venom	Dendroaspis polylepis (black mamba)	A complex mixture, mostly protein	LD_{50}: 5.7	NR	mouse[153]
Venom	Haemachatus haemachatus	A complex mixture, mostly protein	LD_{50}: 1.8	s.c.	mouse[107]
			LD_{50}: 1.5	i.p.	mouse[107]
			LD_{50}: 0.38	i.v.	mouse[107]
Venom	Indian krait	A complex mixture, mostly protein	LD_{50}: 0.10	NR	mouse[107]
Venom	N. haje	A complex mixture, mostly protein	LD_{50}: 1.7	s.c.	mouse[107]
			LD_{50}: 1.3	i.p.	mouse[107]
			LD_{50}: 0.42	i.v.	mouse[107]

SNAKE VENOMS (Continued)

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Venom	N. naja	A complex mixture, mostly protein	LD_{50}: 0.25	i.v.	mouse[107]
			LD_{50}: 0.35	i.p.	mouse[107]
			LD_{50}: 0.45	s.c.	mouse[107]
Toxin A	N. naja	Protein	LD_{50}: 0.15	NR	mouse[154]
Venom	N. naja atra	A complex mixture, mostly protein	LD_{50}: 0.63	s.c.	mouse[107]
			LD_{50}: 0.44	i.p.	mouse[107]
			LD_{50}: 0.40	i.v.	mouse[107]
Venom	N. nivea	A complex mixture, mostly protein	LD_{50}: 0.65	s.c.	mouse[107]
			LD_{50}: 0.6	i.p.	mouse[107]
			LD_{50}: 0.2	i.v.	mouse[107]
Venom	Notechis scutatus (Australian tiger snake)	A complex mixture, mostly protein	LD_{50}: 0.10	NR	mouse[107]
Venom	Ophrophagus hannah	A complex mixture, mostly protein	LD_{50}: 2.0	i.p.	mouse[107]
Hemorrhagic Principle 1	Trimeresurus flavoviridus (habu)	A complex mixture, mostly protein	LD_{50}: 0.23	NR	mouse[155]

SNAKE VENOMS (Continued)

Poison	Source	Nature	Toxicity (mg/kg)	Method	Animal
Venom Protein	Vipera ammodytes (Bulgarian viper)	Protein (110,000 MW)	MLD: 0.90	NR	mouse[156]
Venom	Vipera lebetina	A complex mixture, mostly protein	LD_{50}: 5.6	d.c.	mouse[157]
			LD_{50}: 0.3	i.v.	mouse[157]
Venom	V. palestinae	A complex mixture, mostly protein	LD_{50}: 1.9	i.p.	mouse[158]

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APPENDIX III.

GLOSSARY

Absorption (verb absorb)	The process of sucking up or taking in of fluids or other substances, as the absorption of water by a sponge; the absorption of gas in a liquid.
Acetylcholinesterase	An enzyme that hydrolyzes acetylcholine most rapidly. See cholinesterase.
Activated charcoal	Charcoal having neutralizing power and greater adsorptive capacity as a result of the removal (by treatment with heat and steam) of foreign materials from its pores.
Active site	Position of the portion of a molecule that is responsible for its activity.
Adsorbate	A substance taken up by, and held on the surface of, an adsorbent.
Adsorbent	A substance that takes up and retains another body on its surface. Activated charcoal, for example, is an adsorbent; whereas the gas held by the charcoal is an adsorbate.
Adsorption (verb adsorb)	The adhesion of liquids or gases to the surface of solid bodies; as, the adsorption of gases by (or on) activated charcoal. (Sorption, a more general term, refers to absorption and adsorption.)
Aerosol	A suspension or dispersion of small solid or liquid particles in air or gas. Examples are mists, fogs, and smokes.

Alkaloid	One of a large group of organic basic substances found in plants. They are usually bitter in taste and physiologically active. The term is sometimes applied to synthetic substances which have structures similar to the plant alkaloids.
Amorphous	Having no definite form; shapeless; not crystallized.
Analgesic	Relieving pain; an agent that alleviates pain without causing loss of consciousness.
Analogs	Chemical compounds that have a common basic structure but differ from one another with respect to a particular chemical group.
Anoxia	Absence or lack of oxygen; reduction of oxygen in body tissues below physiological levels.
Anesthetic	A drug or agent that is used to abolish the sensation of pain.
Antibody	A substance formed by the body in antagonism to specific foreign bodies (antigens) such as toxins; for example, antitoxin.
Anticholinesterase	Substance which inhibits action of the enzyme cholinesterase.
Antidote	Remedy for counteracting a poison.
Antigen	A substance, usually a protein, carbohydrate, or fat-carbohydrate complex, that stimulates the production of an antibody when introduced directly into animal tissues.
Antihistaminic	A drug which counteracts the action of histamine.

Antiplant agent	A chemical which causes damage to plants.
Antiserum	A serum that contains antibody or antibodies. It is produced in an animal body that had been subjected to the action of antigen either by injection into the tissues or blood, or by infection.
Antitoxin	A substance present in the blood serum or other body fluids which is antagonistic to a specific toxin that stimulated its production.
Antivenin	A serum containing antibody against venom (for example, insect and snake venoms).
Areactogenic	Absence of side reactions.
Ataxia	Failure of muscular coordination; irregularity of muscular action.
Autonomous nervous system	The involuntary portion of the nervous system concerned with regulation of the activity of heart, blood vessels, smooth muscle, glands, and viscera.
Anticoagulant	A substance that prevents or delays coagulation of blood.
Bacillus	A rod-shaped bacterium.
Biosynthesis	Building up of a chemical compound in a living organism.
Bradycardia	Abnormal slowness of the heartbeat, as evidenced by slowing of the pulse rate to 60, or less.
Cardiovascular	Pertains to the heart and blood vessels.
Catalepsy	A condition characterized by a waxy rigidity (flexibilitas cerea) of the muscles so that the patient tends to remain in any position in which he is placed.

Catalyst	A substance which accelerates a chemical reaction and can be recovered practically unchanged at the end of the reaction.
Catatonic stupor	Partial or complete unconsciousness resulting from catatonia, a form of schizophrenia.
Central nervous system (CNS)	An assemblage of several billion nerve cells with their processes, collaterals, and terminals which make up the brain, cerebellum, medulla, and spinal cord.
Chemical ammunition	A type of ammunition, the filler of which is primarily a chemical agent (toxic chemical agent), training and riot control agent, a smoke or an incendiary.
Chemical warfare agent (or chemical agent)	A solid, liquid, or gas which, through its chemical properties, produces lethal or damaging effects on man, animals, plants or material, or produces a screening smoke or flame.
Cholinergic	A term applied to nerve fibers that liberate acetylcholine at a synapse when a nerve impulse passes, or to substances with an action similar to acetylcholine.
Cholinesterase	An esterase enzyme which is necessary to maintain orderly passage of nerve impulses from the nerve endings to the muscles, glands, and organs of the body by hydrolysis of acetylcholine.
Cholinolytic	A substance that blocks the action of acetylcholine or of cholinergic agents.
Cholinomimetic	A substance with an action similar to acetylcholine.

Clonic convulsion	A convulsion marked by an alternating contraction and relaxation of the muscles.
Coagulant	A substance that promotes or accelerates the coagulation of blood.
Colloid	Any substance in a certain state of fine division, in which the particles range in diameter from about 0.2 to 0.005 micron. Mixed with certain media, colloids form so-called colloidal solutions, colloidal systems, or sols.
Concentration	The quantity of chemical present in a unit volume. Concentrations of airborne chemical agents are usually expressed in milligrams of agent per cubic meter of air (mg/m^3).
Contamination	The deposition and/or absorption of chemical agents on and by structures, areas, personnel, or objects. Contamination density for liquid chemical agents is usually expressed in mg/m^2, kg/km^2, or pounds per hectare.
Curariform	Resembling curare in physiological properties.
Cyanosis	A bluish discoloration, applied especially to such discoloration of skin and mucous membranes due to excessive concentration of reduced hemoglobin in the blood.
Cytolysis	A dissolving action on cells.
Cytostatic	To check the growth or multiplication of cells.
DANC	A decontaminant consisting of 6.25% solution of 1,3-dichloro-5-dimethylhydantoin in acetylene tetrachloride.

Decontamination	The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical agents.
Defoliant	A chemical compound which will cause trees or shrubs to lose their leaves.
Depressive	A lowering or decrease in functional activity.
Desiccant	Drying; a drying agent.
Detection	The determination of the presence of a chemical agent through application of human senses or by devices employing physical, chemical, or electronic techniques.
Detector crayon	Chalklike crayon composed of material which changes color on contact with a chemical agent; normally used for detection of liquid agents such as blister agents.
Detector paper	Paper treated with a chemical compound that changes color in the presence or absence of certain toxic chemical agents.
Detoxification	Reduction of toxicity of poisons by chemical changes induced in the body to produce a relatively nontoxic compound that is more readily eliminated from the body.
Dialysis	Process of separating crystalloids from colloidal substances in solution by diffusion of the former through a semipermeable membrane.
Dicotyledonous	Of or like a plant having two cotyledons, or seed leaves.

Dosage	The concentration of chemical agent to which a person is subjected, multiplied by the time of exposure. It is usually expressed as concentration (C) multiplied by time (t) or mg-min/m^3 as the inhalation dose. Skin dosage is equal to time of exposure of an individual's unprotected skin multiplied by concentration of chemical agent cloud in contact with skin.
Dose	The amount of agent that is taken into or absorbed by the body. a. Lethal dose - Dose required to cause death. b. Incapacitating dose - Dose required to cause a nonlethal casualty. c. Effective dose - That amount of chemical agent required to produce a desired physiological effect.
DS-2	Decontaminant consisting of 70% diethylene-triamine, 28% ethylene glycol monomethyl ether, and 2% NaOH.
Electrolysis	Destruction of a chemical compound by passage of an electric current.
Electrophoresis	The movement of charged particles, suspended in a liquid on various supporting media, under the influence of an applied electric field.
Emetic	An agent that causes vomiting.
Emulsion	A suspension of fine particles (globules) of a liquid in another liquid. See Colloid.
Endotoxin	A toxic substance produced by a bacterium and liberated by the disintegration of the bacterial cell.

Enterotoxin	Toxin which is specific for intestinal mucosa cells; also a toxin formed in the intestine.
Enzymatic test	A test for presence of nerve agents in which the color produced is the result of the action of cholinesterase enzyme on a substrate.
Enzyme	A protein produced by a living organism, which catalyzes one or more chemical reactions.
Erythema	A name applied to redness of the skin produced by congestion of the capillaries, which may result from a variety of causes, the etiology or a special type of lesion often being indicated by a modifying term.
Esterase	An enzyme or ferment capable of hydrolyzing esters; that is, of decomposing them into their acidic and alcoholic constituents. Cholinesterase is an esterase.
Exotoxin	A toxin formed and excreted by a microorganism.
Extractive	Any substance present in an organized tissue and requiring extraction by some special method.
Fibrinolytic	Capable of hydrolyzing or liquefying fibrin (clotting substance in blood).
Ganglia	Groups of nerve cell bodies.
Ganglion-blocking	A substance that blocks the nerve impulses passing through the ganglion. The latter is a mass of nerve cells serving as a center of nervous influence.

Gel diffusion	A process by which a substance is allowed to spread widely in a gelatinous colloid.
Hallucinogen	A substance that produces a sense perception not founded on objective reality, i.e., hallucination.
Hemagglutination	The clumping of red blood cells.
Hemoglobin	The oxygen-carrying pigment of red blood cells.
Hemolysin	A substance causing hemolysis either alone or in presence of complement.
Hemolysis	The dissolution of red blood corpuscles and the liberation of their hemoglobin.
Hemolytic	Capable of causing destruction of the red blood corpuscles with the liberation of hemoglobin.
Hemopoietic (hematopoietic)	A substance that promotes formation of red cells.
Herbicide	A preparation that kills weeds and other undesirable plants.
Histotoxic	Poisonous to tissue.
Homogenate	Obtained by the mechanical breakdown of material to a smaller and more uniform size.
Hopcalite	A porous granular material consisting of copper oxide and manganese dioxide, and possibly cobalt and silver oxides for use in filter of protective mask to convert carbon monoxide to carbon dioxide.
Hormone	Any of various substances secreted into the body fluids by internal secretory glands. Hormones activate specific receptive organs. Examples are adrenalin and pituitrin.

Hydrolysis	It is the interaction of a chemical substance with water to cause decomposition of the substance.
Hygroscopic	A substance which attracts or adsorbs moisture from the air.
Hypertension	Abnormally high blood pressure.
Hyperthermia	An abnormally high body temperature; a fever.
Hypnotic	A drug that acts to induce sleep. Also, pertaining to or of the nature of hypnotism.
Hypotension	Abnormally low blood pressure.
Hypoxic	Producing a deficiency of oxygen in inspired air or low oxygen tension.
Ichthyotoxin	Poisonous principle found in some types of fish.
ICt_{50}, ID_{50}	See Median Incapacitating Dosage.
ID	See Incapacitating Dose.
Immune	Resistant to the effects of any particular toxic substance.
Immunity	Power which the body of an individual acquires to resist an infection or toxin intoxification.
Immunization, Active	The process by which immunity is conferred through the production of antibodies by an individual's own body cells. Antibodies are produced by the stimulus of antigens.
Immunization, Passive	The process of conferring transient immunity to a disease or toxic chemical by inoculation with serum from an animal already actively immunized against the disease or toxic chemical.

Immunogen	An antigenic substance capable of inducing immunity.
Immunophoresis	A combination of electrophoresis and diffusion techniques to distinguish substances by differences in electrophoretic mobility and antigenic activity; the supporting medium may be agar gel, cellulose acetate, or other material.
Immunosorbent	Antigen-coated particles of a supporting medium, such as cellulose.
Impermeable protective clothing	Clothing made of material which prevents passage of toxic chemical agents in any physical form and which can be worn for only short periods of time because of excessive heat load.
Impinger	A device for collecting samples of aerosol particles from the atmosphere.
Inactivate	To destroy the activity of.
Incapacitating agent	An agent that produces temporary physical or mental effects which will render individuals incapable of concerted effort in the performance of their assigned duties.
Incapacitating dose (ID)	The quantity of a chemical agent sufficient to cause incapacitation.
Incendiary	A chemical agent used primarily for igniting combustible substances.
Incubation time	The period of time between the entrance of a chemical agent in the body and the appearance of signs or symptoms of resultant intoxication.
Indirect (passive) hemagglutination	Serological test for detection of antigen (e.g., toxin). Red blood corpuscles, on which specific antibody was previously adsorbed, agglutinates in the presence of antigen as the result of an antigen-antibody reaction.

Intoxication	State of being poisoned.
Intraperitoneally	Within the peritoneal cavity of the serous membrane lining the abdominopelvic walls.
Intravenously	Within a vein.
In vitro	Observed in a test tube.
In vivo	Observed within a living body.
Inversion	A reversal in the normal temperature lapse rate, in which the temperature rises with increased elevation instead of falling.
I.V. (or i.v.)	See Intravenously.
I.P. (or i.p.)	See Intraperitoneally.
Isolectric point	The pH of a substance at which the net electrical charge on a molecule in solution is zero, such as that found in amino acid and protein molecules.
Jaundice	A syndrome characterized by hyperbilirubinemia and deposition of bile pigment in the skin and mucous membranes with resulting yellow appearance of the patient.
Labile	Unstable; for example, thermolabile indicates unstable to heat.
Lacrimator	A substance which increases the flow of tears, such as certain riot control agents.
Lapse	A marked decrease of air temperature with increasing altitude (the ground being warmer than the surrounding air). This condition is usually encountered when skies are clear and

between 1100 and 1600 hr. During lapse conditions, strong convection currents are found; for chemical and biological operations, the state is defined as unstable. This condition is normally considered the most unfavorable for the release of chemical agents.

LCt_{50}, LD_{50} ---------- See Median Lethal Dosage.

Lethal Dosage (LD) ---------- The dosage sufficient to cause death. The lethal dose is generally expressed as the median lethal dose (LD_{50}) or the amount of chemical agent sufficient to kill 50% of exposed animals.

Lyophilization ---------- The process of freezing and dehydrating a substance under vacuum.

Lysis ---------- Destruction of cells by a specific substance.

Macromolecule ---------- A molecule of high-molecular-weight.

Malaise ---------- A vague feeling of bodily discomfort.

Mass immunization ---------- Immunization of a group of animals or humans simultaneously.

Median Incapacitating Dosage (or ID_{50} or ICt_{50}) ---------- The incapacitating dosage of an agent is generally expressed as the median incapacitating dosage--the amount of inhaled vapor or liquid agent on the skin which is sufficient to disable 50% of exposed personnel. For inhalation effect, the median incapacitating dosage is expressed as the ICt_{50}. Liquid contamination on skin or injection of toxic substance into body to cause incapacitation, the median incapacitating dosage is expressed as ID_{50} (mg/kg body weight).

Median Lethal Dosage (LCt_{50} or LD_{50})	The median lethal dosage of an agent employed for inhalation as a vapor or aerosol is generally expressed as the LCt_{50}. The LCt_{50} of a chemical agent is the dosage (vapor concentration of the agent multiplied by the time of exposure) that is lethal to 50% of exposed personnel. The unit used to express LCt_{50} is milligram minutes per cubic meter. (NOTE: Lethal dosage may also be expressed in other than median, for example: LCt_{25} is the amount required to kill 25% of an exposed group of personnel). Liquid contamination, on skin or injection of toxic substance into body to cause death, the median lethal dosage is expressed as LD_{50} (mg/kg body weight).
Metabolism	The sum of all the physical and chemical processes by which living organized substance is produced and maintained, and also the transformation by which energy is made available for use by the organism.
Methemoglobin	A compound formed from hemoglobin by oxidation of the ferrous to the ferric state with essentially ionic bonds.
Micron	A unit of length, the thousandth part of one millimeter, or the millionth part of one meter. It is equivalent to about one twenty-five thousandth of an inch.
MLD	Minimum lethal dose.
Mole (mol)	The amount of substance in a system containing as many elementary entities as there are atoms in 12 g of carbon-12. The entities may be atoms, molecules, ions, electrons, or other particles.

Molecular sieve	Particles of uniform size in certain types of supporting media that have the ability to separate the chemical components in a mixture according to molecular size.
Monocotyledonous	Of or like any seed plant having a single cotyledon.
MW	Molecular weight.
Mydriasis	Extreme or morbid dilation of the pupil of eye.
M5 Ointment	A substance that serves as a source of active chlorine in a medium that resists its removal by water or mechanical action.
M13 Individual Decontaminating and Reimpregnating Kit	A kit containing a bag filled with fuller's earth for adsorbing liquid CW agents and bags filled with chloramide powder to decontaminate droplets of V-agents and mustard on clothing.
Nausea	An unpleasant sensation, vaguely referred to the epigastricum and abdomen, and often culminating in vomiting.
Necrosis	Death of a cell or group of cells in contact with living tissue; e.g., destruction of epidermal cells.
Neuromuscular	Pertains to nerve and muscle.
Neuron	A nerve cell with its processes, collaterals, and terminals; regarded as a structural unit of the nervous system.
Neurotoxin	Substance that is poisonous or destructive to nerve tissue.

Neurotropic	Having an affinity or predilection for nervous tissue.
NR	Not reported.
Paralysis	Loss or impairment of motor function in part due to lesion of the neural or muscular mechanism; also, by analogy impairment of sensory function (sensory paralysis).
Paresis	Slight or incomplete paralysis.
Passive hemagglutination	See indirect hemagglutination.
Peptizer	A substance which hastens or facilitates the dispersal of a colloidal material in a dispersion medium. It is used to lower the final viscosity of a thickened fuel and facilitates the formation of a gel at lower temperatures than would otherwise be possible.
Percutaneous	Means "through the skin." Percutaneous effects are achieved by penetration of the skin by a chemical agent liquid, vapor, or aerosol.
Peripheral nervous system	That portion of the nervous system consisting of the nerves and ganglia outside the brain and spinal cord.
p.o.	Perorally, or the amount of a substance taken by mouth.
Pharmacological	Pertaining to the effects of drugs on living things.
Physiological	Pertaining to the science that concerns the functions of the living organism and its parts.
Phytotoxin	A toxin derived from a plant. Ricin, from the castor oil bean, is an example.

Plant growth regulator	A chemical antiplant agent which regulates or inhibits plant growth.
Polyvalent	Heterogeneous mixture containing more than one type of toxin, toxoid, or antitoxin.
Proteolytic	Pertaining to and characterized by an agent that promotes the hydrolysis of proteins into proteoses, peptones and other products by means of enzymes.
Protoxin	Inactive precursor of a toxin, formed by certain bacteria in the course of producing an exotoxin.
Psychochemical	A chemical substance affecting psychological functions.
Psychopharmacology	Study of action drugs on psychological functions.
Psychotropic	Causing a change in the mental processes in response to a stimulus.
Pyrophoric	A term applied to a fuel or compound which ignites spontaneously in air as a result of its reaction with oxygen.
Reactogenicity	Tendency to produce side reactions.
r.t.	Respiratory tract.
Riot control agent	A chemical that produces temporary, irritating or disabling effects when in contact with the eyes or when inhaled.
S.C. (or s.c.)	Subcutaneously, or the amount of substance injected under the skin.

Sedative	An agent that allays excitement.
Serum	The clear liquid which separates out from the clot and corpuscles in the clotting of blood.
Sorption	Includes both absorption and adsorption.
Spasmolytic	Checking spasms; antispasmodic.
STB	Supertropical bleach consisting of calcium hydroxide and calcium hypochlorite; used as a decontaminant.
Sublethal	Not fatal; i.e., below lethal levels.
Submerged culture	A technique in which organisms are grown while submerged in a liquid that is being agitated continuously.
Substrate	Substance upon which another substance, usually an enzyme, acts.
Suspension	The condition in which particles of a solid are dispersed through a fluid but not dissolved in it.
Synergism	The joint action of agents so that their combined effect is greater than the algebraic sum of their individual effects.
Syrette	A small container with needle attached designed for self-injection of medications such as morphine or atropine.
Systemic	Of, relating to, or common to a system; of or pertaining to the body as a whole.
Systemic poisoning	Poisoning resulting from the absorption of a toxic material into the blood stream.
Tachycardia	Excessive rapidity in the action of the heart. The term is usually applied to a pulse rate about 100/min.

Total Obscuring Power (T.O.P.)	Total obscuring power of a smoke. Area in square feet covered by the smoke from one pound of smoke-producing material spread out in a layer of such thickness and density that it will exactly obscure the filament of a standard 40-watt lamp.
Toxin	Generally, any poisonous substance of microbic, vegetable, or animal origin. Specifically, substances related to proteins; these true toxins are more or less unstable, requiring a latent period to produce symptoms and induce in suitable animals the formation of specific antitoxins.
Toxoid	Toxin treated in order to destroy its toxicity but still capable of inducing the formation of antibodies on injection.
Toxophoric	Chemical group or site in the molecule of a toxin responsible for its toxicity.
Training agent	An agent authorized for training purposes.
Tranquilizer	An agent which acts on the emotional state, quieting or calming the patient without affecting clarity of consciousness.
Tremor	An involuntary trembling or quivering.
Urticant	Causes an itching or tingling sensation.
Vaccine	A preparation of killed or attenuated infective agent used in vaccination to induce immunity. May also contain toxoids.
Vasoconstrictor	Causing constriction of the blood vessels; an agent that causes constriction of the blood vessels.

Venom	Poison or toxic substance secreted by a snake and insect.
Viable	Living.
Warhead (chemical)	That part of a missile, projectile, torpedo, rocket, or other munition which contains chemical agents.
Whetlerite	A solution for impregnating charcoal to provide protection against certain types of CW agents. It consists of cupric carbonate [$CuCO_3$:$Cu(OH)_2$], chromic oxide, silver oxide, 28% aqueous ammonia, and ammonium carbonate (114:34.6:3.2:284:142) in 390 ml H_2O.[12]

APPENDIX IV.

AGENTS AND ANTIDOTES, THEIR CODES AND DESIGNATIONS

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RELEASABLE TO UK, CANADA, AUSTRALIA, AND NEW ZEALAND

Classified by Cdr, USAFSTC
Exempt from GDS of EO 11652
Exemption Category: 1 & 2
Declassify on: IMPDET

(b)(1)

RELEASABLE TO UK, CANADA, AUSTRALIA, AND NEW ZEALAND

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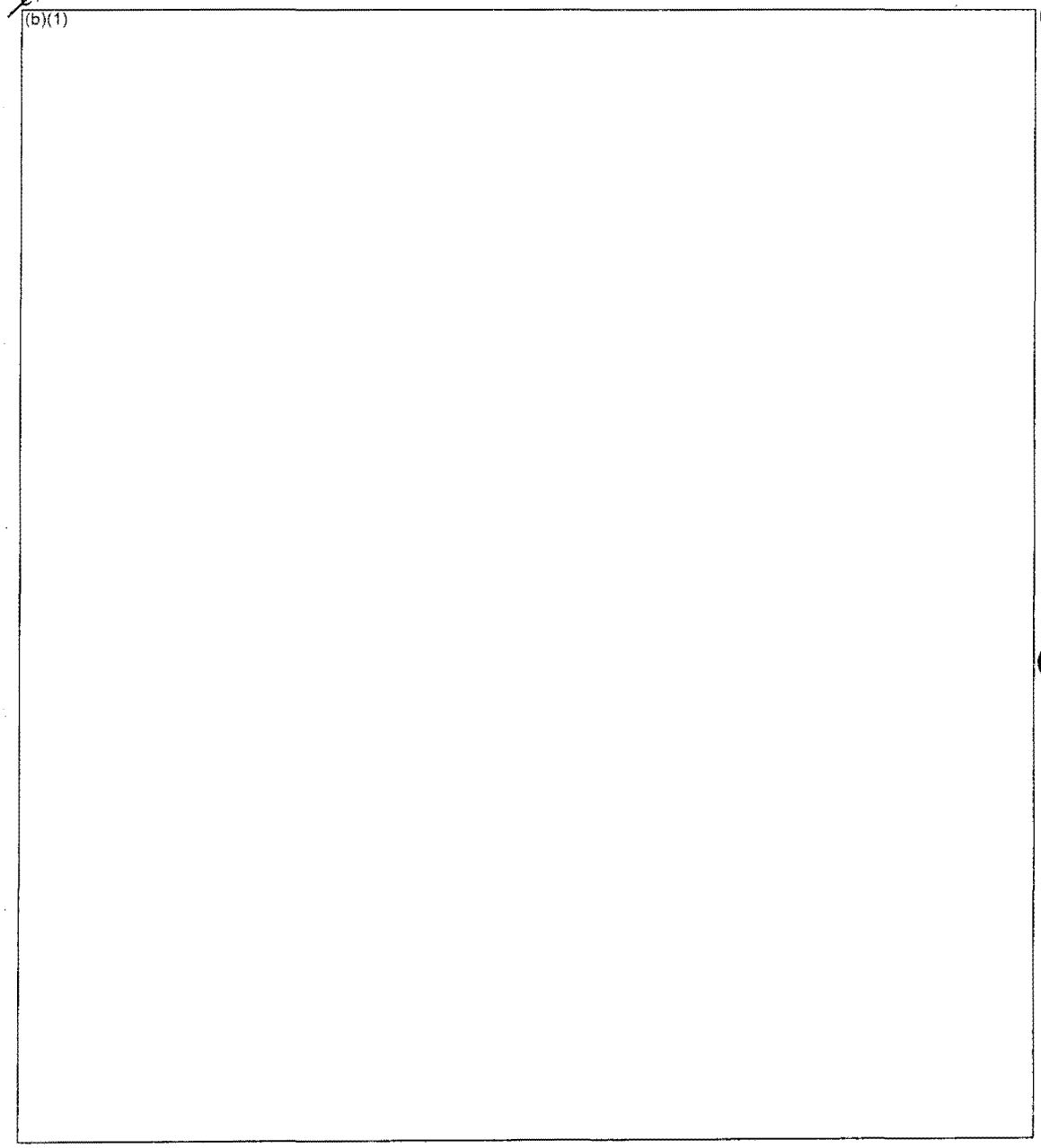

RELEASABLE TO UK, CANADA, AUSTRALIA, AND NEW ZEALAND

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RELEASABLE TO UK, CANADA, AUSTRALIA, AND NEW ZEALAND

(b)(1)

NOT RELEASABLE TO FOREIGN NATIONALS

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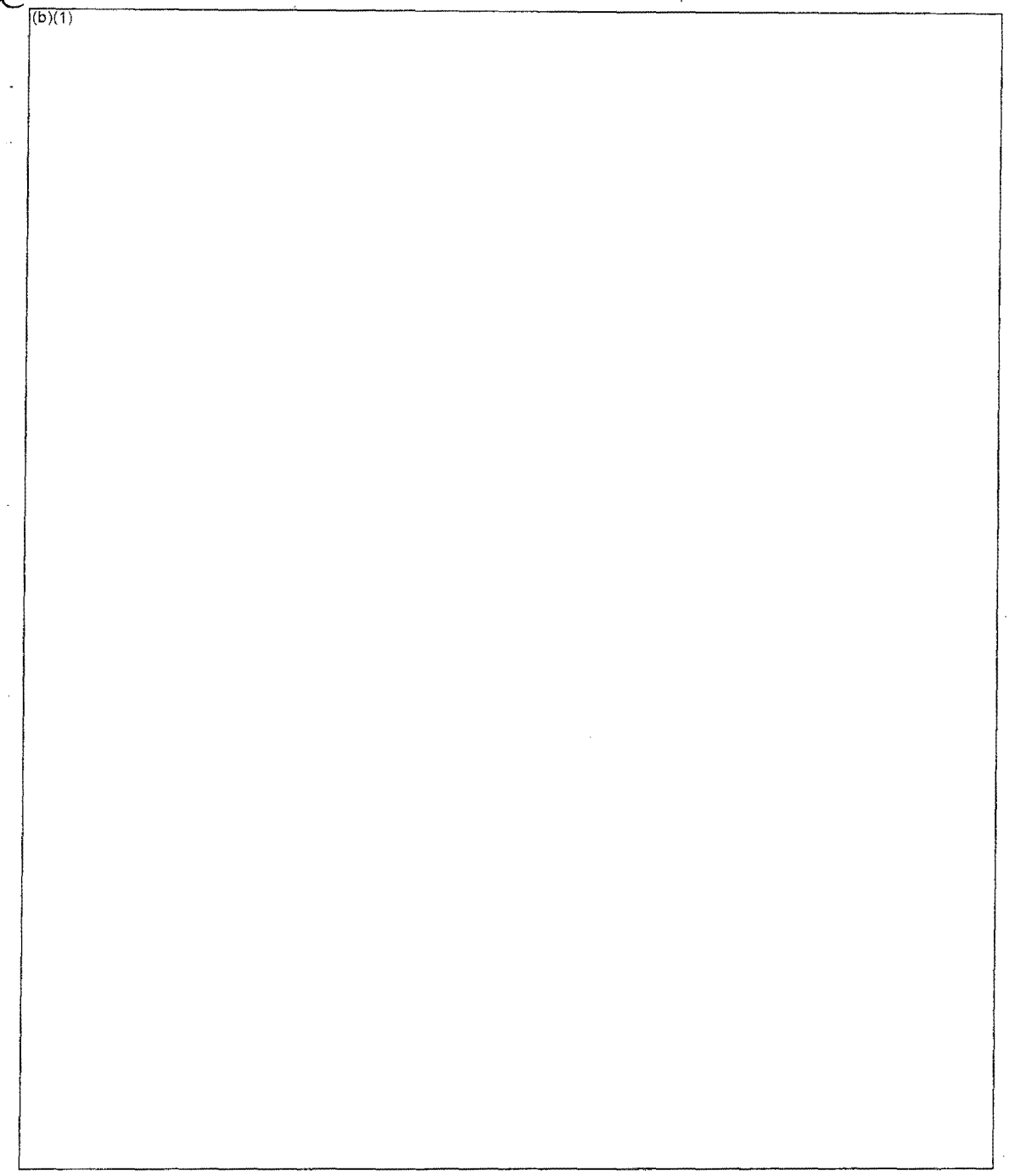

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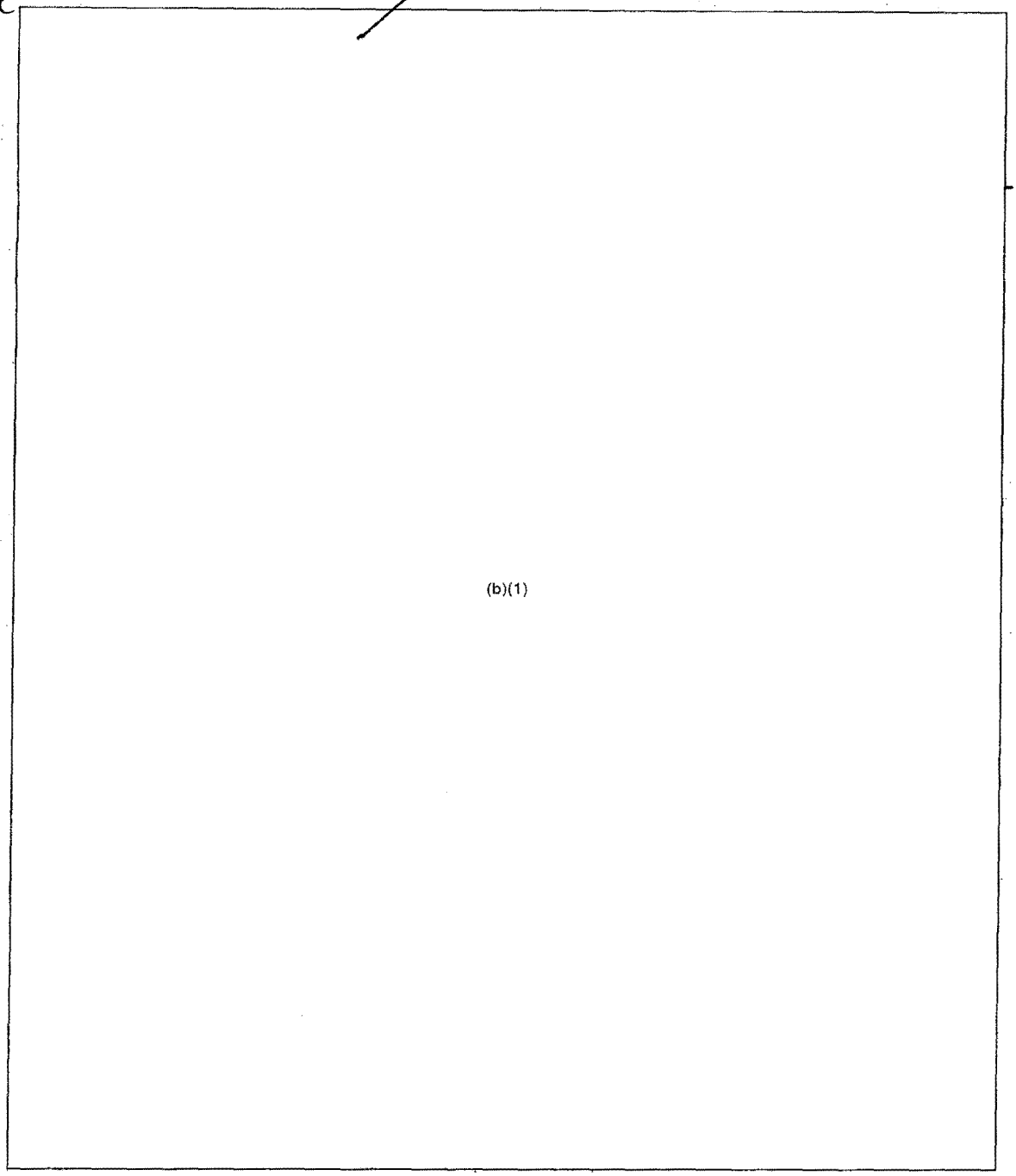

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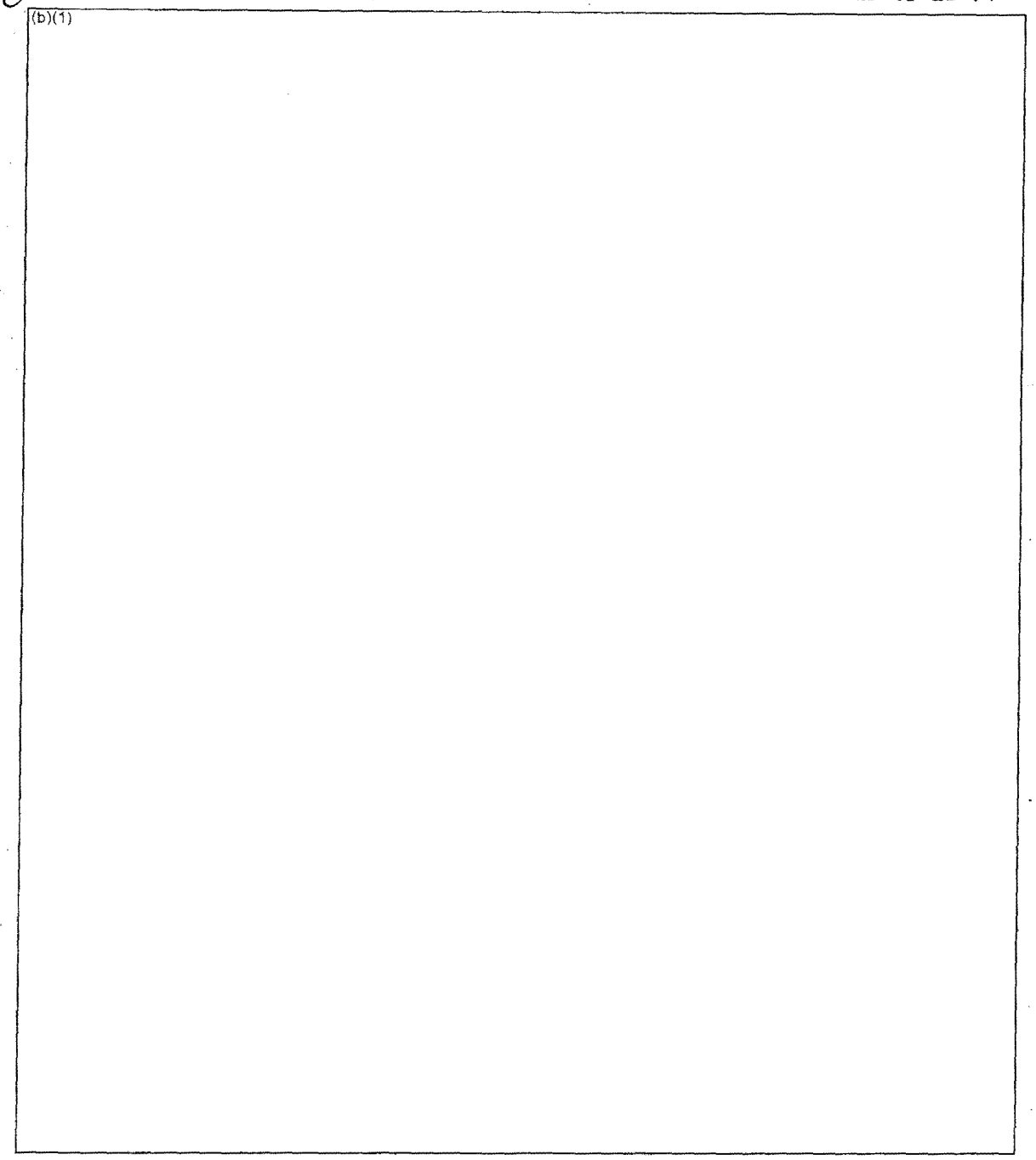

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