

# U. S. ARMY CENTER FOR HEALTH PROMOTION & PREVENTIVE MEDICINE

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## OFFICE TO THE DEPUTY FOR TECHNICAL SERVICES

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*Last updated 23 July 1998*

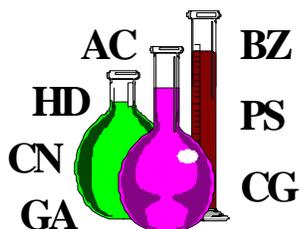
### The Deputy for Technical Services' Publications

#### Detailed Chemical Facts Sheets

**Note:** The links on this page point to Adobe Acrobat PDF files. Click here for more [Information](#).

- [\*Blood Agent Hydrogen Cyanide \(AC\)\*](#)
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- *Vomiting Agent Adamsite (DM)*
- *Nerve Agent GA*
- *Nerve Agent GB*
- *Nerve Agent GD*
- *Sulfur Mustard Agents H & HD*
- *Blister Agent Mustard - Lewisite Mixture (HL)*
- *Blister Agent Nitrogen Mustard (HN-1)*
- *Blister Agent Nitrogen Mustard (HN-2)*
- *Blister Agent Nitrogen Mustard (HN-3)*
- *Sulfur Mustard Agent HT*
- *Blister Agent Lewisite (L)*
- *Tear Agent Chloropicrin (PS)*
- *White Phosphorous (WP)*
- *Nerve Agent VX*



*Detailed Facts About Blood Agent Hydrogen Cyanide*

(AC)

218-07-1096

*Physical Properties of Hydrogen Cyanide*

<i>Chemical Structure</i>	H-CN
<i>Chemical Formula</i>	HCN
<i>Description</i>	Pure AC is a nonpersistent, colorless liquid that is highly volatile. It has a faint odor similar to bitter almonds that sometimes cannot be detected even at lethal concentrations.
<i>Molecular Weight</i>	27.03
<i>Vapor Pressure (mm Hg)</i>	742 @ 25°C
<i>Boiling Point</i>	25.7°C
<i>Freezing Point</i>	-13.4°C
<i>Density</i>	Liquid = 0.7 Vapor = 0.94 (air = 1)
<i>Solubility</i>	Highly soluble and stable in water and alcohol; soluble in ether, glycerine, chloroform, and benzene.
<i>Flash Point</i>	-18°C
<i>Volatility</i>	37,000 mg/m <sup>3</sup> @ -40°C 1,080,000 mg/m <sup>3</sup> @ 25°C

### ***Toxicity Values***

LC <sub>50</sub> (inhalation, 0.5 min)	= 2,000 mg-min/m <sup>3</sup>
LC <sub>50</sub> (inhalation, 30 min)	= 20,600 mg-min/m <sup>3</sup>
LD <sub>50</sub> (skin)	= 100 mg/kg (liquid)
NOAEL (inhalation)	= 670 mg-min/m <sup>3</sup>
RfD (ingestion)	= 0.750 mg/l (liquid)

### ***Exposure Limits***

Workplace Time-Weighted Average -	11.0 mg/m <sup>3</sup>
General Population Limits -	No standard identified

## ***Toxic Properties of AC***

*Hydrogen cyanide is a fast acting, highly poisonous material. It may be fatal if inhaled, swallowed, or absorbed through the skin. It is an extremely hazardous liquid and vapor under pressure. With prompt treatment following overexposure, recovery is normally quick and complete. AC inactivates the enzyme cytochrome oxidase, preventing the utilization of oxygen by the cells.*

### ***Overexposure Effects***

AC poisoning causes a deceptively healthy pink to red skin color. However, if physical injury or lack of oxygen is involved, the skin color may be bluish. Human health effects of overexposure by inhalation, ingestion, or skin contact may include nonspecific symptoms such as reddening of the eyes, flushing of the skin, nausea, headaches, dizziness, rapid respiration, vomiting, drowsiness, drop in blood pressure, rapid pulse, weakness, and loss of consciousness; central nervous system stimulation followed by central nervous system depression, hypoxic convulsions, and death due to respiratory arrest; temporary alteration of the heart's electrical activity with irregular pulse, palpitations, and inadequate circulation. Higher AC inhalation exposures may lead to fatality. In a few cases, disturbances of vision or damage to the optic nerve or retina have been reported, but the exposures have been acute and at lethal or near-lethal concentrations. Skin permeation can occur in amounts capable of producing systemic toxicity. There are no reports of human sensitization.

### ***Emergency and First Aid Procedures***

Inhalation: remove patient to fresh air, and lay patient down; administer oxygen and amyl nitrite; keep patient quiet and warm; even with inhalation poisoning, thoroughly check clothing and skin to assure no cyanide is present; seek medical attention immediately.

Eye Contact: flush eyes immediately with plenty of water; remove contaminated clothing; keep patient quiet and warm; seek medical attention immediately.

Skin Contact: wash skin promptly to remove the cyanide while removing all contaminated clothing, including shoes; do not delay; skin absorption can occur from cyanide dust, solutions, or HCN vapor; absorption is slower than inhalation, usually measured in minutes compared to seconds; HCN is absorbed much faster than metal cyanides from solutions such as sodium,

potassium or copper cyanide solutions; even after washing the skin, watch the patient for at least 1 to 2 hours because absorbed cyanide can continue to work into the bloodstream; wash clothing before reuse and destroy contaminated shoes.

Ingestion: give patient one pint of 1 percent sodium thiosulfate solution (or plain water) immediately by mouth and induce vomiting; repeat until vomit fluid is clear; never give anything by mouth to an unconscious person; give oxygen; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves:                      Wear Butyl or Neoprene rubber gloves.

Eye Protection:                         Wear chemical splash goggles as a minimum.

Other:                                        Have available and use as appropriate - rubber suits and gloves; full-body chemical suit; self-contained breathing air supply; HCN detector; First Aid and Medical Treatment supplies, including oxygen resuscitators.

### ***Reactivity Data***

Stability:                                  Unstable with heat, alkaline materials, and water. Do not store wet HCN; may react violently with strong mineral acids; experience shows mixtures with about 20 percent or more sulfuric acid will explode; effects with other acids are not quantified, but strong acids like hydrochloric or nitric would probably react similarly.

Decomposition:                         See Polymerization.

Polymerization:                         Can occur violently in the presence of heat, alkaline materials, or moisture. Once initiated, polymerization becomes uncontrollable since the reaction is autocatalytic, producing heat and alkalinity; confined polymerization can cause a violent explosion. HCN is stabilized with small amounts of acid to prevent polymerization; it should not be stored for extended periods unless routine.

***Persistency***                             Short; the agent is highly volatile, and in the gaseous state it dissipates quickly in the air.

### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military/Biological Agents and Compounds*, 1990.

2. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.
4. Genium's Reference Collection, *Material Safety Data Sheets Collection: Sheet No. 686*, Genium Publishing Corporation, Schenectady, New York, 1989.

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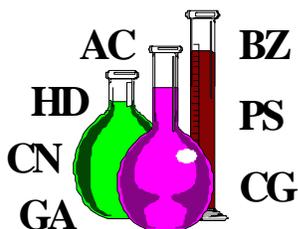
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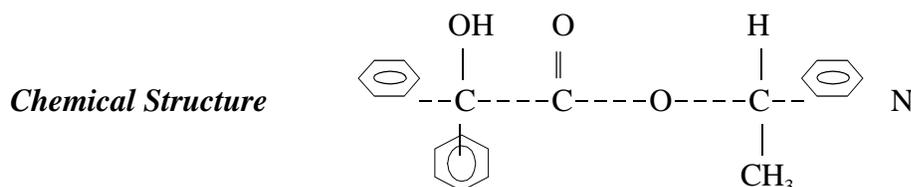
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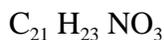
*Detailed Facts About Psychedelic Agent 3 -  
Quinuclidinyl Benzilate  
(BZ)*

218-16-1096

*Physical Properties of 3-Quinuclidinyl Benzilate*



*Chemical Formula*



*Description*

An odorless white crystalline solid.

*Molecular Weight*

337.4

*Boiling Point*

320°C

*Vapor Pressure (mm Hg)*

Negligible; about 0.5 m/m<sup>3</sup> @ 70°C

*Melting Point*

167.5°C

*Density*

Solid = 1.33  
Vapor = 11.6

*Solubility*

Slightly soluble in water; soluble in dilute acids, trichloroethylene, warm dimethylformamide, and most organic solvents, such as alcohol and chloroform; insoluble in aqueous alkali.

*Flash Point*

246°C

**Volatility** Negligible; about 0.5 mg/m<sup>3</sup> @ 70°C.

**Toxicity Values**  
ICt<sub>50</sub> = 101 mg-min/m<sup>3</sup> (15 l/min)  
LCt<sub>50</sub> = 200,000 mg-min/m<sup>3</sup> (estimated)

**Exposure Limits**

Workplace Time-Weighted Average - 0.004 mg/m<sup>3</sup>  
General Population Limits - 0.0001 mg/m<sup>3</sup>

***Toxic Properties of 3-Quinuclidinyl Benzilate***

*The chemical BZ, also known as “agent buzz” was produced at Pine Bluff Arsenal between 1962 and 1965. It was dropped from the chemical arsenal because its effects on enemy front-line troops would be varied and unpredictable.*

BZ is usually disseminated as an aerosol with the primary route of entry into the body through the respiratory system; the secondary route is through the digestive tract. BZ blocks the action of acetylcholine in both the peripheral and central nervous systems. As such, it lessens the degree and extent of the transmission of impulses from one nerve fiber to another through their connecting synaptic junctions. It stimulates the action of noradrenaline (norepinephrine) in the brain, much as do amphetamines and cocaine. Thus, it may induce vivid hallucinations as it sedates the victim. Toxic delirium is very common.

***Overexposure Effects***

BZ is a very potent psychoactive chemical affecting the central nervous system as well as the organs of circulation, digestion, salivation, sweating, and vision. Its pharmacological action is similar to that of other anticholinergic drugs (e.g., atropine, scopolamine, etc.), but longer lasting. Acute exposure produces increased heart and respiratory rates; mydriasis; mouth, skin, and lip dryness; cycloplegia; high temperature; ataxia; flushing of face and neck; hallucinations; stupor; forgetfulness; and confusion. The initial symptoms after ½ to 4 hours of exposure include: dizziness, mouth dryness, and increased heart rate; secondary symptoms, after 3-5 hours of exposure, include: restlessness, involuntary muscular movements, rear vision impairment, and total incapacitation; final symptoms, after 6-10 hours of exposure are psychotropic in nature. After 3-4 days, full recovery from BZ intoxication is expected.

***Emergency and First Aid Procedures***

Inhalation: remove individual from exposure immediately; start resuscitation and administer oxygen if breathing is irregular or has stopped; seek medical attention immediately.

Eye Contact: flush eyes with water for at least 15 minutes; do not rub eyes; seek medical attention immediately.

Skin Contact: wash from skin and clothing with water; remove any contaminated clothing; seek medical attention immediately.

Ingestion: do not induce vomiting; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: Wear Butyl (M3 or M4) or Neoprene gloves.

Eye Protection: Wear protective eye glass (goggles with hooded ventilation) as a minimum.

Other: Wear maximum protection for non-lab operations consisting of M9 mask and hood, M3 butyl rubber suit, M2A1 butyl boots, M3 or M4 gloves, unimpregnated underwear; or demilitarization protective ensemble (DPE). For specific BZ operations, the local safety office will determine the required level of protective clothing; it will be specified in the local standing operating procedures. Wear lab coats and impervious gloves for lab operations; have masks readily available.

### ***Reactivity Data***

Stability: Stable in storage and glass containers. Resistance to air oxidation at ambient temperature (t<sub>1/2</sub> at 25°C and pH 7 - 3-4 weeks). Stable in 0.1N H<sub>2</sub>SO<sub>4</sub>. Thermally stable in solution (t<sub>1/2</sub> > 2 hours at 235°C for pure sample).

Conditions to Avoid: BZ lightly attacks aluminum and anodized aluminum after 3 months at 71°C. No effects on steel or stainless steel after 3 months.

Hazardous Decomposition: Pyrolysis occurs at 170°C after prolonged periods yielding CO, CO<sub>2</sub>, benzophenone and benzhydrol; appreciable hydrolysis in acidic or basic solutions occurs yielding 3-quinuclidinol and benzoic acid; BZ is oxidized by hypochlorite at a pH of 1-13.

Hazardous Polymerization: Will not occur.

***Persistence*** No available information.

### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/ Biological Agents and Compounds*, 1990.

2. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling and Disposal of Chemical Agents and Hazardous Chemical*, 1969.
3. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
4. U.S. Department of the Army, Edgewood Research Development and Engineering Center (ERDEC), *Material Safety Data Sheet*, 1995.
5. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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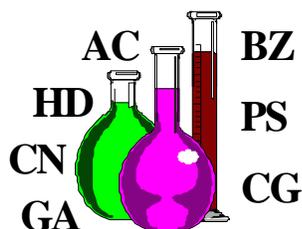
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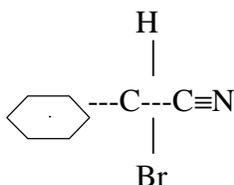


*Detailed Facts About Tear Agent  $\alpha$ -Bromobenzylcyanide (CA)*

218-18-1096

*Physical Properties of Tear Agent Bromobenzylcyanide*

*Chemical Structure*



*Chemical Formula*

C<sub>8</sub> H<sub>6</sub> BrN

*Description*

Pure bromobenzylcyanide is a colorless crystalline solid with a sour or rotten fruit odor.

*Molecular Weight*

196.0

*Boiling Point*

242°C

*Vapor Pressure (mm Hg)*

0.11 @ 20°C

*Freezing Point*

25.5°C

*Density*

Solid = 1.52 @ 20°C  
Liquid = 1.47 @ 25°C  
Vapor = 4.0 (air = 1)

*Solubility*

Soluble in organic liquids. Insoluble in water and cold alcohol; also, soluble in phosgene, chloropicrin, and benzyl cyanide.

*Flash Point*

None; decomposes but does not burn.

**Volatility**  
17 mg/m<sup>3</sup> @ 0°C  
115 mg/m<sup>3</sup> @ 20°C  
217 mg/m<sup>3</sup> @ 30°C

**Toxicity Values**  
IC<sub>t50</sub> = 30 mg-min/m<sup>3</sup> (approximately)  
LC<sub>t50</sub> = 8,000 to 11,000 mg-min/m<sup>3</sup>  
(estimated)

### **Exposure Limits**

Workplace Time-Weighted Average - No standard available  
General Population Limits - No standard available

## **Toxic Properties of Bromobenzylcyanide**

*CA was the first tear agent that came into existence at the end of the World War I. It was outmoded in 1920 with the introduction of the CN series and is now obsolete in NATO inventories. The tear compounds cause a flow of tears and irritation of the skin. Because tear compounds produce only transient casualties, they are widely used for training, riot control, and situations where long-term incapacitation is unacceptable. When used against poorly equipped guerrilla or revolutionary armies, these compounds have proved extremely effective. When released indoors, they can cause serious illness or death.*

### **Overexposure Effects**

CA is usually used in solution with ether or acetone as an aerosol. It produces a severe burning sensation to the mucous membranes and equally severe lacrimation to the eyes accompanied by headache and nausea. The nausea may lead to vomiting although the vomiting is more of a psychological reaction than physiological. CA will go into solution with human sweat and will incur a burning sensation to the face, especially in the areas around the mouth, nose, and eyes. It will penetrate clothing, making the areas around the neck, armpits, the tender skin areas behind the elbows, knees and around the buttocks and crotch susceptible to rashes and blisters. The vapors can be lethal in enclosed or confined spaces within a few minutes without prior respiratory protection. Nausea can lead to unconsciousness which may mean suffocation.

### **Emergency and First-Aid Procedures**

Inhalation: remove victim from the source immediately, seek medical attention immediately.

Eye Contact: don a respiratory protective mask; flush eyes immediately with copious amounts of water; seek medical attention immediately.

Skin Contact: remove victim from the source immediately, decontaminate the skin immediately with copious amounts of water; decontaminate clothing with steam or by boiling; 20 percent alcohol caustic soda is effective on material, but may damage it; seek medical attention immediately.

Ingestion: give victim milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves:	Wear Butyl toxicological agent protective gloves (M3, M4, or glove set).
Eye Protection:	Wear chemical goggles; wear a mask/respirator in open areas.
Other:	Wear a complete set of protective clothing to include gloves and lab coat with a respiratory mask readily available.

### ***Reactivity Data***

Stability:	Stable in glass, lead-lined, or enamel-lined containers; reaction with iron may be explosive.
Hydrolysis Rate:	Very slow.
Hydrolysis Products:	Complex condensation products.
Corrosive Properties:	Vigorous corrosive action on all common metals except lead; reaction with iron may be explosive.

### ***Persistence***

Depends on munitions used and the weather; heavily splashed liquid persists one to two days under average weather conditions.

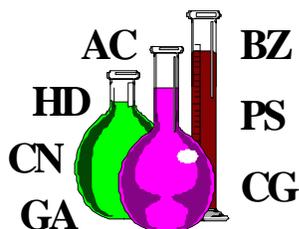
### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
2. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Rahway, New Jersey, 1989.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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*Detailed Facts About Choking Agent Phosgene  
(CG)*

218-01-1096

*Physical Properties of Phosgene*

<i>Chemical Structure</i>	$\begin{array}{c} \text{Cl}-\text{C}=\text{O} \\   \\ \text{Cl} \end{array}$
<i>Chemical Formula</i>	$\text{CCl}_2\text{O}$
<i>Description</i>	CG is foglike in its initial concentration, but it becomes colorless as it spreads; it has both a newly mown hay and highly toxic suffocating odor.
<i>Molecular Weight</i>	98.92
<i>Boiling Point</i>	7.6°C
<i>Vapor Pressure (mm Hg)</i>	1180 @ 20°C
<i>Freezing Point</i>	-128°C
<i>Density</i>	Liquid = 1.37@20°C Vapor = 3.4 (air = 1)
<i>Solubility</i>	Limited in water; decomposes immediately; completely miscible in most organic solvents.
<i>Flash Point</i>	Nonflammable
<i>Volatility</i>	528,000 mg/m <sup>3</sup> @ -40°C 2,200,000 mg/m <sup>3</sup> @ -10°C 4,300,000 mg/m <sup>3</sup> @ 7.6°C

### ***Toxicity Values***

IC <sub>t50</sub> (inhalation)	= 1,600 mg-min/m <sup>3</sup>
LCL <sub>0</sub> (inhalation, 5 min)	= 1,010 mg-min/m <sup>3</sup>
LCL <sub>0</sub> (inhalation, 30 min)	= 10,800 mg-min/m <sup>3</sup>
LC <sub>t50</sub> (inhalation)	= 3,200 mg/m <sup>3</sup>
TCL <sub>0</sub> (inhalation, 30 min)	= 3,030 mg-min/m <sup>3</sup>

### ***Exposure Limits***

Workplace Time-Weighted Average -	0.4 mg/m <sup>3</sup>
General Population Limits -	0.0025 mg/m <sup>3</sup>

## ***Toxic Properties of Phosgene***

*Phosgene was first used in the dye industry in the late 19th century to process colorfast materials. The Germans introduced CG in 1915 for use in World War I. By some estimates, more than 80 percent of all chemical agent fatalities in World War I were due to phosgene. In the late 1920s, many countries manufactured phosgene as a chemical warfare agent; it still remains in the chemical arsenals. Phosgene is also an important industrial compound used in the preparation and manufacture of many organic chemicals.*

### ***Overexposure Effects***

Phosgene is a corrosive, highly toxic gas used as a delayed-casualty agent resulting in fluid buildup in the lungs (“dryland drowning”). It affects the upper respiratory tract, skin, and eyes and causes severe respiratory damage as well as burns to the skin and eyes. Acute inhalation may cause respiratory and circulatory failure with symptoms of chills, dizziness, thirst, burning of eyes, cough, viscous sputum, dyspnea, feeling of suffocation, tracheal rhonchi, burning in throat, vomiting, pain in chest and cyanosis. Rapid progression to pulmonary edema and pneumonia, and death from respiratory and circulatory failure may occur. Pulmonary edema can suddenly occur up to 48 hours after exposure. Phosgene is a severe mucous membrane irritant. Chronic inhalation may cause irreversible pulmonary changes resulting in emphysema and fibrosis. Acute skin contact lesions similar to those of frostbite and burns; it is a severe skin irritant. Chronic skin contact may result in dermatitis. Acute eye contact may result in conjunctivitis, lacrimation, lesions similar to those of frostbite, and burns; chronic eye contact may result in conjunctivitis.

### ***Emergency and First Aid Procedures***

Inhalation: remove victim to fresh air; keep individual calm and avoid any unnecessary exertion or movement; maintain airway and blood pressure; trained persons should administer oxygen if breathing is difficult; give artificial respiration if victim is not breathing; seek medical attention immediately.

Eye Contact: flush eyes immediately with running water or normal saline for at least 15 minutes; hold eyelids apart during irrigation; do not delay rinsing to avoid permanent eye injury; seek medical attention immediately.

Skin Contact: unlikely that emergency treatment will be required; gently wrap affected part in blankets if warm water is not available or practical to use; allow circulation to return naturally; if adverse effects occur, seek medical attention immediately.

Ingestion: treat symptomatically and supportively; if vomiting occurs, keep head lower than hips to prevent aspiration; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: Wear appropriate protective gloves to prevent any possibility of contact with skin; Butyl and Neoprene rubber gloves are preferred.

Eye Protection: Wear splash-proof or dust-resistant safety goggles and a faceshield to prevent contact with substance.

Other: Wear respirators based on contamination levels found in the workplace; must not exceed the working limits of the respirator and must be jointly approved by NIOSH; employer should provide an eye wash fountain and quick drench shower for emergency use.

### ***Reactivity Data***

Stability: Stable in steel containers of CG is dry.

Hazardous Polymerization: Will not occur.

Incompatibilities: Reacts explosively with thionyl chloride or potassium; reacts violently with hexafluoro isopropylidene, amino lithium, ammonia, and strong acids; reacts with tert-butyl azidoformate to form explosive carbide; reacts with 2,4-hexadiyn-1, 6-diol to form 2, 4-hexadiyn-1, 6-bischloroformate, a shock sensitive compound; reacts with isopropyl alcohol to form isopropyl chloroformate and hydrogen chloride; thermal decomposition may occur in the presence of iron salts and result in explosion.

Instability Conditions: Reacts with vapors of sodium with luminescence at about 260°C.

Decomposition: Moist phosgene is very corrosive; it decomposes in the presence of moisture to form hydrochloric acid and carbon monoxide; thermal decomposition may release toxic and/or hazardous gases.

***Persistency***

Short; however, vapor may persist for some time in low places under calm or light winds and stable atmospheric conditions (inversion).

***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
2. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.
3. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc, Rahway, New Jersey, 1989.
4. Somani, Satu M., *Chemical Warfare Agents*, Academic Press, Inc., San Diego, California, 1992.
5. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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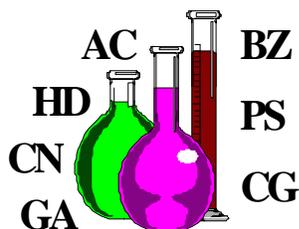
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*Detailed Facts About Blood Agent Cyanogen Chloride*

*(CK)*

218-06-1096

*Physical Properties of Cyanogen Chloride*

<i>Chemical Structure</i>	CNCl
<i>Chemical Formula</i>	CNCl
<i>Description</i>	Cyanogen chloride is a colorless gas with a sharp, pepperish odor similar to that of most tear gasses. The odor of CK often goes unnoticed because it is so irritating to the mucous membranes. CK is a liquid at temperatures below 55°F.
<i>Molecular Weight</i>	61.471
<i>Boiling Point</i>	12.8°C
<i>Vapor Pressure (mm Hg)</i>	1,000 @ 25°C
<i>Freezing Point</i>	-6.9°C
<i>Density</i>	Liquid = 1.18 Vapor = 2.1 (air = 1)
<i>Solubility</i>	Slightly soluble in water; dissolves readily in alcohol, carbon disulfide, acetone, benzene, carbon tetrachloride, chloropicrin, HD, and AC.
<i>Flash Point</i>	None
<i>Volatility</i>	2,600,000 mg/m <sup>3</sup> @ 12.8°C

### ***Toxicity Values***

IC <sub>50</sub>	= 7,000 mg-min/m <sup>3</sup>
LC <sub>50</sub>	= 11,000 mg-min/m <sup>3</sup>
NOAEL (inhalation)	= 1,525 mg-min/m <sup>3</sup>
RfD (ingestion)	= 0.750 mg/l

### ***Exposure Limit***

Workplace Time-Weighted Average -	0.6 mg/m <sup>3</sup>
General Population Limits -	No standard identified

## ***Toxic Properties of Cyanogen Chloride***

*Cyanogen chloride irritates the eyes and respiratory tract, even in low concentrations. Acute exposure produces intense irritation of the lungs characterized by coughing and breathing problems, which may quickly lead to a pulmonary edema. Inside the body, cyanogen chloride converts to hydrogen cyanide, which inactivates the enzyme cytochrome oxidase, preventing the utilization of oxygen by the cells. The general action of CK, interference with the use of oxygen in the body, is similar to that of AC. However, CK differs from AC in that it has strong irritating and choking effects and slows breathing.*

### ***Overexposure Effects***

CK is absorbed through the skin and mucosal surfaces and is dangerous when inhaled because toxic amounts are absorbed through bronchial mucosa and alveoli. It is similar in toxicity and mode of action to AC, but is much more irritating. CK can cause a marked irritation of the respiratory tract, hemorrhagic exudate of the bronchi and trachea as well as pulmonary edema. It is improbable that anyone would voluntarily remain in areas with a high enough concentration to exert a typical nitrile effect. The liquid form will burn skin and eyes. Long-term exposure will cause dermatitis, loss of appetite, headache, and upper respiratory irritation in humans.

### ***Emergency and First Aid Procedures***

**Inhalation:** if the patient is conscious, direct first aid and medical treatment toward the relief of any pulmonary symptoms; put patient immediately at bed rest with head slightly elevated; seek medical attention immediately; administer oxygen if there is any dyspnea or evidence of pulmonary edema; in case of long exposures, combined therapy, with oxygen plus amyl nitrite inhalations and artificial respiration is recommended.

**Eye Contact:** flush affected areas with copious amounts of water immediately; hold eyes open while flushing.

**Skin Contact:** wash skin promptly to remove the cyanogen chloride; remove all contaminated clothing, including shoes; do not delay.

**Ingestion:** give victim water or milk; do not induce vomiting.

### ***Protective Equipment***

Protective Gloves:	Wear Butyl or Neoprene rubber gloves.
Eye Protection:	Wear chemical safety goggles if dust or solutions of cyanide salts may come into contact with the eye; wear full-length face shields with forehead protection if dusts, molten salts, or solutions of cyanide salts contact the face.
Other:	Wear appropriate chemical cartridge respirator depending on the amount of exposure; rescue personnel should be equipped with self-contained breathing apparatus; have available and use as appropriate rubber suits, full-body chemical suits, safety shoes, safety shower, and eyewash fountain.

### ***Reactivity Data***

Stability:	Unstable; polymerizes without stabilizer; stable for less than 30 days in canister munitions; will polymerize to form the solid cyanuric chloride which is corrosive and may explode.
Decomposition:	2,4,6 - Trichloro-s-Triazine which can polymerize violently.
Polymerization:	Hazardous polymerization may occur; avoid high temperature storage and moisture.

<b><i>Persistency</i></b>	Short; vapor may persist in jungle and forest for some time under suitable weather conditions.
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### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military/Biological Agents and Compounds*, 1990.
2. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.
3. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.

4. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.
5. Genium's Reference Collection, *Material Safety Data Sheet No. 240*, Genium Publishing Corporation, Schenectady, New York, 1988.

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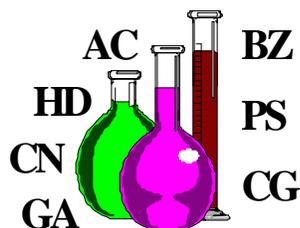
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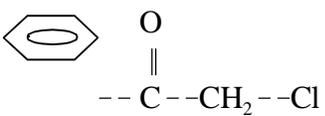
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*Detailed Facts About Tear Agent 2-Chloroacetophenone  
(CN)*

218-19-1096

*Physical Properties of Tear Agent 2-Chloroacetophenone*

<i>Chemical Structure</i>	
<i>Chemical Formula</i>	C <sub>6</sub> H <sub>5</sub> COCH <sub>2</sub> Cl
<i>Description</i>	CN is a colorless-to gray crystalline solid with a sharp, irritating floral odor. The odor threshold for CN is 0.1 mg/m <sup>3</sup> .
<i>Molecular Weight</i>	154.60
<i>Boiling Point</i>	247°C
<i>Vapor Pressure (mm Hg)</i>	0.0026 @ 0°C 0.0041 @ 20°C 0.152 @ 51.7°C
<i>Freezing Point</i>	54°C
<i>Density</i>	Solid = 1.318 @ 20°C Liquid = 1.187 @ 58°C Vapor = 5.3 (air = 1)
<i>Solubility</i>	Insoluble in water
<i>Flash Point</i>	118°C

**Volatility**  
2.36 mg/m<sup>3</sup> @ 0°C  
34.3 mg/m<sup>3</sup> @ 20°C  
1060 mg/m<sup>3</sup> @ 51.7°C

**Toxicity Values**  
IC<sub>t50</sub> = 80 mg-min/m<sup>3</sup>  
LC<sub>t50</sub> = 7,000 mg-min/m<sup>3</sup> from solvent  
= 14,000 mg-min/m<sup>3</sup> from grenade  
RfC (inhalation) = 0.00003 mg/m<sup>3</sup>

### **Exposure Limits**

Workplace Time-Weighted Average - 0.3 mg/m<sup>3</sup>  
General Population Limits - 0.00003 mg/m<sup>3</sup>

## ***Toxic Properties of Chloroacetophenone***

*The United States considers agent CN (popularly known as mace or tear gas) and its mixtures with various chemicals to be obsolete for military deployment. It is highly toxic by inhalation and ingestion.*

### **Overexposure Effects**

Alpha-chloroacetophenone vapors may cause a tingling or runny nose, burning and/or pain of the eyes, blurred vision, and tears. Burning in the chest, difficult breathing, and nausea may also occur as well as skin irritation, rash, or burns. It can also cause difficulty if swallowed.

### **Emergency and First Aid Procedures**

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin using soap or mild detergent and water immediately; remove the contaminated clothing immediately and wash the skin using soap or mild detergent and water; seek medical attention immediately when there are chemical burns or evidence of skin irritation.

Ingestion: induce vomiting by having victim touch the back of the throat with finger or by giving victim syrup of ipecac as directed; do not induce vomiting if victim is unconscious; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves:	Wear impervious gloves.
Eye Protection:	Wear dust- and splash-proof safety goggles where there is any possibility of solid CN or liquids containing CN may contact the eyes; wear face shield; wear appropriate protective mask.
Other:	Wear a complete set of protective clothing to include gloves and lab coat, apron, boots, plastic coveralls; other protective clothing and equipment should be available to prevent contact with skin or clothing; remove contaminated clothing immediately; do not wear clothing until it has been properly laundered.

### ***Reactivity Data***

Stability:	Stable in closed containers at room temperature under normal storage and handling conditions.
Incompatibility:	Water or steam.
Hazardous Decomposition:	Toxic and corrosive vapors are produced when combined with water or steam.

***Persistency*** Short because the compounds are disseminated as an aerosol.

### ***References***

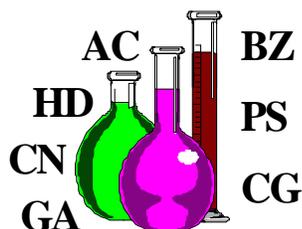
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3. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.
4. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 1995-1996*, American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, Ohio.

5. Genium's Reference Collection, *Material Safety Data Sheet No. 603, 2-Chloroacetophenone*, Genium Publishing Corporation, Schenectady, New York, 1986.
6. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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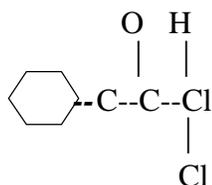


*Detailed Facts About Tear Agent Chloroacetophenone  
in Benzene and Carbon Tetrachloride  
(CNB)*

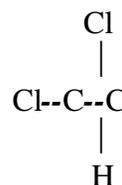
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*Physical Properties of Tearing Agent Chloroacetophenone  
in Benzene and Carbon Tetrachloride*

*Chemical Structure*



chloroacetophenone (CN)  
(10 parts)



carbon tetrachloride (45 parts)



benzene (45 parts)

*Chemical Formula*

Chloroacetophenone (CN) - C<sub>6</sub> H<sub>5</sub> COCH<sub>2</sub> Cl  
(10 parts by weight)

Carbon Tetrachloride - CCl<sub>4</sub>  
(45 parts by weight)

Benzene - C<sub>6</sub> H<sub>6</sub>  
(45 parts by weight)

*Description*

CNB is a slightly brown liquid smelling heavily of benzene. It has an immediate strong irritating effect on the eyes and respiratory tract. CNB is flammable.

*Molecular Weight*

119.7

*Freezing Point*

-7°C to -30°C

**Agent CNB** - The chemical mixture of chloroacetophenone in benzene and carbon tetrachloride. The Chemical Abstract Service Registry Number is not available.

<b>Density</b>	Liquid = 1.14 g/cc @ 20°C Vapor = approximately 4 (air = 1)		
<b>Solubility</b>	No data available		
<b>Flash Point</b>	Below 4.47°C; one of the main reasons CNB ceased to be used by police agencies.		
<b>Volatility</b>	Benzene -	320,624 mg/m <sup>3</sup> @ 20°C 420,111 mg/m <sup>3</sup> @ 25°C	
	Carbon Tetrachloride-	766,000 mg/m <sup>3</sup> @ 20°C	
<b>Toxicity Values</b>	IC <sub>t50</sub>	= 80 mg-min/m <sup>3</sup>	LC <sub>t50</sub> =
11,000 mg-min/m <sup>3</sup>			(about the same as CN)

### **Exposure Limits**

#### Alpha-Chloroacetophenone (CN)

Workplace Time-Weighted Average -	3 mg/m <sup>3</sup>
General Population Limits -	0.32 mg/m <sup>3</sup>

#### Benzene

Workplace Time-Weighted Average -	1 mg/m <sup>3</sup>
General Population Limits -	32 ppm

#### Carbon tetrachloride

Workplace Time-Weighted Average -	2 mg/m <sup>3</sup>
General Population Limits -	31 mg/m <sup>3</sup>

## **Toxic Properties of Tear Agent Chloroacetophenone in Benzene and Carbon Tetrachloride**

*CNB was adopted in 1920 and remained in use until it was replaced by Chloroacetophenone and Chloropicrin in Chloroform. The advantages claimed for CNB was that its lower chloroacetophenone content made it more satisfactory than chloroacetophenone in chloroform (CNC) for training purposes.*

### **Overexposure Effects**

CNB is a formulation of chloroacetophenone. Like CN, CNB has a pronounced lacrimatory effect, resulting in a natural reflex to shut the eyes. It is similarly irritating to the skin, especially the face and such exposed portions of the body where sweat accumulates. CNB will penetrate clothing or adhere to it under long exposure due to its benzene component. The same rashes caused by CN will be caused by CNB. CNB has a slightly more powerful choking effect than CN. Eye toxicity remains about the same as CN. Some sensitive individuals may experience



***Persistency***

Short.

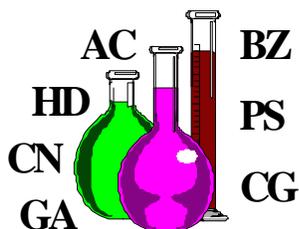
***References***

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3. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.
4. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
5. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 1995-1996*, American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, Ohio.
6. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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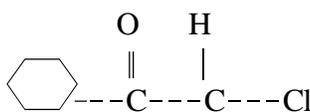


*Detailed Facts About Tear Agent Chloroacetophenone  
and Chloropicrin in Chloroform  
(CNS)*

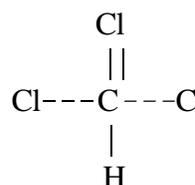
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*Physical Properties of Tearing Agent Chloroacetophenone  
and Chloropicrin in Chloroform*

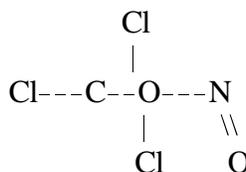
*Chemical Structure*



chloroacetophenone  
(23.0%)



chloroform  
(38.5%)



chloropicrin  
(38.5%)

*Chemical Formula*

Chloroacetophenone (CN) -  $C_6H_5COCH_2Cl$   
(23 percent)  
Chloropicrin (PS) -  $C(NO_2)Cl_3$   
(38.4 percent)  
Chloroform -  $CHCl_3$   
(38.4 percent)

*Description*

CNS is a clear liquid smelling like flypaper; it has an immediately strong irritating effect on the eyes and respiratory tract. CNS may cause severe nausea.

*Molecular Weight*

141.78 (based on components)

<b><i>Boiling Point</i></b>	Begins at 60°C with chloroform and is complete with boiling of CN at 247°C.	
<b><i>Vapor Pressure (mm Hg)</i></b>	78 @ 20°C	
<b><i>Freezing Point</i></b>	2°C; this is the point at which crystals of CN separate and is not a true freezing point as in the case of a pure compound.	
<b><i>Density</i></b>	Liquid = 1.47 g/cc @ 20°C Vapor = approximately 5.0 (air = 1)	
<b><i>Solubility</i></b>	No data available.	
<b><i>Flash Point</i></b>	None.	
<b><i>Volatility</i></b>	605,000 mg/m <sup>3</sup> @ 20°C 900,500 mg/m <sup>3</sup> @ 30°C 1,620,000 mg/m <sup>3</sup> @ 50°C	
<b><i>Toxicity Values</i></b>	ICt <sub>50</sub>	= 60 mg-min/m <sup>3</sup>
	LCt <sub>50</sub>	= 11,400 mg-min/m <sup>3</sup>

***Exposure Limits***

Alpha-Chloroacetophenone (CN)

Workplace Time-Weighted Average -	0.3 mg/m <sup>3</sup>
General Population Limits -	0.32 mg/m <sup>3</sup>

Chloropicrin

Workplace Time-Weighted Average -	0.7 mg/m <sup>3</sup>
General Population Limits -	0.67 mg/m <sup>3</sup>

Chloroform

Workplace Time-Weighted Average -	240 mg/m <sup>3</sup>
General Population Limits -	49 mg/m <sup>3</sup>

***Toxic Properties of Tear Agent Chloroacetophenone and Chloropicrin in Chloroform***

*CNS is a formulation of chloroacetophenone (CN). CNS was formulated not so much as a tear agent but as a vomiting agent. CNS was an American chemical warfare materiel developed after WWI; it has a mixture of 23 percent chloroacetophenone (CN), 38.4 percent chloropicrin (PS), and 38.4 percent chloroform.*

### ***Overexposure Effects***

CNS is an example of multiple-component mixtures developed to achieve desired dissemination characteristics. Its hazards exist for inhalation, ingestion, and skin and eye exposure. It produces nausea within a minute of inhalation by a moderately sensitive person. If inhaled for longer periods, vomiting, colic (severe abdominal pains and cramps), and diarrhea are to be expected in its victims. Persons who are exposed to very large quantities of the vapors or liquid concentrations may suffer these symptoms for weeks. CNS is a non-lethal choking agent. It will cause the victims to gasp for air (thus inhaling more CNS) while causing discomfort to the bronchial tubes and lung sacs. CNS vapors may go into solution with sweat, making it a skin irritant, especially the face. If allowed to penetrate the clothing, CNS will cause stinging under the armpits, elbows, knees, and the area around the crotch and buttocks. Skin rashes may result after prolonged exposures. Prolonged eye exposure would not be recommended.

### ***Emergency and First Aid Procedures***

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin with soap or mild detergent and water immediately; remove the contaminated clothing immediately, and wash the skin using soap or mild detergent and water; seek medical attention immediately when there are chemical burns or evidence of skin irritation.

Ingestion: induce vomiting by having victim touch the back of his throat with finger or by giving victim syrup of ipecac as directed; do not induce vomiting if victim is unconscious; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves:                      Wear impervious gloves.

Eye Protection:                         Wear dust- and splash-proof safety goggles where there is any possibility of solid CNB or liquids containing CNB contacting the eyes; wear appropriate protective mask.

Other:                                        Wear a complete set of protective clothing to include gloves and lab coat, apron, boots, plastic coveralls; other protective clothing and equipment should be available to prevent contact with skin or clothing; remove contaminated clothing immediately; do not wear clothing until it has been properly laundered.

### ***Reactivity Data***

Stability:	Stable in storage.
Hydrolysis Rate:	Does not readily hydrolyze.
Hydrolysis Products:	Hydrogen chloride and a hydroxyacetophenone.
Corrosive Properties:	Very little.
<b><i>Persistence</i></b>	Short.

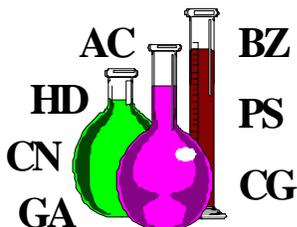
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5. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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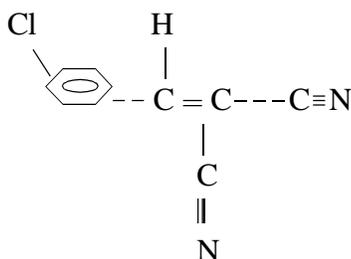


*Detailed Facts About Tear Agent  
O-Chlorobenzylidene Malononitrile  
(CS)*

218-23-1096

*Physical Properties of Tear Agent  
O-Chlorobenzylidene Malononitrile*

*Chemical Structure*



*Chemical Formula*

$\text{C}_{10} \text{H}_5 \text{Cl N}_2$

*Description*

CS is a white crystalline solid; burnt to create a colorless gas with an acrid pepperlike smell.

*Molecular Weight*

188.5

*Boiling Point*

310°C to 315°C

*Vapor Pressure (mm Hg)*

$3.4 \times 10^{-5}$  @ 20°C

*Freezing Point*

93°C to 95°C

*Density*

Solid = 1.04 g/cc  
Vapor - several times heavier than air

*Solubility*

Soluble in hexane, benzene, methylene chloride, acetone, dioxane, ethyl acetate, and pyridine; insoluble in water and ethanol.

*Flash Point*

197°C

**Volatility** 0.71 mg/m<sup>3</sup> @ 25°C

**Toxicity Values**  
ICt<sub>50</sub> = 10 to 20 mg-min/m<sup>3</sup>  
LCt<sub>50</sub> = 61,000 mg-min/m<sup>3</sup>

**Exposure Limits**

Workplace Time-Weighted Average - 0.4 mg/m<sup>3</sup>  
General Population Limits - No standard identified

***Toxic Properties of O-Chlorobenzylidene Malononitrile***

*CS was developed in the late 1950s as a riot-control substance. It is a more potent irritant than chloroacetophenone but less incapacitating. In the late 1960s, stocks of CS replaced CN. Presently, the U.S. Army uses CS for combat training and riot control purposes.*

**Overexposure Effects**

CS is disseminated by burning, explosion, and aerosol formation. It is immediately irritating to the eyes and upper respiratory tract. Warm vapors mix with human sweat to cause a burning sensation to the eyes, nose, and mouth. Conjunctivitis and pain in the eyes, lacrimation, erythema of the eyelids, runny nose, burning throat, coughing and constricted feeling in the chest are the effects which will occur immediately and will persist 5 to 20 minutes after removal from the contaminated area.

It is immediately dangerous to life and health at a concentration of 2 mg/m<sup>3</sup>. It is not an accumulative agent in the human body, although it accumulates in the landscape. CS is the most persistent of the tear agents, absorbing into the most porous surfaces including soil and plaster.

**Emergency and First Aid Procedures**

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep the victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water for at least 15 minutes; apply an ophthalmic corticosteroid ointment after decontamination; treat delayed erythema with a bland shake lotion (such as calamine lotion) or a topical corticosteroid depending on severity; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin thoroughly using soap and water; remove the contaminated clothing immediately; if irritation persists after washing, seek medical attention immediately.

Ingestion: give victim copious amounts of water immediately; induce vomiting by having victim touch the back of throat with finger; do not make an unconscious person vomit; seek medical attention immediately.

## ***Protective Equipment***

Protective Gloves:	Wear impervious gloves; rubber gloves.
Eye Protection:	Wear face shields or dust- and splash-proof safety goggles to prevent any possibility of skin contact.
Other:	Wear protective mask and overclothing in confined spaces; use a chemical cartridge respirator with organic vapor cartridges in combination with a high efficiency particulate filter; wear a self-contained breathing apparatus with a full face piece or an air purifying, full-face piece respirator with an organic vapor canister.

Do not use standard decontaminants or detergents that contain chlorine bleach because the materials can react to form compounds more toxic than CS. Contaminated surfaces should be decontaminated using a solution of equal parts (by volume) methanol and water with 18 percent (by weight) sodium hydroxide or commercial lye added to the solution. Also, an aqueous solution containing 10 percent monoethanolamine anionic detergent can be used as a decontaminant.

## ***Reactivity Data***

Stability:	Stable in storage.
Incompatibility:	Incompatible with strong oxidizers.
Hazardous Decomposition:	When heated to decomposition, CS emits very toxic fumes.
Hydrolysis Products:	AQ Alkaline.

***Persistency*** Varies, depending upon amount of contamination.

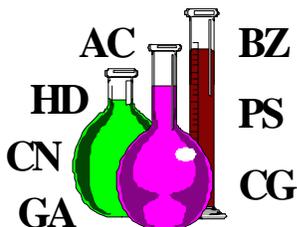
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3. *Hazardous Substances Data Bank*, January 1996.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Blister Agent Phosgene Oxime*

(CX)

218-13-1096

*Physical Properties of Blister Agent Phosgene Oxime*

<i>Chemical Structure</i>	$\begin{array}{c} \text{Cl} \quad \quad \text{OH} \\ \quad \backslash \quad / \\ \quad \text{C} = \text{N} \\ \quad / \\ \quad \text{Cl} \end{array}$
<i>Chemical Formula</i>	CHCl <sub>2</sub> NOH
<i>Description</i>	CX may appear as a colorless, low-melting point (crystalline) solid or as a liquid. It has a high vapor pressure, slowly decomposes at normal temperatures; it has a disagreeable, penetrating odor.
<i>Molecular Weight</i>	113.9
<i>Boiling Point</i>	53° to 54°C
<i>Vapor Pressure (mm Hg)</i>	11.2 @ 25°C (solid) 13 @ 40°C (liquid)
<i>Freezing Point</i>	35° to 40°C
<i>Density</i>	Liquid = no data Vapor = 3.9 (air = 1)
<i>Solubility</i>	Forms hydrate which is very soluble in water, (~70%)
<i>Volatility</i>	7.6 x 10 <sup>4</sup> mg/m <sup>3</sup> @ 40°C

**Agent CX** - The chemical dichloroformoxime or Phosgene Oxime, Chemical Abstract Service Registry Number is not available.

<b><i>Toxicity Values</i></b>	Beginning irritation (12 sec)	= 0.2 mg-min/m <sup>3</sup>
	Unbearable irritation (1 min)	= 3 mg-min/m <sup>3</sup>
	LCt <sub>50</sub>	= 3,200 mg-min/m <sup>3</sup> (estimated)

### ***Exposure Limits***

Workplace Time-Weighted Average -	No standard available
General Population Limits -	No standard available

## ***Toxic Properties of Blister Agent Phosgene Oxime***

*CX is an urticant producing instant, almost intolerable pain and local tissue destruction immediately on contact with skin and mucous membranes. It is toxic through inhalation, skin and eye exposure, and ingestion. Its rate of detoxification in the body is unknown.*

### ***Overexposure Effects***

CX vapors are violently irritating to the eyes. Very low concentrations can cause inflammation, lacrimation, and temporary blindness; higher concentrations can cause corneal corrosion and dimming of vision. Contact with the skin can cause skin lesions of the corrosive type. It is characterized by the appearance within 30 seconds of a central blanched area surrounded by an erythematous ring. Subcutaneous edema follows in about 15 minutes. After 24 hours, the central blanched area becomes necrotic and darkened, and an eschar is formed in a few days. Healing is accompanied by sloughing of the scab; itching may be present throughout healing.

### ***Emergency and First Aid Procedures***

Inhalation: remove from the source immediately; give artificial respiration if breathing has stopped; seek medical attention immediately.

Eye Contact: flush eyes immediately with copious amounts of water; seek medical attention immediately.

Skin Contact: remove victim from the source immediately; decontaminate the skin immediately by flushing with copious amounts of water to remove any phosgene oxime which has not yet reacted with tissue; seek medical attention immediately.

Ingestion: do not induce vomiting; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: Wear Butyl toxicological agent protective gloves (M3, M4 or glove set).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear a complete set of protective clothing to include gloves and lab coat for general lab work; have an M9, M40, or M17 mask readily available.

### ***Reactivity Data***

Stability: Unstable in metal; store in glass or enamel-lined storage vessels.

Decomposition Rate: Half-life; gradually decomposes at reflux (129°C); decomposes on storage above -20°C.

Hydrolysis Rate: Very slow in H<sub>2</sub>O @ pH7; 5% decomposition in 6 days at room temperature; reacts violently in alkaline solution.

Hydrolysis Products: Monohydrate: H  
In hot acid: CO<sub>2</sub> [HH<sub>2</sub>OH]<sup>+</sup> Cl and HCl

Corrosive Properties: Corrosive to most metals.

### ***Persistency***

Soil - approximately 2 hours.  
Surface (wood, metal, masonry, rubber, paint) - relatively nonpersistent.  
Water - relatively nonpersistent.

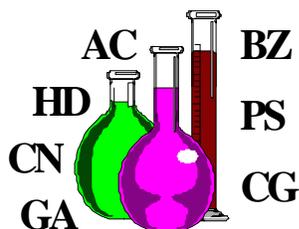
### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
2. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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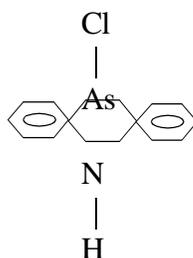


*Detailed Facts About Vomiting Agent Adamsite  
(DM)*

218-17-1096

*Physical Properties of Adamsite*

*Chemical Structure*



*Chemical Formula*

$C_{12}H_8AsClN$

*Description*

Light green to yellow crystals at room temperature; irritates nasal passages similar to pepper; no odor, but irritating.

*Molecular Weight*

277.54

*Boiling Point*

410°C

*Vapor Pressure (mm Hg)*

Forms no appreciable vapor.

*Freezing Point*

195°C

*Density*

Solid = 1.65 @ 20°C  
Vapor = negligible

*Solubility*

Soluble in furfural and acetone; slightly soluble in common organic solvents; insoluble in water. Not readily soluble in any of the liquid chemical warfare agents.

*Flash Point*

Does not flash.

**Volatility** 19,300 mg/m<sup>3</sup> @ 0°C  
26,000 to 120,000 mg/m<sup>3</sup> @ 20°C  
72,500 to 143,000 mg/m<sup>3</sup> @ 25°C

**Toxicity Values** Ict<sub>50</sub> = 22 to 150 mg-min/m<sup>3</sup>  
Lct<sub>50</sub> = variable, average 11,000 mg-min/m<sup>3</sup>  
NOAEL (inhalation) = 4 mg-min/m<sup>3</sup>

***Airborne Exposure Limit (AEL)***

Workplace Time-Weighted Average - No standard identified  
General Population Limits - No standard identified

***Toxic Properties of Adamsite***

*DM was first produced during World War I. Adamsite was not toxic enough for the battlefield, but it proved to be too drastic for use against civilian mobs; it was banned for use against civilian populations in the 1930s in the Western nations. DM was produced worldwide until superseded by the CN series of tear agents.*

***Overexposure Effects***

DM is a vomiting compound. It is normally a solid, but upon heating, DM first vaporizes and then condenses to form aerosols. It is toxic through inhalation, ingestion, and skin contact. Adamsite is dispersed as an aerosol, irritating to the eyes and respiratory tract but not necessarily to the skin. Under field conditions, vomiting agents can cause great discomfort to the victims; when released indoors, they can cause serious illness or death. Symptoms include irritation of eyes and mucous membranes, coughing, sneezing, severe headache, acute pain and tightness in the chest, nausea, and vomiting. DM has been noted to cause necrosis of corneal epithelium in humans. The human body will detoxify the effects of mild exposures within 30 minutes of evacuation. Severe exposures may take several hours to detoxify and minor sensory disturbances may persist for up to one day.

***Emergency and First Aid Procedures***

Inhalation: remove victim to fresh air; wear a mask/respirator in spite of coughing, sneezing, salivation, and nausea; lift the mask from the face briefly, if necessary, to permit vomiting or to drain saliva from the facepiece; seek medical attention immediately.

Eye Contact: don a respiratory protective mask; seek medical attention immediately.

Skin Contact: rinse the nose and throat with saline water or bicarbonate of soda solution; wash exposed skin and scalp with soap and water and allow to dry on the skin; dust the skin with borated talcum.

Ingestion: seek medical attention immediately; carry on duties as vigorously as possible; this will help to lessen and shorten the symptoms; combat duties usually can be performed in spite of the effects of sternutators.

### ***Protective Equipment***

Protective Gloves: Wear Chemical Protective Glove Set.

Eye Protection: Wear chemical goggles; wear a mask/respirator in open areas.

Other: Wear additional protective clothing, such as gloves and lab coat with an M9, M17, or M40 mask readily available in closed or confined spaces.

### ***Reactivity Data***

Stability: Stable in pure form; after 3 months, caused extensive corrosion of aluminum, anodized aluminum, and stainless steel; will corrode iron, bronze, and brass when moist.

Hydrolysis Rate: Acidic (pH) - 0.5 percent; prevents hydrolysis at room temperature; 9.8 percent HCl; prevents hydrolysis @ 70°C. Basic (pH) - slowly hydrolyzes in water.

Hydrolysis Products:  $[\text{NH}(\text{C}_6\text{H}_4)_2\text{AS}]_2\text{O}$  & HCl.

Corrosive Properties: Titanium - 71°C, 6 months, appeared good.  
Stainless Steel - 43°C, 30 days, slight discoloration.  
Common Steel - 43°C, 30 days, covered with rust.  
Aluminum Anodized - 43°C, 30 days, minor corrosion and pitting. Aluminum - 43°C, 30 days, severe corrosion.

### ***Persistency***

Short, because compounds are disseminated as an aerosol. Soil - persistent Surface (wood, metal, masonry, rubber, paint) - persistent. Water - persistent; when material is covered with water, an insoluble film forms which prevents further hydrolysis.

### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
2. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.

3. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
4. Somani, Satu M., *Chemical Warfare Agents*, Academic Press, Inc., San Diego, California, 1992.
5. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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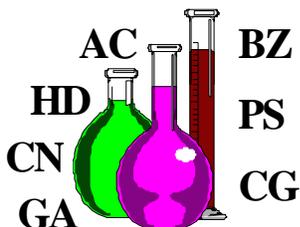
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Nerve Agent GA*

218-02-1096

*Physical Properties of Nerve Agent GA*

<i>Chemical Structure</i>	$\begin{array}{c} \text{O} \quad \text{CH}_3 \\   \quad / \\ \text{CH}_3\text{CH}_2\text{-O-P-N} \\   \quad \backslash \\ \text{CN} \quad \text{CH}_3 \end{array}$
<i>Chemical Formula</i>	C <sub>5</sub> H <sub>11</sub> N <sub>2</sub> O <sub>2</sub> P
<i>Description</i>	G-type nerve agents are clear, colorless, and tasteless liquids, chemically similar to organophosphate pesticides such as Malathion or Parathion. GA has a slightly fruity odor.
<i>Molecular weight</i>	162.3
<i>Boiling Point</i>	247.5°C
<i>Vapor Pressure (mm Hg)</i>	0.07 @ 24°C
<i>Freezing Point</i>	-50°C
<i>Density</i>	Liquid = 1.07 - Liquid Vapor = 5.6 (air = 1)
<i>Solubility</i>	Miscible
<i>Flash Point</i>	78°C

**Volatility**  
90 mg/m<sup>3</sup> @ 0°C  
610 mg/m<sup>3</sup> @ 25°C  
858 mg/m<sup>3</sup> @ 30°C

**Toxicity Values**  
LC<sub>50</sub> (inhalation, 0.5 to 2 min.) = 135 mg-min/m<sup>3</sup> @ respiratory minute volume (RMV) of 15 l/min  
= 200 mg-min/m<sup>3</sup> @ RMV of 10 l/min  
LD<sub>50</sub> (skin) = 14 to 15 mg/kg

### ***Exposure Limits***

Workplace Time-Weighted Average - 0.0001 mg/m<sup>3</sup>  
General Population Limits - 0.000003 mg/m<sup>3</sup>

## ***Toxic Properties of Nerve Agent GA***

*GA-type nerve agents stored in the unitary stockpile are in ton containers, artillery shells, mortar projectiles, rockets, and land mines.*

G-type nerve agents are considered to be nonpersistent chemical agents that may present a significant vapor hazard to the respiratory tract, eyes, or skin. GA-type nerve agents affect the body by blocking the action of the enzyme acetylcholinesterase. When this enzyme is blocked, large amounts of the chemical acetylcholine build up at critical places within the nervous system, causing hyperactivity of the muscles and body organs stimulated by these nerves. The signs and symptoms of exposure to GA-type nerve agents depend upon the *route of exposure* and the *amount of exposure*.

### ***Overexposure Effects***

Signs and symptoms are the same regardless of route the poison enters the body (by inhalation, absorption, or ingestion): runny nose; tightness of chest; dimness of vision and miosis (pinpointing of the eye pupils); difficulty in breathing; drooling and excessive sweating; nausea; vomiting; cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These signs and symptoms are followed by cessation of breathing and death.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; if severe signs of agent exposure appear, administer immediately, in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available; do not use mouth-to-mouth resuscitation when facial contamination exists; administer oxygen if breathing is difficult; seek medical attention immediately.  
Eye Contact: flush eyes immediately with water for 10-15 minutes then don a respiratory



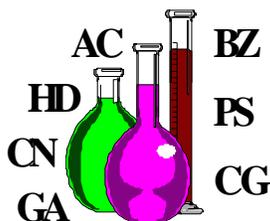
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
3. Army Regulation (AR) 385-61, *The Army Toxic Chemical Agent Safety Program*, July 1983.
4. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Nerve Agent GB*

218-03-1096

*Physical Properties of Nerve Agent GB*

<i>Chemical Structure</i>	$\begin{array}{c} \text{O} \quad \text{CH}_3 \\   \quad   \\ \text{H}_3\text{C}-\text{P}-\text{O}-\text{CH} \\   \quad   \\ \text{F} \quad \text{CH}_3 \end{array}$
<i>Chemical Formula</i>	$\text{C}_4 \text{H}_{10} \text{FO}_2 \text{P}$
<i>Description</i>	GB-type nerve agents are clear, colorless, and tasteless liquids. They are odorless in vapor and pure form.
<i>Molecular Weight</i>	140.1
<i>Boiling Point</i>	147°C
<i>Vapor Pressure (mm Hg)</i>	2.9 @ 25°C
<i>Freezing Point</i>	-57°C
<i>Density</i>	Liquid = 1.09 Vapor = 4.9 (air = 1)
<i>Solubility</i>	Miscible
<i>Flash Point</i>	Nonflammable
<i>Volatility</i>	4,100 mg/m <sup>3</sup> @ 0°C 22,000 mg/m <sup>3</sup> @ 25°C 29,800 mg/m <sup>3</sup> @ 30°C

<b>Toxicity Values</b>	IC <sub>50</sub> (skin)	= 35 mg-min/m <sup>3</sup> (15 l/min)
	LC <sub>50</sub> (inhalation 0.5 to 2 min)	= 70 mg-min/m <sup>3</sup> (15 l/min)
	LD <sub>50</sub> (skin)	= 24 mg/kg
	1% Lethality	= 10 mg-min/m <sup>3</sup>
	No Death Levels	= 6 mg-min/m <sup>3</sup>

### ***Exposure Limits***

Workplace Time-Weighted Average -	0.0001 mg/m <sup>3</sup>
General Population Limits -	0.000003 mg/m <sup>3</sup>

## ***Toxic Properties of Nerve Agent GB***

*G-type nerve agents stored in the unitary stockpile are in ton containers, artillery shells, mortar projectiles, rockets, and land mines.*

GB is a lethal anticholinesterase agent. Its toxic hazard is high for inhalation, ingestion, and eye and skin exposure. Due to its high volatility, it is mainly an inhalation threat. Its rate of detoxification in the body is low. Effects of chronic exposures are cumulative. Following a single exposure to GB, daily exposure to concentrations of any nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depends on duration of exposure and time intervals between exposures.

### ***Overexposure Effects***

Signs and symptoms are the same regardless of route the poison enters the body (by inhalation, absorption, or ingestion): runny nose; tightness of chest; dimness of vision and miosis (pinpointing of the eye pupils); difficulty in breathing; drooling and excessive sweating; nausea; vomiting; cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These signs and symptoms are followed by cessation of breathing and death.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; if severe signs of agent exposure appear, administer immediately in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available; do not use mouth-to-mouth resuscitation when facial contamination exists; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes then don a respiratory protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; administer an intramuscular injection with the Mark I Kit if local sweating and muscular symptoms occur; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams (mg) intramuscular injection of the MARK I Kit auto injectors; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves:                      Wear Butyl Glove M3 and M4 Norton, Chemical Protective Glove Set.

Eye Protection:                         Wear chemical goggles use goggles and faceshield for splash hazards.

Other:                                        Wear gloves and lab coat with M9 or M17 mask readily available for general lab work.

### ***Reactivity Data***

Stability:                                  Stable when pure, ~20 hours

Incompatibility:                         Attacks tin, magnesium, cadmium plated steel, some aluminums; slight attack on copper, brass, lead; practically no attack on 1020 steel, Inconel and K-monel.

Hydrolyzes to form HF under acid conditions and isopropyl alcohol and polymers under basic conditions.

***Persistency***                             Evaporates at approximately the same rate as water; depends upon munitions used and the weather.

### ***References***

1. Department of the Army Pamphlet (DA PAM) 40-8, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX*, December 1990.
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.

3. Army Regulation (AR) 385-61, *The Army Toxic Chemical Agent Safety Program*, July 1983.
4. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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LD<sub>50</sub> (percutaneous, = 5 mg/kg  
bare skin)

### ***Exposure Limits***

Workplace Time-Weighted Average - 0.00003 mg/m<sup>3</sup>  
General Population Limits - 0.000003 mg/m<sup>3</sup>

## ***Toxic Properties of Nerve Agent GD***

*G-type agents stored in the unitary stockpile are in ton containers, artillery shells, mortar projectiles, rockets, and land mines.*

GD is a lethal anticholinesterase agent. Although it is primarily a vapor hazard, its toxic hazard is high for inhalation, ingestion, and eye and skin exposure. Its rate of detoxification in the body is low.

### ***Overexposure Effects***

Signs and symptoms are the same regardless of route the poison enters the body (by inhalation, absorption, or ingestion): runny nose; tightness of chest; dimness of vision and miosis (pinpointing of the eye pupils); difficulty in breathing; drooling and excessive sweating; nausea; vomiting; cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These signs and symptoms are followed by cessation of breathing and death.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; if severe signs of agent exposure appear, administer immediately, in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available, but do not use mouth-to-mouth resuscitation when facial contamination exists; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes then don a respiratory protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; administer an intramuscular injection with the Mark I Kit if local sweating and muscular symptoms occur; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams intramuscular injection of the MARK I Kit auto injectors; seek medical attention immediately.

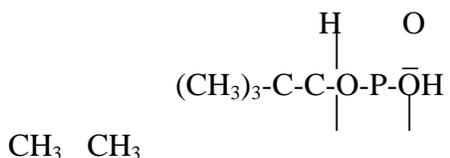
### ***Protective Equipment***

- Protective Gloves: Wear Butyl Glove M3 and M4 Norton, Chemical Protective Glove Set.
- Eye Protection: Wear chemical goggles; use goggles and faceshield for splash hazards.
- Other: Wear gloves and lab coat with M9 or M17 mask readily available for general lab work.

### ***Reactivity Data***

Stability: Stable after storage in steel for 3 months at 65°C. GD corrodes steel at the rate of  $1 \times 10^{-5}$  inch/month; ~12 hours.

GD will hydrolyze to form HF and



Hazardous Polymerization: Will not occur.

***Persistency*** Depends upon munitions used and the weather. Heavily splashed liquid persists 1 to 2 days under average weather conditions.

### ***References***

1. Department of the Army Pamphlet (DA PAM) 40-8, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents, GA, GB, GD, and VX*, December 1990.
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.

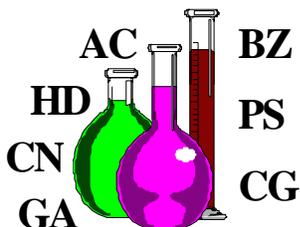
3. Army Regulation (AR) 385-61, *The Army Toxic Chemical Agent Safety Program*, July 1983.
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Sulfur Mustard Agents  
H and HD*

218-08-1096

*Physical Properties of Sulfur Mustard HD*

*Chemical Structure  
Chemical Formula*

$\text{ClCH}_2\text{CH}_2\text{-S-CH}_2\text{CH}_2\text{Cl}$   
 $\text{C}_4(\text{H}_8)\text{C}_{12}(\text{S})$

*Description*

Mustard agent *liquid* is colorless when pure, but it is normally a yellow to brown oily substance. Mustard agent *vapor* is colorless with a slight garlic- or mustard-like odor.

*Molecular Weight*

159.08

*Vapor Pressure (mm Hg)*

0.072 @ 20°C  
0.11 @ 25°C

*Boiling Point*

215-217°C; slowly vaporizes at ordinary temperatures.

*Freezing Point*

14.5°C

*Density*

Liquid = 1.27  
Vapor = 5.4 (air = 1)

*Solubility*

Very sparingly soluble in  $\text{H}_2\text{O}$ ; freely soluble in animal oils, fats, organic solvents.

**Agent HD** - The chemical Distilled mustard or bis(2-chloroethyl) sulfide; HD is H that has been purified by washing and vacuum distillation to reduce sulfur impurities, Chemical Abstract Service Registry No. 505-60-2.

*Flash Point*

105°C

*Volatility*

75  $\text{mg/m}^3$  @ 0°C (solid)  
610  $\text{mg/m}^3$  @ 20°C (liquid)  
2,860  $\text{mg/m}^3$  @ 40°C

### ***Toxicity Values***

IC <sub>50</sub> (eyes)	= 200 mg-min/m <sup>3</sup>
IC <sub>50</sub> (inhalation)	= 1,500 mg-min/m <sup>3</sup>
IC <sub>50</sub> (skin)	= 2,000 mg-min/m <sup>3</sup> @70° to 80°F (humid environment) = 1,000 mg-min/m <sup>3</sup> @90°C (dry environment)
LC <sub>50</sub> (inhalation)	= 1,500 mg-min/m <sup>3</sup>
LCL <sub>0</sub> (inhalation, 10 min)	= 1,496 mg-min/m <sup>3</sup>
LD <sub>50</sub> (skin)	= 100 mg/kg
LD <sub>50</sub> (oral)	= 0.7 mg/kg
1% Lethality	= 150 mg-min/m <sup>3</sup>
No Deaths Level	= 100 mg-min/m <sup>3</sup>
NOAEL (inhalation)	= 1.4 mg-min/m <sup>3</sup>

### ***Exposure Limits***

Workplace Time-Weighted Average -	0.003 mg/m <sup>3</sup>
General Population Limits -	0.0001 mg/m <sup>3</sup>

### ***Toxic Properties of Sulfur Mustard***

*Mustard agents stored in the unitary stockpile are in ton containers, artillery shells, and other munitions. Stockpiled at Aberdeen Proving Ground, MD; Anniston Army Depot, AL; Blue Grass Army Depot, KY; Pine Bluff, AR; Pueblo Depot Activity, CO; Tooele Army Depot, UT; and Umatilla Depot Activity, OR.*

### ***Overexposure Effects***

HD is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood forming) tissues, which are especially sensitive. The rate of detoxification of HD in the body is very slow, and repeated exposures produce a cumulative effect. The physiological action of HD may be classified as local and systemic. The local action results in conjunctivitis or inflammation of the eyes, erythema which may be followed by blistering or ulceration; inflammation of the nose, throat, trachea, bronchi, and lung tissue. Injuries produced by HD heal much more slowly and are more susceptible to infection than burns of similar intensity produced by physical means or by most other chemicals. Systemic effects of mustard may include malaise, vomiting, and fever, with onset time about the same as that of the skin erythema.

With amounts approaching the lethal dose, injury to bone marrow, lymph nodes, and spleen may result. HD has been determined to be a human carcinogen by the International Agency for Research on Cancer.

### ***Emergency and First Aid Procedures***

Inhalation: remove victim from the source immediately, administer artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes is absolutely essential; remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers, and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

Skin Contact: don respiratory protective masks and gloves; remove victim from agent source immediately, flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within 1 minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution; then wash contaminated skin area with soap and water; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: MANDATORY - Wear Butyl toxicological agent protective gloves (M3, M4, gloveset).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear gloves and lab coat with M9 or M17 mask readily available for general lab work.

In addition, wear daily clean smock, foot covers, and head cover when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Stable at ambient temperatures; decomposition temperatures is 149°C to 177°C; can be active for at least three years in soil; stable for days-week, under normal atmospheric temperature; slowly hydrolyzed by water; destroyed by strong oxidizing agents.

Incompatibility: Rapidly corrosive to brass @ 65°C; will corrode steel at

.001 in. of steel per month @ 65°C.

Hazardous Decomposition: Mustard will hydrolyze to form HCl and thiodiglycol.

Hazardous Polymerization: Will not occur.

**Persistency** Depends on munition used and the weather; heavily splashed liquid persists 1 to 2 days in concentration to provide casualties of military significance under average weather conditions, and a week to months under very cold conditions.

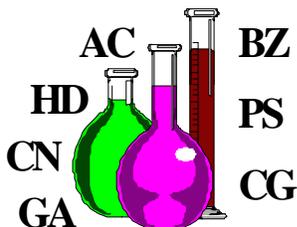
### **References**

1. Department of the Army Pamphlet (DA PAM) 40-173, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT*, 30 August 1991.
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
3. Institute of Medicine, National Academy of Sciences, C.M. Pechura and D.P. Rall, eds., *Veterans at Risk: The Health Effects of Mustard Gas and Lewisite*, National Academy Press, Washington, D.C., 1993.
4. Papirmeister, B., et al., *Medical Defense Against Mustard Gas: Toxic Mechanisms and Pharmacological Implications*, Boca Raton, Florida: CRC Press, 1991.
5. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Blister Agent Mustard-Lewisite Mixture (HL)*

218-15-1096

*Physical Properties of Mustard-Lewisite Mixture*

**Chemical Formula**

HD:  $C_1 CH_2 CH_2 SCH_2 CH_2 C_1$   
L:  $C_2 H_2 As Cl_3$

**Description**

HL is a liquid mixture of mustard (HD) and Lewisite (L) designed to provide a low freezing point for use in cold weather and high altitudes. The eutectic mixture (lowest freezing point) is 63% lewisite and 37% mustard. HL has a garlic-like odor from its HD content.

**Molecular Weight**

186.4, based on the eutectic mixture.

**Boiling Point**

Indefinite, but below 190°C; decomposes before boiling.

**Vapor Pressure (mm Hg)**

0.248 @ 20°C

**Freezing Point**

-25.4°C pure;  
-42°C plant purity (calculated)

**Density**

Liquid = approximately 1.66 @ 20°C  
Vapor = 6.4 (air = 1)

**Solubility**

Practically insoluble in water.

**Flash Point**

High enough not to interfere with the military use of agent.

**Volatility**

240 mg/m<sup>3</sup> @ -11°C  
2,730 mg/m<sup>3</sup> @ 20°C  
10,270 mg/m<sup>3</sup> @ 40°C  
(Calculated from above vapor pressure; actual volatility is somewhat lower.)

**Agent HL** - The chemical mixture of Sulfur Mustard and Lewisite. Chemical Abstract Service Registry Number is not available.

<b>Toxicity Values</b>	LCt <sub>50</sub> (inhalation)	= about 1,500 mg-min/m <sup>3</sup>
	LCt <sub>50</sub> (skin)	= about 10,000 mg-min/m <sup>3</sup>
	ICt <sub>50</sub> (eye)	= 200 mg-min/m <sup>3</sup>
	ICt <sub>50</sub> (skin)	= 1,500 to 2,000 mg-min/m <sup>3</sup>

### **Exposure Limits**

Workplace Time-Weighted Average -	0.003 mg/m <sup>3</sup>
General Population Limits -	No standard available

## **Toxic Properties of Mustard-Lewisite Mixture**

*HL is a vesicant agent that is not detoxified in the body. Locally, HL affects both the skin and eyes.*

### **Overexposure Effects**

HL is a vesicant and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues, which are especially sensitive. The rate of detoxification of HL in the body is very slow, and repeated exposure produces a cumulative effect. Contamination of the skin produces immediate stinging of the skin, turning red within 30 minutes. Blistering is delayed for about 13 hours and tends to cover the entire area of reddened skin. Blisters from HL exposures are deeper and more painful than with HD. Local action on the eyes is extremely rapid, and produces severe necrotic damage and loss of eyesight. Exposure of eyes to HL vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea. When HL vapor/aerosol is inhaled, the respiratory tract becomes inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, diarrhea, and fever. The respiratory damage is similar to that produced by mustard, except in the most severe cases. In these cases, fluid in the chest cavity may accompany fluid in the lungs. HL is absorbed through skin contact and inhalation of vapors, causing systemic toxicity such as damage to the lungs, bone marrow, lymph nodes, spleen, and endocrine system.

### **Emergency and First Aid Procedures**

Inhalation: remove from the source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes are absolutely essential; remove person from the liquid source; flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

Skin Contact: don respiratory protective mask and gloves; remove victim from agent source immediately; flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid

household bleach within one minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water; wash thoroughly if shower facilities are available; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: Wear Butyl toxicological agent protective gloves (M3, M4, or glove set).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear gloves and lab coat for general lab work; have an M9, M40, or M17 mask readily available.

### ***Reactivity Data***

Stability: Stable at ambient temperatures and in lacquered steel containers. HL is a persistent agent depending on pH and moisture and has been known to remain active for up to three years in soil.

Incompatibility: Conditions to avoid: rapidly corrosive to brass @ 65°C; will corrode steel at a rate of .0001 inches of steel per month @ 65°C.

Hazardous Decomposition: HL will hydrolyze into HCL, thiodiglycol, and non-vesicant arsenic compound.

Hazardous Polymerization: Will not occur.

***Persistency*** Depends on munitions used and the weather. Somewhat shorter than that of HD, heavily splashed liquid of which persists 1 to 2 days under average weather conditions, and a week or more under very cold conditions.

### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.

2. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
3. U.S. Army Chemical Research, Development and Engineering Center, *Material Safety Data Sheet: HL*, January 1991.
4. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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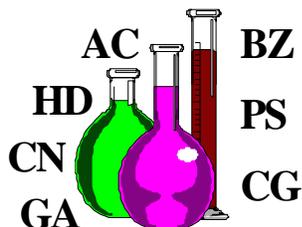
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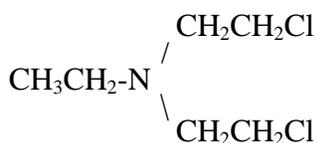


*Detailed Facts About Blister Agent Nitrogen Mustard  
(HN-1)*

218-10-1096

*Physical Properties of HN-1*

*Chemical Structure*



*Chemical Formula*



*Description*

HN-1 is oily, colorless to pale yellow with a faint, fishy, or musty odor.

*Molecular Weight*

170.08

*Vapor Pressure (mm Hg)*

0.0773 @ 10°C  
0.25 @ 25°C  
0.744 @ 40°C

*Boiling Point*

194°C calculated; decomposes.

*Freezing Point*

-34°C

*Density*

Liquid = 1.09 at 25°C  
Vapor = 5.9 times heavier than air

*Solubility*

Sparingly soluble in water; freely soluble in acetone and other organic solvents.

*Flash Point*

No immediate danger of fire or explosion.

**Volatility**  
127 mg/m<sup>3</sup> @ -10°C  
308 mg/m<sup>3</sup> @ 0°C  
1,520 mg/m<sup>3</sup> @ 20°C  
3,100 mg/m<sup>3</sup> @ 30°C

**Toxicity Values**  
ICt<sub>50</sub> (eye contact) = 200 mg-min/m<sup>3</sup>  
ICt<sub>50</sub> (percutaneous) = 9,000 mg-min/m<sup>3</sup>  
LCt<sub>50</sub> (inhalation) = 1,500 mg-min/m<sup>3</sup>  
LCt<sub>50</sub> (percutaneous) = 20,000 mg-min/m<sup>3</sup>

vapor)

NOAEL (inhalation) = 2 mg-min/m<sup>3</sup>

### **Exposure Limits**

Workplace Time-Weighted Average - 0.003 mg/m<sup>3</sup>  
General Population Limits - No standard identified

## **Toxic Properties of HN-1**

*HN-1 was the first compound of the HN series developed in the late 1920s and early 1930s. HN-1 was designed as a pharmaceutical (to remove warts) and became a military agent; HN-2 was designed as a military agent and became a pharmaceutical; HN-3 was designed as a military agent and is the only one of these agents that remains anywhere as a military agent. These agents are more immediately toxic than the sulfur mustards.*

### **Overexposure Effects**

The vapors are irritating to the eyes and nasal membranes even in low concentration. HN-1 is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues. HN-1 is not naturally detoxified by the body; therefore, repeated exposure produces a cumulative effect.

### **Emergency and First Aid Procedures**

Inhalation: remove from source immediately, give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, pulling eyelids apart with fingers, and pouring water into eyes; do not cover eyes with bandages; protect eyes with dark or opaque goggles after flushing eyes; seek medical attention immediately.

Skin Contact: don respiratory mask and gloves; remove victim from source immediately and remove contaminated clothing; decontaminate the skin immediately by flushing with a 5 percent solution of liquid household bleach; wash off with soap and water after 3-4 minutes to remove decon agent and protect against erythema; seek medical attention immediately, to prevent systemic toxicity, decontamination should be done as late as 2 or 3 hours after exposure even if it

increases the severity of the local reaction; further cleans with soap and water.

Ingestion: do not induce vomiting; give victims milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: MANDATORY - Wear Butyl toxicological agent protective gloves (M3, M4, or glove set).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear full protective clothing consisting of the M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, treated underwear, M9 series mask and coveralls (if desired). Wear gloves and lab coat with M9, M17, or M40 Mask readily available for general lab work,.

In addition, wear daily clean smock, foot covers, and head cover when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Polymerizes slowly.

Rate of Hydrolysis: Slow.

Hydrolysis Products: Hydroxyl derivatives and condensation products.

Incompatibility: Corrosive to ferrous alloys beginning at 65°C.

Hazardous Decomposition: Toxic intermediate products are produced during hydrolysis. Approximate half-life in water at 25°C is 1.3 minutes. Decomposition comes through slow change into quaternary ammonium salts. Decomposition point is below 94°C.

***Persistency*** Depends on munitions used and the weather; somewhat shorter duration of effectiveness for HD, heavily splashed liquid of which persists 1 to 2 days under average weather conditions, and a week or more under very cold conditions.

### ***References***

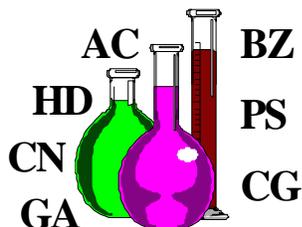
1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.

2. DA FM 8-285, *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, 1990.
3. *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Eleventh Edition*, Merck & Co., Inc., Rahway, New Jersey, 1989.
4. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Blister Agent Nitrogen Mustard  
(HN-2)*

218-11-1096

*Physical Properties of HN-2*

<i>Chemical Structure</i>	$\begin{array}{c} \text{CH}_2\text{CH}_2\text{Cl} \\   \\ \text{H}_3\text{C}-\text{N} \\   \\ \text{CH}_2\text{CH}_2\text{Cl} \end{array}$
<i>Chemical Formula</i>	$(\text{C}_1 \text{CH}_2 \text{CH}_2)_2 \text{N C H}_3$
<i>Description</i>	HN-2 is pale amber to yellow oily liquid; fruity odor in high concentrations; smells like soft soap with a fishy smell in low concentrations.
<i>Molecular Weight</i>	156.07
<i>Vapor Pressure (mm Hg)</i>	0.130 @ 10°C 0.290 @ 20°C 0.427 @ 25°C 1.25 @ 40°C
<i>Boiling Point</i>	75°C
<i>Freezing Point</i>	-65°C to -60°C
<i>Density</i>	Liquid = 1.15 g/cc @ 20°C Vapor = 5.4 times heavier than air
<i>Solubility</i>	Soluble in acetone and organic solvents and oil; sparingly soluble in water.
<i>Flash Point</i>	No immediate danger of fire or explosion.

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*Agent HN-2* - Nitrogen Mustard. The chemical 2,2'-Dichloro-N-methyldiethylamine, Chemical Abstract Service Registry No. 51-75-2.

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*Volatility* 1,150 mg/m<sup>3</sup> @ 10°C 3,580 mg/m<sup>3</sup> @ 25°C

5,100 mg/m<sup>3</sup> @ 30°C  
10,000 mg/m<sup>3</sup> @ 40°C

### ***Toxicity Values***

IC<sub>t50</sub> (eye contact) = 100 mg-min/m<sup>3</sup>  
IC<sub>t50</sub> (percutaneous vapor) = 9,500 mg-min/m<sup>3</sup>  
LC<sub>t50</sub> (inhalation) = 3,000 mg-min/m<sup>3</sup>  
NOAEL (inhalation) = 2 mg-min/m<sup>3</sup>

### ***Exposure Limits***

Workplace Time-Weighted Average - No standard identified  
General Population Limits - No standard identified

## ***Toxic Properties of HN-2***

*HN-2, the second of a series of nitrogen mustard compounds developed in the late 1920s and early 1930s, was designed as a military agent which became a pharmaceutical substance called Mustine. The chemical intermediate it produces is used as an antineoplastic drug. These agents are more immediately toxic than the sulfur mustards.*

### ***Overexposure Effects***

HN-2 is highly irritating to the eyes and throat; in high concentrations it can cause blindness. Absorbed into the bloodstream it will seriously interfere with the functioning of hemoglobin and will eventually damage the endocrine system. HN-2 is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. HN-2 is not naturally detoxified by the body; therefore, repeated exposure produces a cumulative effect.

### ***Emergency and First Aid Procedures***

Inhalation: remove from source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, pulling eyelids apart with fingers, and pouring water into eyes; do not cover eyes with bandages; protect eyes with dark or opaque goggles after flushing eyes; seek medical attention immediately.

Skin Contact: don respiratory mask and gloves; remove victim from source immediately and remove contaminated clothing; decontaminate the skin immediately by flushing with a 5 percent solution of liquid household bleach; wash off with soap and water after 3-4 minutes to remove decon agent and protect against erythema; seek medical attention immediately; to prevent systemic toxicity, decontaminate as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction; further clean with soap and water.

Ingestion: do not induce vomiting; give victims milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: MANDATORY - Wear Butyl toxicological agent protective gloves (M3, M4, or glove set).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear full protective clothing consisting of the M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, treated underwear, M9 series mask and coveralls (if desired). Wear gloves and lab coat with M9, M17, or M40 mask readily available for general lab work.

In addition, wear daily clean smock, foot covers, and head cover when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Not stable; decomposes before boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion; dry crystals are stable.

Incompatibility: No actions on metals, or other materials.

Hazardous Decomposition: Approximate half-life in water at 25°C is 4 minutes; decomposition point is below boiling point.

Hazardous Polymerization: Polymerized components will present an explosion hazard in open air.

Rate of Hydrolysis: Slow, except in presence of alkalis; products formed are complex polymeric quaternary ammonium salts; dimerizes fairly rapidly in water.

***Persistency*** Depends on munitions used and the weather; somewhat shorter duration of effectiveness for HD, heavily splashed liquid of which persists 1 to 2 days under average weather conditions, and a week or more under very cold conditions.

### ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.

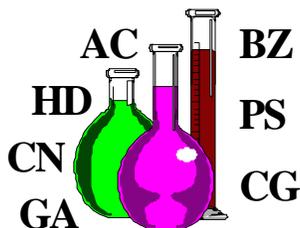
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Blister Agent Nitrogen Mustard  
(HN-3)*

218-12-1096

*Physical Properties of HN-3*

<i>Chemical Structure</i>	$\begin{array}{c} \text{CH}_2\text{CH}_2\text{Cl} \\ / \\ \text{ClCH}_2\text{CH}_2\text{-N} \\ \backslash \\ \text{CH}_2\text{CH}_2\text{Cl} \end{array}$
<i>Chemical Formula</i>	$\text{N}(\text{CH}_2\text{CH}_2\text{Cl})_3$
<i>Description</i>	HN-3 is a colorless to pale yellow liquid with a butter almond odor; most stable in storage of three nitrogen mustards.
<i>Molecular Weight</i>	204.54
<i>Vapor Pressure (mm Hg)</i>	0.0109 @ 25°C
<i>Boiling Point</i>	256°C calculated, decomposes.
<i>Freezing Point</i>	-3.7°C
<i>Density</i>	Liquid = 1.24 at 25°C Vapor = 7.1 heavier than air
<i>Solubility</i>	Soluble in sulfur mustards and chloropicrin; insoluble in water; soluble in ether, benzene, and acetone.
<i>Flash Point</i>	High enough not to interfere with military use of the agent.

**Volatility**  
13 mg/m<sup>3</sup> @ 0°C  
121 mg/m<sup>3</sup> @ 25°C  
180 mg/m<sup>3</sup> @ 30°C  
390 mg/m<sup>3</sup> @ 40°C

**Toxicity Values**  
ICt<sub>50</sub> (eye) = 200 mg-min/m<sup>3</sup>  
ICt<sub>50</sub> (skin) = 2,500 mg-min/m<sup>3</sup>  
LCt<sub>50</sub> (inhalation) = 1,500 mg-min/m<sup>3</sup>  
LCt<sub>50</sub> (skin) = 10,000 mg-min/m<sup>3</sup>  
NOAEL (inhalation) = 2 mg-min/m<sup>3</sup>

### **Exposure Limits**

Workplace Time-Weighted Average - No standard identified  
General Population Limits - No standard identified

## **Toxic Properties of HN-3**

*HN-3 was the last of the nitrogen mustard agents developed. It was designed as a military agent and is the only one of the nitrogen mustards that is still used for military purposes. It is the principal representative of the nitrogen mustards because its vesicant properties are almost equal to those of HD.*

### **Overexposure Effects**

HN-3 is a cumulative poison which is highly irritating to the eyes and throat. Eye irritation, tearing, and photophobia develop immediately after exposure. The median incapacitating dose for eyes is 200 mg-min/m<sup>3</sup>. Blistering of the skin may occur after liquid exposure, severe or persistent exposure, or vapor condensation in sweat. Usually a rash will develop from liquid contamination within an hour, replaced by blistering between six and twelve hours after exposure.

HN-3 interferes with hemoglobin functioning in the blood, hindering the production of new blood cells and destroying white blood cells.

### **Emergency and First Aid Procedures**

Inhalation: remove from source immediately, give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, pulling eyelids apart with fingers and pouring water into eyes; do not cover eyes with bandages; protect eyes with dark or opaque goggles after flushing eyes; seek medical attention immediately.

Skin Contact: don respiratory mask and gloves; remove victim from source immediately and remove contaminated clothing; decontaminate the skin immediately by flushing with a 5 percent solution of liquid household bleach; wash off with soap and water after 3-4 minutes to remove decon agent and protect against erythema; seek medical attention immediately, to prevent systemic toxicity, decontaminate as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction; further clean with soap and water.

Ingestion: do not induce vomiting; give victims milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: MANDATORY - Wear Butyl toxicological agent protective gloves (M3, M4, or glove set).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear full protective clothing consisting of the M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, underwear, M9 series mask and coveralls (if desired). For general lab work, wear gloves and lab coat with M9, M17, or M40 mask readily available.

In addition, wear daily clean smock, foot covers, and head cover when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Slow but steady polymerization; not stable; decomposes before boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion.

Incompatibility: No actions on metals or other materials

Hazardous Decomposition: Approximate half-life in water at 25°C is 4 minutes; decomposition point is below boiling point.

Hazardous Polymerization: Polymerized components will present an explosion hazard in open air.

Rate of Hydrolysis: Slow, except in presence of alkalis; products formed are complex polymeric quaternary ammonium salts; dimerizes fairly rapidly in water.

***Persistency*** Considerably longer than for HD. HN-3 use is emphasized for terrain denial. It can be approximately 2x or 3x the persistence of HD and adheres well to equipment and personnel especially in cold weather.

### ***References***

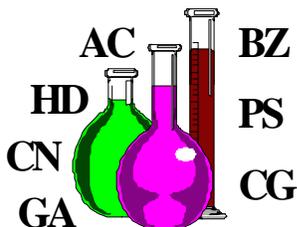
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Sulfur Mustard Agent HT*

218-09-1096

*Physical Properties of Sulfur Mustard Agent HT*

*Chemical Structure*

Plant mixture of 60% Sulfur Mustard (HD) and 40% Sulfur Mustard (T) by weight; (The CDC has pointed out that with time, these proportions change. Also, presence of impurities has resulted in reaction products.)

*Chemical Formula*

HD:  $C_4 H_8 C_{12} S$   
T:  $C_8 H_{16} C_{12} O S_2$

*Description*

T is a sulfur and chlorine compound similar in structure to HD and is a clear yellowish liquid with a slight garlic- or mustard-like odor.

*Molecular Weight*

159.08

*Boiling Point*

Above 228°C

*Freezing Point*

0.0 to 1.3°C

*Density*

Liquid = 1.27  
Vapor = 6.92 (air = 1)

*Solubility*

Practically insoluble in water.

*Flash Point*

100°C (approximately)

*Volatility*

831 mg/m<sup>3</sup> @ 25°C

*Toxicity Values*

Not established in humans.

### ***Exposure Limits***

Workplace Time-Weighted Average - 0.003 mg/m<sup>3</sup>  
General Population Limits - 0.0001 mg/m<sup>3</sup>

### ***Toxic Properties of Sulfur Mustard Agent HT***

*HT is a lethal vesicant composed of approximately 60-percent HD and 40-percent agent T. The effects of HT would encompass those of both HD and T.*

### ***Overexposure Effects***

HD is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow, and repeated exposures produce a cumulative effect. It causes blisters, irritates the eyes, and it is toxic when inhaled. HD has been determined to be a human carcinogen by the International Agency for Research on Cancer.

### ***Emergency and First Aid Procedures***

Inhalation: remove victim from the source immediately; administer artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes is absolutely essential; remove victim from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers, and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

Skin Contact: don respiratory protective masks and gloves; remove victim from agent source immediately; flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within 1 minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution; then wash contaminated skin area with soap and water; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: MANDATORY - Wear Butyl toxicological agent protective gloves (M3, M4, gloveset).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear gloves and lab coat with M9 or M17 mask readily available for general lab work.

In addition, wear daily clean smock, foot covers, and head cover when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Stable at ambient temperatures; decomposition temperature is 165°C to 185°C.

Incompatibility: Rapidly corrosive to brass @ 65°C; will corrode steel at .001 in. of steel per month @ 65°C.

Hazardous Decomposition: HT will hydrolyze to form HCl and thiodiglycol, and bis-(2-(2-hydroxyethylthio) ethyl ether.

Hazardous Polymerization: Will not occur.

***Persistence*** Depends on munition used and the weather; heavily splashed liquid persists 1 to 2 days in concentration to provide casualties of military significance under average weather conditions, and a week to months under very cold conditions.

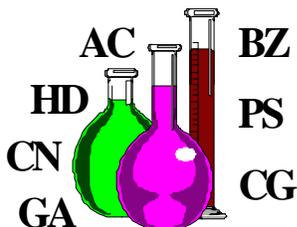
### ***References***

1. Department of the Army Pamphlet (DA PAM) 40-173, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents, H, HD, and HT*, 30 August 1991.
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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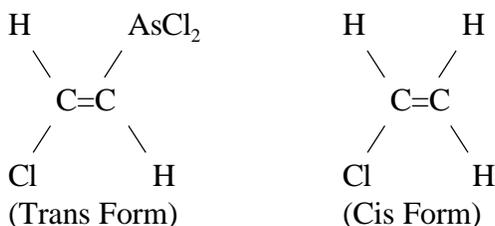


*Detailed Facts About Blister Agent Lewisite  
(L)*

218-14-1096

*Physical Properties of Lewisite*

*Chemical structure*



*Chemical Formula*

$\text{C}_2 \text{H}_2 \text{AsCl}_3$

*Description*

Pure Lewisite is a colorless, oily liquid with very little odor. The plant sample (war gas) has a geranium-like odor and is an amber to dark brown liquid.

*Molecular Weight*

207.32

*Vapor Pressure (mm Hg)*

0.35 @ 25°C  
0.22 @ 20°C

*Boiling Point*

197°C (Trans)                      170°C (Cis)

*Freezing Point*

-1°C (Trans)                      -45°C (Cis)

*Density*

Liquid = 1.89  
Vapor = 7.1 (air=1)

*Solubility*

Insoluble in H<sub>2</sub>O; soluble in ordinary organic solvents.

*Flash Point*

None

*Volatility*

1,060 mg/m<sup>3</sup> @ 0°C  
4,480 mg/m<sup>3</sup> @ 20°C  
8,620 mg/m<sup>3</sup> @ 30°C

### ***Toxicity Values***

IC <sub>50</sub> (eyes)	= <300 mg-min/m <sup>3</sup>
LC <sub>50</sub> (inhalation)	= 1,200 to 1,500 mg-min/m <sup>3</sup>
LC <sub>50</sub> (skin)	= >1,500 mg-min/m <sup>3</sup>
LC <sub>50</sub> (skin vapor exposure)	= 100,000 mg-min/m <sup>3</sup>
LDL <sub>0</sub> (skin)	= 20 mg/kg
1% Lethality	= 150 mg-min/m <sup>3</sup>
No Deaths Level	= 100 mg-min/m <sup>3</sup>
NOAEL (oral)	= 0.5 to 1.0 mg/kg (estimated based on animal studies)

### ***Exposure Limits***

Workplace Time-Weighted Average -	0.003 mg/m <sup>3</sup>
General Population Limits -	0.003 mg/m <sup>3</sup>

## ***Toxic Properties of Blister Agent Lewisite***

*Lewisite stored in the unitary stockpile is in ton containers. Stockpile is at Tooele Army Depot, UT.*

### ***Overexposure Effects***

L is a vesicant (blister agent); also, it 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, absorbed in tissues, and a systemic poison. When inhaled in high concentrations, it may be fatal in as short a time as 10 minutes. L is not detoxified by the body. Common routes of entry into the body include ocular, percutaneous, and inhalation.

### ***Emergency and First Aid Procedures***

Inhalation: remove from the source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes is absolutely essential; remove person from the liquid source; flush the eyes immediately with water for 10-15 minutes by tilting the head to the side, pulling eyelids apart with fingers, and pouring water slowly into the eyes; do not cover eyes with bandages, but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

Skin Contact: remove victim from source immediately and remove contaminated clothing; immediately decon affected areas by flushing with 10 percent sodium carbonate solution; wash off with soap and water after 3 to 4 minutes to protect against erythema; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: Wear Norton Chemical Protection Glove Set, M3 Butyl Rubber.

Eye Protection: Wear protective eye glasses as a minimum; use goggles and face shield for splash hazards.

Other: Wear full protective clothing (Level A) consisting of M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, impregnated underwear, M9 series mask and coveralls (if desired), or the 30 mil Demilitarization Protective Ensemble (DPE) if available, or NIOSH-approved equivalent; wear gloves and lab coat with M9, M17, or M40 mask readily available for general lab work.

In addition, wear daily clean smock, foot covers, and head covers when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Reasonably stable; however, in presence of moisture, it hydrolyses rapidly, losing its vesicant property.

Incompatibility: Corrosive to steel at a rate of  $1 \times 10^{-5}$  to  $5 \times 10^{-5}$  in/month at 65 °C.

Hazardous Decomposition Products: It hydrolyses in acidic medium to form HCl and non-volatile (solid) chlorovinylarsenious oxide, which is a less potent vesicant than Lewisite. Hydrolysis in alkaline medium, as in decontamination with alcoholic caustic or carbonate solution, produces acetylene and trisodium arsenate ( $\text{Na}_3 \text{AsO}_4$ ). Therefore, decontaminated solution would contain toxic arsenic.

***Persistency*** Somewhat shorter than for HD; very short duration under humid conditions.

### ***References***

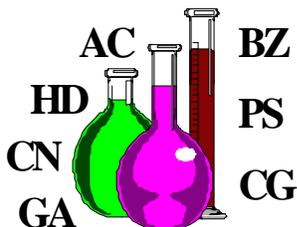
1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.

2. Pechura, C.M, and Rall, D.P., eds, *Veterans at Risk: The Health Effects of Mustard Gas and Lewisite*, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, D.C., 1993.
3. U.S. Army Chemical Research, Development and Engineering Center, *Material Safety Data Sheet: Lewisite*, January 1991.
4. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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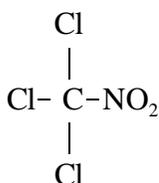


*Detailed Facts About Tear Agent Chloropicrin  
(PS)*

218-22-1096

*Physical Properties of Chloropicrin*

*Chemical Structure*



*Chemical Formula*

CCl<sub>3</sub>NO<sub>2</sub>

*Description*

PS is a colorless, oily liquid with a stinging pungent odor.

*Molecular Weight*

164.3

*Boiling Point*

112°C

*Vapor Pressure (mm Hg)*

20 @ 20°C

*Freezing Point*

-69°C

*Density*

Liquid = 1.66 g/cc  
Vapor = 5.6 (air = 1)

*Solubility*

Insoluble in water; soluble in organic solvents, lipids, organophosphorus compounds, mustards, phosgene, diphosgene, and Cl<sub>2</sub>.

*Flash Point*

Not combustible, but with strong initiation, heated material under confinement will detonate.

**Volatility**

	55,700 mg/m <sup>3</sup> @ 0°C
	99,000 mg/m <sup>3</sup> @ 10°C
	164,500 mg/m <sup>3</sup> @ 20°C
	210,700 mg/m <sup>3</sup> @ 25°C
	267,500 mg/m <sup>3</sup> @ 30°C

**Toxicity Values**                      LC<sub>50</sub>        = 2,000 mg-min/m<sup>3</sup>

**Exposure Limits**

Workplace Time-Weighted Average -	0.7 mg/m <sup>3</sup>
General Population Limits -	No standard available

***Toxic Properties of Chloropicrin***

*PS was used in large quantities during World War I; it was stockpiled during World War II and is no longer authorized for military use. PS is more toxic than chlorine but less toxic than phosgene (CG).*

***Overexposure Effects***

Chloropicrin is a powerful irritant whose vapors cause lung, skin, eye, nose and throat irritation, coughing and vomiting. As an eye irritant, it produces immediate burning, pain and tearing. In high concentration, PS damages the lungs, causing pulmonary edema. Exposure to liquid PS can cause severe burns on the skin that generally result in blisters and lesions. The lowest irritant concentration is 9 mg-min/m<sup>3</sup> for 10 minutes, and the median lethal concentration is 2,000 mg-min/m<sup>3</sup>.

***Emergency and First Aid Procedures***

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep the victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin using soap or mild detergent and water; remove the contaminated clothing immediately; wash the skin using soap or mild detergent and water; if irritation persists after washing, seek medical attention immediately.

Ingestion: give victim copious amounts of water immediately; induce vomiting by having victim touch the back of his throat with his finger; do not make an unconscious person vomit; seek medical attention immediately.

## ***Protective Equipment***

Protective Gloves:	Wear impervious gloves.
Eye Protection:	Wear face shields (eight-inch minimum) or dust- and splash-proof safety goggles to prevent any possibility of skin contact with liquid chloropicrin.
Other:	Wear a complete set of protective clothing to include gloves and lab coat, apron, boots, plastic coveralls; other protective clothing and equipment should be available to prevent contact with the skin or clothing; remove contaminated clothing immediately, do not wear clothing until it has been properly laundered.

## ***Reactivity Data***

Stability:	Instability occurs with high temperatures or severe shock, particularly when involving containers of greater than 30 gallons capacity; unstable liquid.
Incompatibilities:	Contact with strong oxidizers may cause fires or explosions.
Hazardous Decomposition:	Toxic gases and vapors (such as oxides of nitrogen, phosgene, nitrosyl chloride, chlorine, and carbon monoxide) may be released when chloropicrin decomposes.
Corrosive Properties:	Liquid chloropicrin will attack some forms of plastics, rubber, and coatings.

***Persistence*** Short.

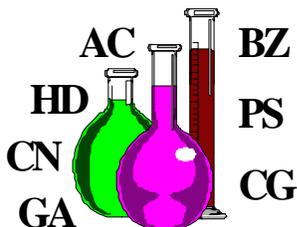
## ***References***

1. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
2. Genium's Reference Collection, *Material Safety Data Sheets No. 702, Chloropicrin*, Genium Publishing Corporation, Schenectady, New York, 1990.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About White Phosphorous  
(WP)*

218-24-1096

*Physical Properties of White Phosphorous*

<i>Chemical Formula</i>	P <sub>4</sub>
<i>Description</i>	White phosphorous is a white or pale yellow, translucent, crystalline solid with a waxy consistency. It is also called yellow phosphorus due to impurities and has a match-like odor.
<i>Molecular Weight</i>	124.11
<i>Boiling Point</i>	280°C
<i>Vapor Pressure (mm Hg)</i>	0.026 @ 20°C
<i>Freezing Point</i>	44°C
<i>Density</i>	Solid = 1.83 @ 20°C
<i>Solubility</i>	Insoluble in water 1 gm/400 ml absolute alcohol 1 gm/102 ml absolute ether 1 gm/40 ml chloroform 1 gm/35 ml benzene 1 gm/0.8 ml carbol disulfide
<i>Flash Point</i>	Ignites spontaneously in air or above 30°C.
<i>Volatility</i>	May be ignited by heat, sparks, or flame; may burn rapidly with flare-burning effect; fire may produce irritating or poisonous gases.

### ***Toxicity Values***

Range from approximately 1 to 16 mg/kg.

### ***Exposure Limits***

Workplace Time-Weighted Average - 0.1 mg/m<sup>3</sup>  
General Population Limits - No standard available

## ***Toxic Properties of White Phosphorous***

*White phosphorous is spontaneously flammable and is an extremely toxic inorganic substance. It is used primarily as a smoke agent and can also function as an antipersonnel flame compound capable of causing serious burns.*

### ***Overexposure Effects***

The vapors of burning phosphorous (yellow) can be a mild irritant; continued exposure can lead to bronchitis, persistent coughing, severe burns, weakness, anemia, loss of appetite, and possibly pneumonia; if ingested, the fatal dose is 1 mg/kg. WP can cause thirst cyanosis, abdominal pain, jaundice; acute poisoning produces shock, coma and death in a short time (symptoms may subside and then return); liver and kidney damage may occur. It can cause very severe, slow-healing burns on contact and particularly deep burns with hemorrhaging. WP can also cause severe burns and permanent damage to the eyes.

Inhalation or ingestion of small amounts of phosphorus over long periods can lead to necrosis or deformation of the lower jaw, damage to teeth, and susceptibility to bone fracture. Persons with pre-existing skin disorders, eye problems, or impaired liver or kidney function may be more susceptible to the effects of the substance.

### ***Emergency and First Aid Procedures***

Inhalation: remove victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep affected victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes with copious amounts of water immediately lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: flush the contaminated skin with water immediately; remove the clothing immediately and flush the skin with water; keep skin wet until medical attention is obtained to prevent any remaining WP from burning; seek medical attention immediately.

Ingestion: if victim is conscious, give victim copious amounts of water immediately; induce vomiting after victim has swallowed the water; do not make unconscious person vomit; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves:	Wear flame-retardant clothing and gloves.
Eye Protection:	Wear dust- and splash-proof safety goggles.
Other:	Wear a complete set of protective clothing necessary to prevent any possible skin contact to include gloves and lab coat, apron, boots, plastic coveralls; other protective clothing and equipment should be available to prevent contact with skin or clothing; remove contaminated clothing immediately; do not wear clothing until it has been properly laundered.

### ***Reactivity Data***

Stability:	Stable in steel drum not in contact with air or oxygen; reactive with many substances including atmospheric oxygen when dry; information on possible reactivity in use must be investigated prior to use; WP is unstable under water.
Hazardous Decomposition:	Phosphorus pentoxide is formed on exposure to air.
Hazardous Polymerization:	WP does not polymerize.
Incompatibilities:	Reacts vigorously or violently with halogens, oxidizers, alkaline compounds, acids, some metals and sulfur compounds, nitrites, and many additional unlisted compounds.

***Persistency*** The dissemination efficiency as flame is very low as thickened.

### ***References***

1. Department of the Army Technical Manual (DA TM) 3-250, *Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.
2. Genium's Reference Collection, *Material Safety Data Sheet No. 25*, Genium Publishing Corporation, 1988.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

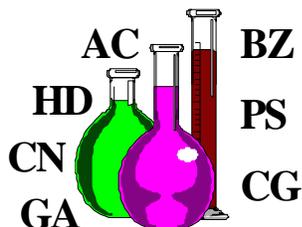
4. *Hazardous Substances Data Bank*, 1995.

5. Meditext (TM), 1995.

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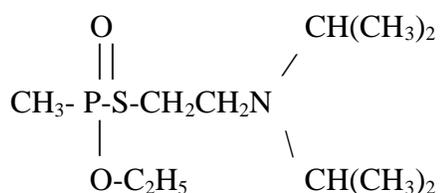


*Detailed Facts About Nerve Agent VX*

218-05-1096

*Physical Properties of Nerve Agent VX*

*Chemical Structure*



*Chemical Formula*

C<sub>11</sub>H<sub>26</sub>NO<sub>2</sub>P S

*Description*

Nerve agent VX is an oily liquid that is clear, odorless, and tasteless. It is amber colored similar in appearance to motor oil.

*Molecular Weight*

267.4

*Vapor Pressure (mm Hg)*

0.0007 @ 25°C

*Boiling Point*

298°C

*Freezing Point*

-51°C

*Density*

Liquid = 1.01  
Vapor = 9.2 (air = 1)

*Solubility*

Moderate in H<sub>2</sub>O

*Flash Point*

159°C

*Volatility*

10.5 mg/m<sup>3</sup> @ 25°C

### ***Toxicity Values***

IC <sub>50</sub> (inhalation)	= 25 mg-min/m <sup>3</sup> (15 l/min)
LC <sub>50</sub> (inhalation)	= 30 mg-min/m <sup>3</sup> (15 l/min)
LD <sub>50</sub> (skin)	= 0.142 mg/kg
1% Lethality	= 4.3 mg-min/m <sup>3</sup>
No Deaths Level	= 2.5 mg-min/m <sup>3</sup>
NOAEL	= 1.6 mg-min/m <sup>3</sup> (estimated)

### ***Exposure Limits***

Workplace Time-Weighted Average -	0.00001 mg/m <sup>3</sup>
General Population Limits -	0.000003 mg/m <sup>3</sup>

## ***Toxic Properties of Nerve Agent VX***

*Nerve Agent VX is stored in the unitary stockpile in ton containers, artillery shells, mortar projectiles, rockets, and land mines. Stockpiled in Anniston Army Depot, AL; Blue Grass Army Depot, KY; Newport Army Ammunition Plant, IN; Pine Bluff Arsenal, AR; Tooele Army Depot, UT; and Umatilla Depot Activity, OR.*

Nerve Agent VX is a persistent, nonvolatile agent that is primarily a liquid exposure hazard to the skin or eyes, although small amounts of VX vapor may be generated under extremely high temperatures. Nerve Agent VX affects the body by blocking the action of the enzyme acetylcholinesterase. When this enzyme is blocked, large amounts of the chemical acetylcholine build up at critical places within the nervous system, causing hyperactivity of the body organs stimulated by these nerves. The signs and symptoms of exposure to Nerve Agent VX depend upon the *route of exposure* and the *amount of exposure*.

### ***Overexposure Effects***

Signs and symptoms of overexposure may occur within minutes or hours depending upon dose. They include: miosis (constriction of pupils) and visual effects, headache and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking, difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. Signs of severe exposure can progress to convulsions and respiratory failure.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; administer immediately in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors if severe signs of agent exposure appear; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available, but do not use mouth-to-mouth resuscitation when facial contamination exists; if breathing is difficult, administer oxygen; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, then don a respiratory

protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; if local sweating and muscular symptoms occur, administer an intramuscular injection with the MARK I Kit; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams intramuscular injection of the MARK I Kit auto injectors; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: Wear Butyl Glove M3 and M4 Norton, Chemical Protective Glove Set.

Eye Protection: Wear chemical goggles; use goggles and faceshield for splash hazards.

Other: Wear gloves and lab coat with M9 or M17 mask readily available for general lab work.

### ***Reactivity Data***

Stability: Persistent; relatively stable at room temperature; unstabilized VX of 95 percent purity decomposed at a rate of 5 percent a month at 71°C.

Hazardous Decomposition Product: During basic hydrolysis of VX up to about 10 percent of the agent is converted to EA2191 (diisopropylaminoethyl methylphosphonothioic acid). Based on the concentration of EA2192 expected to be formed during hydrolysis and its toxicity (1.4 mg/kg dermal in rabbit at 24 hours in a 10/90 wt% ethanol/water solution), a Class B poison would result.

A large scale decon procedure, which uses both HTH and NaOH, destroys VX by oxidation and hydrolysis. Typically, the large scale product contains 0.2 - 0.4 wt percent EA2192 at 24 hours. At pH 12, the EA2192 in the large scale product has a half-life of about 14 days. Thus, a 90 day holding period at pH 12 results in about a 64-fold reduction of EA2192 (six half-lives). This holding period has been shown to be sufficient to reduce the toxicity of the product below that of a Class B poison.

Other less toxic products are ethyl methylphosphonic acid, methylphosphonic acid,

diisopropylaminoethyl mercaptan, diethyl methylphosphonate, and ethanol.

A small scale decontamination procedure uses sufficient HTH to oxidize all VX; thus no EA2192 is formed.

Hazardous Polymerization: Will not occur.

**Persistency** Depends upon munitions used and the weather. Heavily splashed liquid persists for long periods of time under average weather conditions.

### **References**

1. Department of the Army (DA PAM) 40-8, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents, GA, GB, GD, and VX*, December 1990.
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
3. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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*Last updated 23 July 1998*

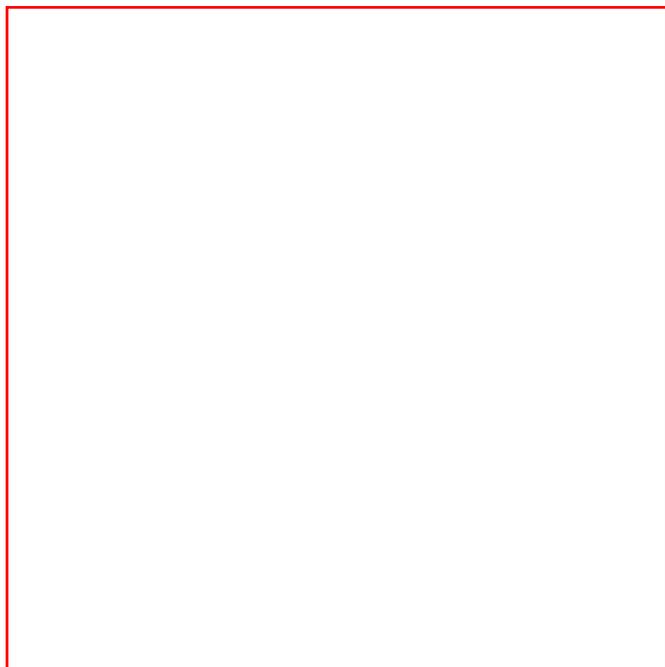
### The Deputy for Technical Services' Publications

#### General Chemical Facts Sheets

**Note:** The links on this page point to Adobe Acrobat PDF files. Click here for more [Information](#).

- [\*Blood Agent Hydrogen Cyanide \(AC\)\*](#)
- [\*Psychodelic Agent 3 - Quinuclidinyl Benzilate \(BZ\)\*](#)
- [\*Tear Agent  \$\alpha\$ -Bromobenzylcyanide\*](#)
- [\*Choking Agent Phosgene\*](#)
- [\*Blood Agent Cyanogen Chloride\*](#)
- [\*Tear Agent 2 - Chloroacetophenone\*](#)
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- [\*Tearing Agent Chloroacetophenone & Chloropicrin in Chloroform\*](#)
- [\*Tear Agent O-Chlorobenzylidene Malononitrile \(CS\)\*](#)
- [\*Blister Agent Phosgene Oxime \(CX\)\*](#)

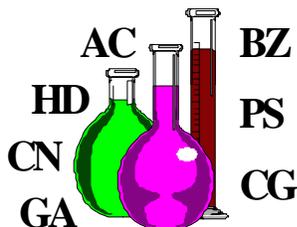
- [\*Vomiting Agent Adamsite \(DM\)\*](#)
- [\*Nerve Agent GA\*](#)
- [\*Nerve Agent GB\*](#)
- [\*Nerve Agent GD\*](#)
- [\*Sulfur Mustard Agents H & HD\*](#)
- [\*Blister Agent Mustard - Lewisite Mixture \(HL\)\*](#)
- [\*Blister Agent Nitrogen Mustard \(HN-1\)\*](#)
- [\*Blister Agent Nitrogen Mustard \(HN-2\)\*](#)
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- [\*Nerve Agent VX\*](#)





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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blood Agent Hydrogen Cyanide (AC)*

218-31-1096

**General**

Hydrogen cyanide is a fast acting, highly poisonous material. It may be fatal if inhaled, swallowed, or absorbed through the skin. It is an extremely hazardous liquid and vapor under pressure. With prompt treatment following overexposure, recovery is normally quick and complete. AC inactivates the enzyme cytochrome oxidase, preventing the utilization of oxygen by the cells. The toxic hazard is high for inhalation, ingestion, and skin and eye exposure, but AC is primarily an inhalation hazard due to its high volatility.

**Synonyms**

Hydrocyanic acid;  
Formonitrile.

**Description**

Pure AC is a nonpersistent, colorless liquid that is highly volatile. It has a faint odor similar to bitter almonds that sometimes cannot be detected even at lethal concentrations. It is one of the quickest acting poisons. It hinders the vital oxidation-reduction reactions in the body resulting in anoxia affecting the central nervous system resulting in respiratory paralysis.

**Overexposure Effects**

AC poisoning causes a deceptively healthy pink to red skin color. However, if physical injury or lack of oxygen is involved, the skin color may be bluish. Human health effects of overexposure by inhalation, ingestion, or skin contact may include nonspecific symptoms such as reddening of the eyes, flushing of the skin, nausea, headaches, dizziness, rapid respiration, vomiting, drowsiness, drop in blood pressure, rapid pulse, weakness, and loss of consciousness; central nervous system stimulation followed by central nervous system depression, hypoxic convulsions, and death due to respiratory arrest; temporary alteration of the heart's electrical activity with irregular pulse, palpitations, and inadequate circulation. Higher AC inhalation exposures may lead to fatality.

In a few cases, disturbances of vision or damage to the optic nerve or retina have been reported, but the exposures have been acute and at lethal or near-lethal concentrations. Skin permeation can occur in amounts capable of producing systemic toxicity. There are no reports of human sensitization.

### ***Emergency and First Aid Procedures***

Inhalation: remove patient to fresh air, and lay patient down; administer oxygen and amyl nitrite; keep patient quiet and warm; even with inhalation poisoning, thoroughly check clothing and skin to assure no cyanide is present; seek medical attention immediately.

Eye Contact: flush eyes immediately with plenty of water; remove contaminated clothing; keep patient quiet and warm; seek medical attention immediately.

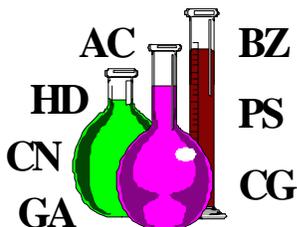
Skin Contact: wash skin promptly to remove the cyanide while removing all contaminated clothing, including shoes; do not delay; skin absorption can occur from cyanide dust, solutions, or HCN vapor; absorption is slower than inhalation, usually measured in minutes compared to seconds; HCN is absorbed much faster than metal cyanides from solutions such as sodium, potassium or copper cyanide solutions; even after washing the skin, watch the patient for at least 1 to 2 hours because absorbed cyanide can continue to work into the bloodstream; wash clothing before reuse and destroy contaminated shoes.

Ingestion: give patient one pint of one percent sodium thiosulfate solution (or plain water) immediately by mouth and induce vomiting; repeat until vomit fluid is clear; never give anything by mouth to an unconscious person; give oxygen; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Psychedelic Agent 3-  
Quinuclidinyl Benzilate  
(BZ)*

218-40-1096

***General***

BZ is an incapacitating agent that has the predominant effect of depressing or blocking the activity of the central nervous system. The chemical BZ, also known as “agent buzz” was produced at Pine Bluff Arsenal between 1962 and 1965. It was dropped from the chemical arsenal because its effects on enemy front-line troops would be varied and unpredictable.

***Synonyms***

Benzilic Acid, 3-Quinuclidinyl ester;  
3-Hydroxyquinuclidine benzilate;  
3-Oxyquinuclidine benzilate;  
3-Quinuclidinylbenzilate;  
beta-Quinuclidinyl benzilate;  
BZ;  
EA2277.

***Description***

BZ is an odorless white crystalline solid. BZ causes excessive nervous activity, often by “boosting” or facilitating transmission of impulses that might otherwise be insufficient to cross certain synapses. The effect is to “flood” the brain with too much information, making concentration difficult and causing indecisiveness and inability to act in a sustained, purposeful manner.

***Overexposure Effects***

BZ is a very potent psychoactive chemical affecting the central nervous system as well as the organs of circulation, digestion, salivation, sweating, and vision. Its pharmacological action is similar to that of other anticholinergic drugs (e.g., atropine, scopolamine, etc.), but longer lasting. Acute exposure produces increased heart and respiratory rates; mydriasis; mouth, skin, and lip dryness; cycloplegia; high temperature; ataxia; flushing of face and neck; hallucinations; stupor; forgetfulness; and confusion. The initial symptoms after ½ to 4 hours of exposure include: dizziness, mouth dryness, and increased heart rate; secondary symptoms, after 3-5 hours of exposure, include: restlessness, involuntary muscular,

movements, rear vision impairment, and total incapacitation; final symptoms, after 6-10 hours of exposure are psychotropic in nature. After 3-4 days, full recovery from BZ intoxication is expected.

### ***Emergency and First Aid Procedures***

Inhalation: remove individual from exposure immediately; start resuscitation and administer oxygen if breathing is irregular or has stopped; seek medical attention immediately.

Eye Contact: flush eyes with water for at least 15 minutes; do not rub eyes; seek medical attention immediately.

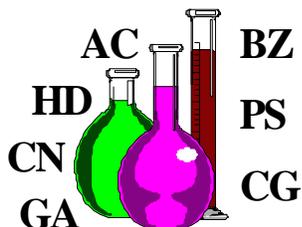
Skin Contact: wash from skin and clothing with water; remove any contaminated clothing; seek medical attention immediately.

Ingestion: do not induce vomiting; seek medical attention immediately.

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*General Facts About Tear Agent  
α-Bromobenzylcyanide  
(CA)*

218-42-1096

**General**

CA was the first tear agent that came into existence at the end of the World War I. It was outmoded in 1920 with the introduction of the CN series and is now obsolete in NATO inventories. The tear compounds cause a flow of tears and irritation of the skin. Because tear compounds produce only transient casualties, they are widely used for training, riot control, and situations where long-term incapacitation is unacceptable. When used against poorly equipped guerrilla or revolutionary armies, these compounds have proved extremely effective. When released indoors, they can cause serious illness or death.

**Synonyms**

4-Bromophenylacetonitrile.

**Description**

Pure bromobenzylcyanide is a colorless crystalline solid with a sour or rotten fruit odor.

**Overexposure Effects**

CA is usually used in solution with ether or acetone as an aerosol. It produces a severe burning sensation to the mucous membranes and equally severe lacrimation to the eyes accompanied by headache and nausea. The nausea may lead to vomiting although the vomiting is more of a psychological reaction than physiological. CA will go into solution with human sweat and will incur a burning sensation to the face, especially in the areas around the mouth, nose, and eyes. It will penetrate clothing, making the areas around the neck, armpits, the tender skin areas behind the elbows, knees and around the buttocks and crotch susceptible to rashes and blisters. The vapors can be lethal in enclosed or confined spaces within a few minutes without prior respiratory protection. Nausea can lead to unconsciousness which may mean suffocation.

**Emergency and First-Aid  
Procedures**

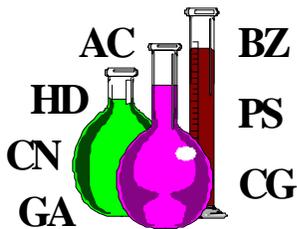
Inhalation: remove victim from the source immediately, seek medical attention immediately.

Eye Contact: don a respiratory protective mask; flush eyes immediately with copious amounts of water; seek medical attention immediately.

Skin Contact: remove victim from the source immediately; decontaminate the skin immediately with copious amounts of water; decontaminate clothing with steam or by boiling; 20 percent alcohol caustic soda is effective on material, but may damage it; seek medical attention immediately.

Ingestion: give victim milk to drink; seek medical attention immediately.

*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Choking Agent Phosgene  
(CG)*

218-25-1096

**General**

CG, normally a chemical agent with a short duration, was used extensively in World War I. More than 80 percent of World War I chemical agent fatalities were caused by CG.

**Synonyms**

Carbonyl chloride;  
Carbon oxychloride;  
Carbon dichloride oxide;  
Carbon dichloride;  
Carbonic acid dichloride;  
Chloroformyl chloride.

**Description**

CG is a severe eye, mucous membrane, and skin irritant. It is highly toxic by inhalation. Two parts per million in air is immediately dangerous to life and health. Being a gas, it is primarily a toxic hazard by inhalation exposure. CG is foglike in its initial concentration but becomes colorless as it disperses. It has an odor of newly mown hay.

**Overexposure Effects**

Phosgene is a corrosive, highly toxic gas used as a delayed-casualty agent resulting in fluid buildup in the lungs (“dryland drowning”). It affects the upper respiratory tract, skin, and eyes and causes severe respiratory damage as well as burns to the skin and eyes. Acute inhalation may cause respiratory and circulatory failure with symptoms of chills, dizziness, thirst, burning of eyes, cough, viscous sputum, dyspnea, feeling of suffocation, tracheal rhonchi, burning in throat, vomiting, pain in chest, and cyanosis. CG is a severe mucous membrane irritant. Chronic inhalation may cause irreversible pulmonary changes resulting in emphysema and fibrosis. Acute skin contact may result in lesions similar to those of frostbite and burns; it is a severe skin irritant. Chronic skin contact may result in dermatitis. Acute eye contact may result in conjunctivitis, lacrimation, lesions similar to those of frostbite, and burns; chronic eye contact may result in conjunctivitis.

## *Emergency and First Aid Procedures*

Inhalation: remove victim to fresh air; keep individual calm and avoid any unnecessary exertion or movement; maintain airway and blood pressure; trained persons should administer oxygen if breathing is difficult; give artificial respiration if victim is not breathing; seek medical attention immediately.

Eye Contact: flush eyes immediately with running water or normal saline for at least 15 minutes; hold eyelids apart during irrigation; do not delay rinsing to avoid permanent eye injury; seek medical attention immediately.

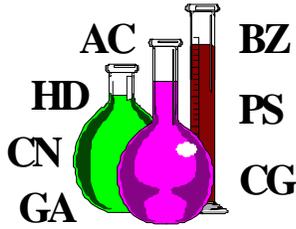
Skin Contact: unlikely that emergency treatment will be required; gently wrap affected part in blankets if warm water is not available or practical to use; allow circulation to return naturally; if adverse effects occur, seek medical attention immediately.

Ingestion: treat symptomatically and supportively; if vomiting occurs, keep head lower than hips to prevent aspiration; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blood Agent Cyanogen Chloride (CK)*

218-30-1096

***General***

Cyanogen chloride irritates the eyes and respiratory tract, even in low concentrations. Acute exposure produces intense irritation of the lungs characterized by coughing and breathing problems, which may quickly lead to a pulmonary edema. Inside the body, cyanogen chloride converts to hydrogen cyanide, which inactivates the enzyme cytochrome oxidase, preventing the utilization of oxygen by the cells. The toxic hazard is high for inhalation, ingestion, and skin and eye exposure, but it is primarily an inhalation hazard due to its high volatility.

***Synonyms***

Chlorcyan;  
Chlorine cyanide;  
Chlorocyan;  
Chlorocyanide;  
Chlorocyanogen;  
Chlorure de cyanogene.

***Description***

Cyanogen chloride is a colorless gas with a sharp, pepperish odor similar to that of most tear gasses. The odor of CK often goes unnoticed because it is so irritating to the mucous membranes. CK is a liquid at temperatures below 55°F.

***Overexposure Effects***

CK is absorbed through the skin and mucosal surfaces and is dangerous when inhaled because toxic amounts are absorbed through bronchial mucosa and alveoli. It is similar in toxicity and mode of action to AC but is much more irritating. CK can cause a marked irritation of the respiratory tract, hemorrhagic exudate of the bronchi and trachea as well as pulmonary edema. It is improbable that anyone would voluntarily remain in areas with a high enough concentration to exert a typical nitrile effect. The liquid form will burn skin and eyes. Long-term exposure will cause dermatitis, loss of appetite, headache, and upper respiratory irritation in humans.

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*Agent CK* - The chemical cyanogen chloride, Chemical Abstract Service Registry No. 0506-77-4.

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### ***Emergency and First Aid Procedures***

**Inhalation:** if the patient is conscious, direct first aid and medical treatment toward the relief of any pulmonary symptoms; put patient immediately at bed rest with head slightly elevated; seek medical attention immediately; administer oxygen if there is any dyspnea or evidence of pulmonary edema; in case of long exposures, combined therapy, with oxygen plus amyl nitrite inhalations and artificial respiration is recommended.

**Eye Contact:** flush affected areas with copious amounts of water immediately; hold eyes open while flushing.

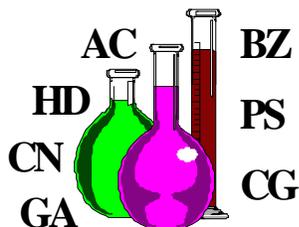
**Skin Contact:** wash skin promptly to remove the cyanogen chloride; remove all contaminated clothing, including shoes; do not delay.

**Ingestion:** give victim water or milk; do not induce vomiting.

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*General Facts About Tear Agent 2-  
Chloroacetophenone (CN)*

218-43-1096

**General**

The United States considers agent CN (popularly known as mace or tear gas) and its mixtures with various chemicals to be obsolete for military deployment. It is highly toxic by inhalation and ingestion. CN tear compound causes flow of tears and irritation of the skin. Since tear compounds produce only transient casualties, they are wisely used for training, riot control, and situations where long-term incapacitation is unacceptable.

**Synonyms**

Phenyacyl chloride;  
Omega=chloroacetophenone;  
Chloroacetophenone;  
Chloromethyl phenyl ketone;  
Phenyl chloromethyl ketone;  
“Tear gas”;  
CN.

**Description**

CN is a colorless-to gray crystalline solid with a sharp, irritating floral odor. The odor threshold for CN is 0.1 mg/m<sup>3</sup>.

**Overexposure Effects**

Alpha-chloroacetophenone vapors may cause a tingling or runny nose, burning and/or pain of the eyes, blurred vision, and tears. Burning in the chest, difficult breathing, and nausea may also occur as well as skin irritation, rash, or burns. It can also cause difficulty if swallowed.

**Emergency and First Aid  
Procedures**

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin using soap or mild detergent and water immediately; remove the contaminated clothing immediately and wash the skin using soap or mild detergent and water; seek medical attention immediately when there are chemical burns or evidence of skin irritation.

Ingestion: induce vomiting by having victim touch the back of the throat with finger or by giving victim syrup of ipecac as directed; do not induce vomiting if victim is unconscious; seek medical attention immediately.

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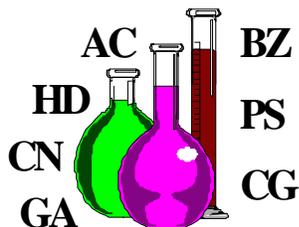
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Tear Agent Chloroacetophenone  
in Benzene and Carbon Tetrachloride  
(CNB)*

218-45-1096

***General***

CNB was adopted in 1920 and remained in use until it was replaced by Chloroacetophenone and Chloropicrin in Chloroform. The advantages claimed for CNB was that its lower chloroacetophenone content made it more satisfactory than chloroacetophenone in chloroform (CNC) for training purposes.

***Description***

CNB is a slightly brown liquid smelling heavily of benzene. It has an immediate strong irritating effect on the eyes and respiratory tract. CNB is flammable.

***Overexposure Effects***

CNB is a formulation of chloroacetophenone. Like CN, CNB has a pronounced lacrimatory effect, resulting in a natural reflex to shut the eyes. It is similarly irritating to the skin, especially the face and such exposed portions of the body where sweat accumulates. CNB will penetrate clothing or adhere to it under long exposure due to its benzene component. The same rashes caused by CN will be caused by CNB. CNB has a slightly more powerful choking effect than CN. Eye toxicity remains about the same as CN. Some sensitive individuals may experience nausea upon exposure. CNB can form lethal concentrations in closed or confined spaces, although concentrations in open are highly unlikely ever to do so.

***Emergency and First Aid  
Procedures***

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

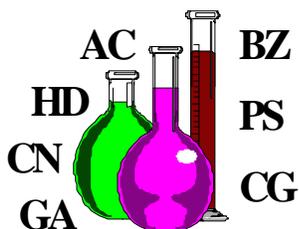
Skin Contact: wash the contaminated skin with soap or mild detergent and water immediately; remove the contaminated clothing immediately; wash the skin using soap or mild detergent and water; seek medical attention immediately when there are chemical burns or evidence of skin irritation.

Ingestion: induce vomiting by having victim touch the back of his throat with finger or by giving victim syrup of ipecac as directed; do not induce vomiting if victim is unconscious; seek medical attention immediately.

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*General Facts About Tear Agent  
Chloroacetophenone and Chloropicrin in  
Chloroform  
(CNS)*

218-44-1096

***General***

CNS is a formulation of chloroacetophenone (CN). CNS was formulated not so much as a tear agent but as a vomiting agent. CNS was an American chemical warfare materiel developed after WWI; it has a mixture of 23 percent chloroacetophenone (CN), 38.4 percent chloropicrin (PS), and 38.4 percent chloroform.

***Description***

CNS is a clear liquid smelling like flypaper; it has an immediately strong irritating effect on the eyes and respiratory tract. CNS may cause severe nausea.

***Overexposure Effects***

CNS is an example of multiple-component mixtures developed to achieve desired dissemination characteristics. Its hazards exist for inhalation, ingestion, and skin and eye exposure. It produces nausea within a minute of inhalation by a moderately sensitive person. If inhaled for longer periods, vomiting, colic (severe abdominal pains and cramps), and diarrhea are to be expected in its victims. Persons who are exposed to very large quantities of the vapors or liquid concentrations may suffer these symptoms for weeks. CNS is a non-lethal choking agent. It will cause the victims to gasp for air (thus inhaling more CNS) while causing discomfort to the bronchial tubes and lung sacs. CNS vapors may go into solution with sweat, making it a skin irritant, especially the face. If allowed to penetrate the clothing, CNS will cause stinging under the armpits, elbows, knees, and the area around the crotch and buttocks. Skin rashes may result after prolonged exposures. Prolonged eye exposure would not be recommended.

***Emergency and First Aid  
Procedures***

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

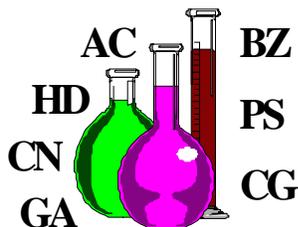
Skin Contact: wash the contaminated skin with soap or mild detergent and water immediately; remove the contaminated clothing immediately, and wash the skin using soap or mild detergent and water; seek medical attention immediately when there are chemical burns or evidence of skin irritation.

Ingestion: induce vomiting by having victim touch the back of his throat with finger or by giving victim syrup of ipecac as directed; do not induce vomiting if victim is unconscious; seek medical attention immediately.

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*General Facts About Tear Agent  
O-Chlorobenzylidene Malononitrile  
(CS)*

218-47-1096

**General**

CS was developed in the late 1950s as a riot-control substance. It is a more potent irritant than chloroacetophenone but is less incapacitating. In the late 1960s, stocks of CS replaced CN. Presently, the U.S. Army uses CS for combat training and riot control purposes.

**Description**

CS is a white crystalline solid; burnt to create a colorless gas with an acrid pepperlike smell.

**Overexposure Effects**

CS is disseminated by burning, explosion, and aerosol formation. It is immediately irritating to the eyes and upper respiratory tract. Warm vapors mix with human sweat to cause a burning sensation to the eyes, nose, and mouth. Conjunctivitis and pain in the eyes, lacrimation, erythema of the eyelids, runny nose, burning throat, coughing and constricted feeling in the chest are the effects which will occur immediately and will persist 5 to 20 minutes after removal from the contaminated area.

It is immediately dangerous to life and health at a concentration of 2 mg/m<sup>3</sup>. It is not an accumulative agent in the human body, although it accumulates in the landscape. CS is the most persistent of the tear agents, absorbing into the most porous surfaces including soil and plaster.

**Emergency and First Aid Procedures**

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep the victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water for at least 15 minutes; apply an ophthalmic corticosteroid ointment after decontamination; treat delayed erythema with a

bland shake lotion (such as calamine lotion) or a topical corticosteroid depending on severity; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin thoroughly using soap and water; remove the contaminated clothing immediately; if irritation persists after washing, seek medical attention immediately.

Ingestion: give victim copious amounts of water immediately; induce vomiting by having victim touch the back of throat with finger; do not make an unconscious person vomit; seek medical attention immediately.

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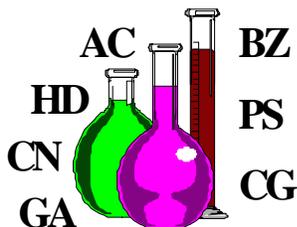
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blister Agent Phosgene Oxime  
(CX)*

218-37-1096

***General***

CX is an urticant producing instant, almost intolerable pain and local tissue destruction immediately on contact with skin and mucous membranes. It is toxic through inhalation, skin and eye exposure, and ingestion. Its rate of detoxification in the body is unknown.

***Synonyms***

Dichloroformoxime;  
CX.

***Description***

CX may appear as a colorless, low-melting point (crystalline) solid or as a liquid. It has a high vapor pressure, slowly decomposes at normal temperatures; it has a disagreeable, penetrating odor.

***Overexposure Effects***

CX vapors are violently irritating to the eyes. Very low concentrations can cause inflammation, lacrimation, and temporary blindness; higher concentrations can cause corneal corrosion and dimming of vision. Contact with the skin can cause skin lesions of the corrosive type. It is characterized by the appearance within 30 seconds of a central blanched area surrounded by an erythematous ring. Subcutaneous edema follows in about 15 minutes. After 24 hours, the central blanched area becomes necrotic and darkened, and an eschar is formed in a few days. Healing is accompanied by sloughing of the scab; itching may be present throughout healing.

***Emergency and First Aid  
Procedures***

Inhalation: remove from the source immediately; give artificial respiration if breathing has stopped; seek medical attention immediately.

Eye Contact: flush eyes immediately with copious amounts of water; seek medical attention immediately.

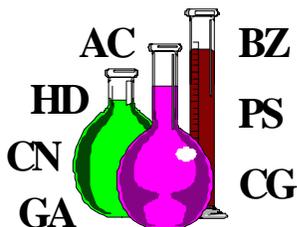
Skin Contact: remove victim from the source immediately; decontaminate the skin immediately by flushing with copious amounts of water to remove any phosgene oxime which has not yet reacted with tissue; seek medical attention immediately.

Ingestion: do not induce vomiting; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Vomiting Agent Adamsite  
(DM)*

218-41-1096

**General**

DM was first produced during World War I. Adamsite was not toxic enough for the battlefield, but it proved to be too drastic for use against civilian mobs; it was banned for use against civilian populations in the 1930s in the Western nations. DM was produced worldwide until superseded by the CN series of tear agents.

**Synonyms**

10 chloro- 5;  
10 dihydrophenarsazine;  
Adamsite.

**Description**

Light green to yellow crystals at room temperature;  
irritates nasal passages similar to pepper; no odor, but irritating.

**Overexposure Effects**

DM is a vomiting compound. It is normally a solid, but upon heating, DM first vaporizes and then condenses to form aerosols. It is toxic through inhalation, ingestion, and skin contact. Adamsite is dispersed as an aerosol, irritating to the eyes and respiratory tract but not necessarily to the skin. Under field conditions, vomiting agents can cause great discomfort to the victims; when released indoors, they can cause serious illness or death. Symptoms include irritation of eyes and mucous membranes, coughing, sneezing, severe headache, acute pain and tightness in the chest, nausea, and vomiting. DM has been noted to cause necrosis of corneal epithelium in humans. The human body will detoxify the effects of mild exposures within 30 minutes of evacuation. Severe exposures may take several hours to detoxify and minor sensory disturbances may persist for up to one day.

**Emergency and First Aid  
Procedures**

Inhalation: remove victim to fresh air; wear a mask/respirator in spite of coughing, sneezing, salivation, and nausea; lift the mask from the face briefly, if necessary, to permit vomiting or to drain saliva from the facepiece; seek medical attention immediately.

Eye Contact: don a respiratory protective mask; seek medical attention immediately.

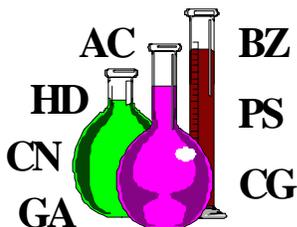
Skin Contact: rinse the nose and throat with saline water or bicarbonate of soda solution; wash exposed skin and scalp with soap and water and allow to dry on the skin; dust the skin with borated talcum.

Ingestion: seek medical attention immediately; carry on duties as vigorously as possible; this will help to lessen and shorten the symptoms; combat duties usually can be performed in spite of the effects of sternutators.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Nerve Agent GA*

218-26-1096

**General**

G-type nerve agents are considered to be nonpersistent chemical agents that may present a significant vapor hazard to the respiratory tract, eyes, or skin. GA-type nerve agents affect the body by blocking the action of the enzyme acetylcholinesterase. When this enzyme is blocked, large amounts of the chemical acetylcholine build up at critical places within the nervous system, causing hyperactivity of the muscles and body organs stimulated by these nerves. The signs and symptoms of exposure to GA-type nerve agents depend upon the *route of exposure* and the *amount of exposure*.

**Synonyms**

Ethyl dimethylphosphoramidocyanidate;  
Dimethylaminoethoxy-cyanophosphine oxide;  
Dimethylamidoethoxyphosphoryl cyanide;  
Ethyl dimethylaminocyanophosphonate;  
Ethyl ester of dimethylphosphoroamidocyanidic acid;  
Ethylphosphorodimethylaminodcyanidate;  
GA;  
EA1205;  
Tabun.

**Description**

G-type nerve agents are clear, colorless, and tasteless liquids, chemically similar to organophosphate pesticides such as Malathion or Parathion. GA has a slightly fruity odor.

**Overexposure Effects**

Signs and symptoms are the same regardless of route the poison enters the body (by inhalation, absorption, or ingestion): runny nose; tightness of chest; dimness of vision and miosis (pinpointing of the eye pupils); difficulty in breathing; drooling and excessive sweating; nausea; vomiting; cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache,

confusion, drowsiness, coma, and convulsion. These signs and symptoms are followed by cessation of breathing and death.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; if severe signs of agent exposure appear, administer immediately, in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available; do not use mouth-to-mouth resuscitation when facial contamination exists; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes then don a respiratory protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; if local sweating and muscular symptoms occur, administer an intramuscular injection with the MARK I Kit; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams (mg) intramuscular injection of the MARK I kit auto injectors; seek medical attention immediately.

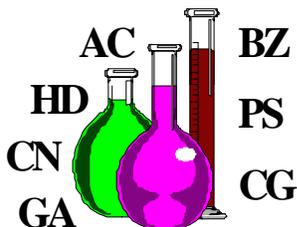
### ***Storage of GA***

Nerve agent GA can be found in ton containers (heavy steel cylinders), artillery shells, mortar projectiles, rockets, and land mines.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Nerve Agent GB*

218-27-1096

**General**

GB is a lethal anticholinesterase agent. Its toxic hazard is high for inhalation, ingestion, and eye and skin exposure. Due to its high volatility, it is mainly an inhalation threat. Its rate of detoxification in the body is low. Effects of chronic exposures are cumulative. Following a single exposure to GB, daily exposure to concentrations of any nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depends on duration of exposure and time intervals between exposures.

**Synonyms**

Isopropyl methylphosphonofluoridate;  
Isopropyl ester of methylphosphonofluoridic acid;  
Methylisopropoxfluorophosphine oxide;  
Isopropyl Methylfluorophosphonate;  
O-Isopropyl Methylisopropoxfluorophosphine oxide;  
O-Isopropyl Methylphosphonofluoridate;  
Methylfluorophosphonic acid, isopropyl ester;  
Isopropoxymethylphosphonyl fluoride;  
GA;  
Zarin; Sarin

**Description**

GB-type nerve agents are clear, colorless, and tasteless liquids. They are odorless in vapor and pure form.

**Overexposure Effects**

Signs and symptoms are the same regardless of route the poison enters the body (by inhalation, absorption, or ingestion): runny nose; tightness of chest; dimness of vision and miosis (pinpointing

of the eye pupils); difficulty in breathing; drooling and excessive sweating; nausea; vomiting; cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These signs and symptoms are followed by cessation of breathing and death.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; if severe signs of agent exposure appear, administer immediately, in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available; do not use mouth-to-mouth resuscitation when facial contamination exists; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes then don a respiratory protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

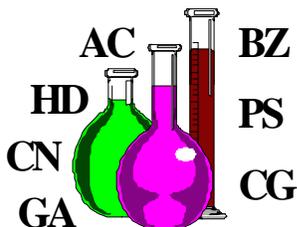
Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; administer an intramuscular injection with the Mark I Kit if local sweating and muscular symptoms occur; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams (mg) intramuscular injection of the MARK I Kit auto injectors; seek medical attention immediately.

### ***Storage of GB***

Nerve agent GB can be found in ton containers (heavy steel cylinders), artillery shells, mortar projectiles, rockets, and land mines.

*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Nerve Agent GD*

218-28-1096

**General**

GD is a lethal anticholinesterase agent. Although it is primarily a vapor hazard, its toxic hazard is high for inhalation, ingestion, and eye and skin exposure. Its rate of detoxification in the body is low.

**Synonyms**

Pinacolyl methylphosphonofluoridate;  
1, 2, 2-Trimethylpropyl methylphosphonofluoridate;  
Methylpinacolyloxyfluorophosphine oxide;  
Pinacolyloxymethylphosphonyl fluoride;  
Pinacolyl methanefluorophosphonate;  
Methylfluoropinacolylphosphonate;  
Fluoromethylpinacolyloxyphosphine oxide;  
Methylpinacolyloxyphosphonyl fluoride;  
Pinacolyl methylfluorophosphonate;  
1, 2, 2-Trimethylpropoxyfluoromethylphosphine oxide;  
GD;  
EA1210;  
Zoman; Soman  
PFMP.

**Description**

GD-type nerve agents are clear, colorless, and tasteless liquids. They have a slight camphor odor and give off a colorless vapor.

**Overexposure Effects**

Signs and symptoms are the same regardless of route the poison enters the body (by inhalation, absorption, or ingestion): runny nose; tightness of chest; dimness of vision and miosis (pinpointing of the eye pupils); difficulty in breathing; drooling and excessive sweating; nausea; vomiting; cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These signs and symptoms are followed by cessation of breathing and death.

## ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; if severe signs of agent exposure appear, administer immediately, in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available, but do not use mouth-to-mouth resuscitation when facial contamination exists; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes then don a respiratory protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; administer an intramuscular injection with the Mark I Kit if local sweating and muscular symptoms occur; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams intramuscular injection of the MARK I Kit auto injectors; seek medical attention immediately.

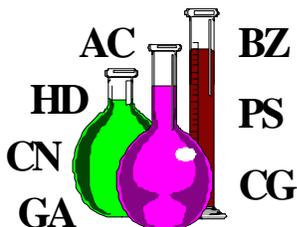
## ***Storage of GD***

Nerve agent GD can be found in ton containers (heavy steel cylinders), artillery shells, mortar projectiles, rockets, and land mines.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Sulfur Mustard Agents  
H and HD*

218-32-1096

**General**

H and HD are blister and alkylating agents, producing cytotoxic action on the hematopoietic (blood-forming) tissues. The rate of detoxification of H and HD in the body is very slow, and repeated exposures produce a cumulative effect. Its toxic hazard is high for inhalation, ingestion, and skin and eye absorption, but the most common acute hazard is from liquid contact with eyes or skin.

**Synonyms**

Sulfide, bis (2-chloroethyl);  
Bis(beta-chloroethyl) sulfide;  
Bis(2-chloroethyl) sulfide;  
1-chloro-2(beta-chloroethylthio)ethane;  
beta, beta'-dichlorodiethyl sulfide;  
Di-2-chloroethyl sulfide;  
beta, beta'-dichloroethyl sulfide;  
2, 2'-dichloroethyl sulfide;  
Sulfur mustard;  
Iprit;  
Kampstoff "Lost";  
Mustard Gas;  
Senfgas;  
S-yperite;  
Yellow Cross Liquid;  
Yperite.

**Description**

Mustard agent *liquid* is colorless when pure, but it is normally a yellow to brown oily substance. Mustard agent *vapor* is colorless with a slight garlic- or mustard-like odor.

**Overexposure Effects**

HD is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood forming) tissues, which are especially sensitive. The rate of detoxification of HD

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**Agent H** - The chemical Levinstein mustard; mixture of 70% bis(2-chloroethyl) sulfide and 30% sulfur impurities produced by unstable Levinstein process.

**Agent HD** - The chemical Distilled mustard or bis(2-chloroethyl) sulfide; HD is H that has been purified by washing and vacuum distillation to reduce sulfur impurities, Chemical Abstract Service Registry No. 505-60-2.

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in the body is very slow, and repeated exposures produce a cumulative effect. The physiological action of HD may be classified as local and systemic. The local action results in conjunctivitis or inflammation of the eyes, erythema which may be followed by blistering or ulceration; inflammation of the nose, throat, trachea, bronchi, and lung tissue. Injuries produced by HD heal much more slowly and are more susceptible to infection than burns of similar intensity produced by physical means or by most other chemicals. Systemic effects of mustard may include malaise, vomiting, and fever, with onset time about the same as that of the skin erythema. With amounts approaching the lethal dose, injury to bone marrow, lymph nodes, and spleen may result. HD has been determined to be a human carcinogen by the International Agency for Research on Cancer.

### ***Emergency and First Aid Procedures***

**Inhalation:** remove victim from the source immediately; administer artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

**Eye Contact:** speed in decontaminating the eyes is absolutely essential; remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers, and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

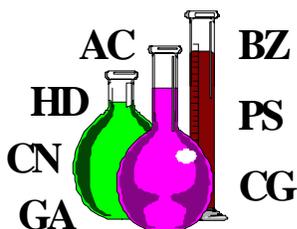
**Skin Contact:** don respiratory protective masks and gloves; remove victim from agent source immediately; flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within 1 minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution; then wash contaminated skin area with soap and water; seek medical attention immediately.

**Ingestion:** do not induce vomiting; give victim milk to drink; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blister Agent Mustard-Lewisite Mixture (HL)*

218-39-1096

**General**

HL is a lethal vesicant and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues. Mustard-Lewisite mixture is a variable of HD and L which provides a low-freezing mixture for use in cold weather operations or as high-altitude spray.

**Synonyms**

Sulfur Mustard/Lewisite;  
HL.

**Description**

HL is a liquid mixture of mustard (HD) and Lewisite (L) designed to provide a low freezing point for use in cold weather and high altitudes. The eutectic mixture (lowest freezing point) is 63% lewisite and 37% mustard. HL has a garlic-like odor from its HD content.

**Overexposure Effects**

HL is a vesicant and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues, which are especially sensitive. The rate of detoxification of HL in the body is very slow, and repeated exposure produces a cumulative effect. Contamination of the skin produces immediate stinging of the skin, turning red within 30 minutes. Blistering is delayed for about 13 hours and tends to cover the entire area of reddened skin. Blisters from HL exposures are deeper and more painful than with HD. Local action on the eyes is extremely rapid and produces severe necrotic damage and loss of eyesight. Exposure of eyes to HL vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea. When HL vapor/aerosol is inhaled, the respiratory tract becomes inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, diarrhea, and fever. The respiratory damage is similar to that produced by mustard, except in the most severe cases. In these cases, fluid in the chest cavity may

accompany fluid in the lungs. HL is absorbed through skin contact and inhalation of vapors, causing systemic toxicity such as damage to the lungs, bone marrow, lymph nodes, spleen, and endocrine system.

### ***Emergency and First Aid Procedures***

Inhalation: remove from the source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes are absolutely essential; remove person from the liquid source; flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark of opaque goggles; seek medical attention immediately.

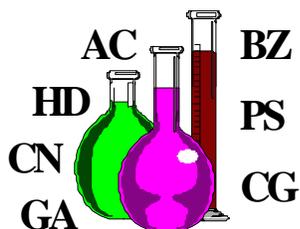
Skin Contact: don respiratory protective mask and gloves; remove victim from agent source immediately; flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within one minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water; wash thoroughly if shower facilities are available; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blister Agent Nitrogen Mustard  
(HN-1)*

218-34-1096

**General**

HN-1 was the first compound of the HN series developed in the late 1920s and early 1930s. HN-1 was designed as a pharmaceutical (to remove warts) and became a military agent; HN-2 was designed as a military agent and became a pharmaceutical; HN-3 was designed as a military agent and is the only one of these agents that remains anywhere as a military agent. These agents are more immediately toxic than the sulfur mustards.

**Synonyms**

Ethylbis(beta-chloroethyl)amine;  
Ethylbis(2-chloroethyl)amine;  
2-Chloro-N-(2-chloroethyl)-N-ethylethanamine;  
Ethyl-S;  
HN1;  
TL329;  
TL1149.

**Description**

HN-1 is a vesicant and an alkylating agent, producing cytotoxic action on the hemopoietic (blood-forming) tissues. It is oily, colorless to pale yellow with a faint, fishy, or musty odor.

**Overexposure Effects**

The vapors are irritating to the eyes and nasal membranes even in low concentration. HN-1 is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues. HN-1 is not naturally detoxified by the body; therefore, repeated exposure produces a cumulative effect.

**Emergency and First Aid  
Procedures**

Inhalation: remove from source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, pulling eyelids apart with fingers, and pouring water into eyes; do not cover eyes with bandages; protect eyes with dark or opaque goggles after flushing eyes; seek medical attention immediately.

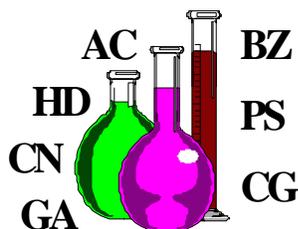
Skin Contact: don respiratory mask and gloves; remove victim from source immediately and remove contaminated clothing; decontaminate the skin immediately by flushing with a 5 percent solution of liquid household bleach; wash off with soap and water after 3-4 minutes to remove decon agent and protect against erythema; seek medical attention immediately; to prevent systemic toxicity, decontamination should be done as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction; further cleans with soap and water.

Ingestion: do not induce vomiting; give victims milk to drink; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blister Agent Nitrogen Mustard  
(HN-2)*

218-35-1096

*General*

HN-2, the second of a series of nitrogen mustard compounds developed in the late 1920s and early 1930s, was designed as a military agent which became a pharmaceutical substance called Mustine. The chemical intermediate it produces is used as an antineoplastic drug. These agents are more immediately toxic than the sulfur mustards.

*Synonyms*

2(2'-dichloroethyl)methylamine;  
Bis(beta-chloroethyl)methylamine;  
N, N-bis(2-chloroethyl)methylamine;  
Beta, beta'-dichlorodiethyl-n-methylamine;  
Di(2-chloroethyl)methylamine;  
Methylbis (beta-chloroethyl)amine;  
N-methyl-bis-chloroethylamine;  
N-methyl-bis(beta-chloroethyl)amine;  
N-methyl-bis(2-chloroethyl)amine;  
N-methyl-2, 2'-dichlorodiethylamine;  
Methyldi (2-chloroethyl)amine;  
2-Chloro-n-(2-chloroethyl)-n-methylethanamine;  
Caryolsin;  
Chloromethine;  
Dichlor Amine;  
Embichin;  
ENT-25294;  
MBA;  
Mechlorethamine;  
Chloramine, Chloramine (the nitrogen mustard);  
N-methyl lost;  
Mustine;  
HN2  
NSC762;  
TL146.

## ***Description***

HN-2 is highly unstable and is no longer seriously considered as a chemical agent. It is rated as somewhat more toxic than HN-1. HN-2 is a pale amber to yellow oily liquid with a fruity odor in high concentrations; smells like soft soap with a fishy smell in low concentrations.

## ***Overexposure Effects***

HN-2 is highly irritating to the eyes and throat; in high concentrations it can cause blindness. Absorbed into the bloodstream it will seriously interfere with the functioning of hemoglobin and will eventually damage the endocrine system. HN-2 is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. HN-2 is not naturally detoxified by the body; therefore, repeated exposure produces a cumulative effect.

## ***Emergency and First Aid Procedures***

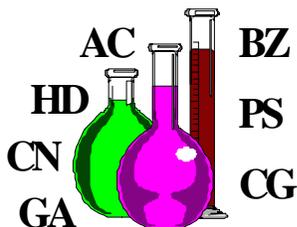
Inhalation: remove from source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, pulling eyelids apart with fingers, and pouring water into eyes; do not cover eyes with bandages; protect eyes with dark or opaque goggles after flushing eyes; seek medical attention immediately.

Skin Contact: don respiratory mask and gloves; remove victim from source immediately and remove contaminated clothing; decontaminate the skin immediately by flushing with a 5 percent solution of liquid household bleach; wash off with soap and water after 3-4 minutes to remove decon agent and protect against erythema; seek medical attention immediately; to prevent systemic toxicity, decontaminate as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction; further clean with soap and water.

Ingestion: do not induce vomiting; give victims milk to drink; seek medical attention immediately.

*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blister Agent Nitrogen Mustard  
(HN-3)*

218-36-1096

**General**

HN-3 was the last of the nitrogen mustard agents developed. It was designed as a military agent and is the only one of the nitrogen mustards that is still used for military purposes. It is the principal representative of the nitrogen mustards because its vesicant properties are almost equal to those of HD.

**Synonyms**

Ethanamine;  
2-chloro-N, N-bis(2-chloroethyl);  
Triethylamine;  
2-2', 2''-trichloro;  
2, 2', 2''-trichlorotriethylamine;  
2-Chloro-N, N-bis(2-chloroethyl)ethanamine;  
Tris (beta-chloroethyl)amine;  
AI3-16198;  
HN3;  
TS160.

**Description**

HN-3 is a vesicant. It also is the most stable in storage of the three nitrogen mustards. HN-3 is a colorless to pale yellow liquid with a butter almond odor.

**Overexposure Effects**

HN-3 is a cumulative poison which is highly irritating to the eyes and throat. Eye irritation, tearing, and photophobia develop immediately after exposure. The median incapacitating dose for eyes is 200 mg-min/m<sup>3</sup>. Blistering of the skin may occur after liquid exposure, severe or persistent exposure, or vapor condensation in sweat. Usually a rash will develop from liquid contamination within an hour, replaced by blistering between six and twelve hours after exposure. HN-3 interferes with hemoglobin functioning in the blood, hindering the production of new blood cells and destroying white blood cells.

### ***Emergency and First Aid Procedures***

Inhalation: remove from source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, pulling eyelids apart with fingers and pouring water into eyes; do not cover eyes with bandages; protect eyes with dark or opaque goggles after flushing eyes; seek medical attention immediately.

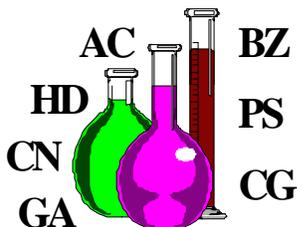
Skin Contact: don respiratory mask and gloves; remove victim from source immediately and remove contaminated clothing; decontaminate the skin immediately by flushing with a 5 percent solution of liquid household bleach; wash off with soap and water after 3-4 minutes to remove decon agent and protect against erythema; seek medical attention immediately; to prevent systemic toxicity, decontaminate as late as 2 or 3 hours after exposure even if it increases the severity of the local reaction; further clean with soap and water.

Ingestion: do not induce vomiting; give victims milk to drink; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Sulfur Mustard Agent HT*

218-33-1096

**General**

HT is a mixture of 60-percent HD and 40-percent agent T. It is expected that the effects of HT would encompass those of both HD and T. Both HD and T are alkylating agents. T is a sulfur and chlorine compound similar in structure to HD. HT has a strong blistering effect, has a longer duration of effectiveness, is more stable, and has a lower freezing point than HD. Its low volatility makes effective vapor concentrations in the field difficult to obtain. Properties are essentially the same as those of HD.

**Synonyms**

HD: Bis-2(2-chloroethyl) sulfide;  
T: Bis-[2-(2-chloroethylthio)-ethyl] ether  
HT;  
Sulfur - Mustard.

**Description**

T is a sulfur and chlorine compound similar in structure to HD and is a clear yellowish liquid with a slight garlic- or mustard-like odor.

**Overexposure Effects**

HD is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow, and repeated exposures produce a cumulative effect. It causes blisters, irritates the eyes, and it is toxic when inhaled. HD has been determined to be a human carcinogen by the International Agency for Research on Cancer.

**Emergency and First Aid Procedures**

Inhalation: remove victim from the source immediately; administer artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes is absolutely essential; remove victim from the liquid source, flush the eyes

immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers, and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

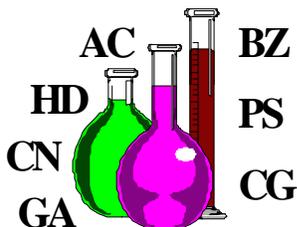
Skin Contact: don respiratory protective masks and gloves; remove victim from agent source immediately; flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within 1 minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution; then wash contaminated skin area with soap and water; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Blister Agent Lewisite  
(L)*

218-38-1096

**General**

L is a vesicant (blister agent); also, it 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, absorbed in tissues, and a systemic poison. When inhaled in high concentrations, it may be fatal in as short a time as 10 minutes. L is not detoxified by the body. Common routes of entry into the body include ocular, percutaneous, and inhalation.

**Synonyms**

Arsine, (2-chlorovinyl) dichloro-;  
Arsonous, dichloride, (2-chloroethenyl)-;  
Chlorovinylarsine dichloride;  
2-Chlorovinyl dichloroarsine;  
beta-Chlorovinyl dichloroarsine;  
Dichloro (2-chlorovinyl) arsine;  
L;  
EA1034.

**Description**

Pure Lewisite is a colorless, oily liquid with very little odor. The plant sample (war gas) has a geranium-like odor and is an amber to dark brown liquid.

**Overexposure Effects**

Lewisite presents both a vapor and liquid hazard and may damage the eyes, skin, respiratory tract, and circulatory system. Exposure to L causes immediate (within 30 seconds) irritation or pain. The vapor may be inhaled into the respiratory tract, causing the immediate onset of burning pain, irritation of the nose, and reflex coughing and chest tightness. The vapor also affects the eyes, with the immediate onset of pain, redness, uncontrollable blinking, and swelling of the eyelids. The vapor or a liquid splash of L on the skin may cause immediate stinging pain and destruction of tissue, following by blistering within 12 hours.

### ***Emergency and First Aid Procedures***

Inhalation: remove from the source immediately; give artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes is absolutely essential; remove person from the liquid source; flush the eyes immediately with water for 10-15 minutes by tilting the head to the side, pulling eyelids apart with fingers, and pouring water slowly into the eyes; do not cover eyes with bandages, but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

Skin Contact: remove victim from source immediately and remove contaminated clothing; immediately decon affected areas by flushing with 10 percent sodium carbonate solution; wash off with soap and water after 3 to 4 minutes to protect against erythema; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

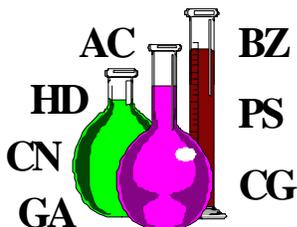
### ***Storage of L***

L is stored in ton containers (heavy steel cylinders) at one military installation on the continental United States - Tooele Army Depot, Utah.

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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About Tear Agent Chloropicrin  
(PS)*

218-46-1096

**General**

PS was used in large quantities during World War I; it was stockpiled during World War II and is no longer authorized for military use. PS is more toxic than chlorine but less toxic than phosgene (CG). PS is a severe respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. It is a possible but unconfirmed tumorigenic agent that decomposes to form toxic chlorine gas and nitrogen oxides near oxygen fires.

**Synonyms**

Nitrotrichloromethane;  
Trichloronitromethane;  
Nitrochloroform.

**Description**

PS is a colorless, oily liquid with a stinging pungent odor.

**Overexposure Effects**

Chloropicrin is a powerful irritant whose vapors cause lung, skin, eye, nose and throat irritation, coughing and vomiting. As an eye irritant, it produces immediate burning, pain and tearing. In high concentration, PS damages the lungs, causing pulmonary edema. Exposure to liquid PS can cause severe burns on the skin that generally result in blisters and lesions. The lowest irritant concentration is 9 mg-min/m<sup>3</sup> for 10 minutes, and the median lethal concentration is 2,000 mg-min/m<sup>3</sup>.

**Emergency and First Aid  
Procedures**

Inhalation: remove the victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep the victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes immediately with copious amounts of water, lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: wash the contaminated skin using soap or mild detergent and water; remove the contaminated clothing immediately; wash the skin using soap or mild detergent and water; if irritation persists after washing, seek medical attention immediately.

Ingestion: give victim copious amounts of water immediately; induce vomiting by having victim touch the back of his throat with his finger; do not make an unconscious person vomit; seek medical attention immediately.

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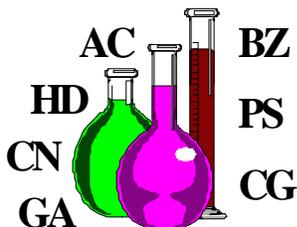
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*U.S. Army Center for Health Promotion and Preventive Medicine*



*General Facts About White Phosphorous  
(WP)*

218-48-1096

**General**

White phosphorous is spontaneously flammable and is an extremely toxic inorganic substance. It is used primarily as a smoke agent and can also function as an antipersonnel flame compound capable of causing serious burns.

**Synonyms**

Yellow phosphorous;  
White phosphorous;  
Phosphorous sticks dry.

**Description**

White phosphorous is a white or pale yellow, translucent, crystalline solid with a waxy consistency. It is also called yellow phosphorous due to impurities and has a match-like odor.

**Overexposure Effects**

The vapors of burning phosphorous (yellow) can be a mild irritant; continued exposure can lead to bronchitis, persistent coughing, severe burns, weakness, anemia, loss of appetite, and possibly pneumonia; if ingested, the fatal dose is 1 mg/kg. WP can cause thirst cyanosis, abdominal pain, jaundice; acute poisoning produces shock, coma and death in a short time (symptoms may subside and then return); liver and kidney damage may occur. It can cause very severe, slow-healing burns on contact and particularly deep burns with hemorrhaging. WP can also cause severe burns and permanent damage to the eyes.

Inhalation or ingestion of small amounts of phosphorous over long periods can lead to necrosis or deformation of the lower jaw, damage to teeth, and susceptibility to bone fracture. Persons with pre-existing skin disorders, eye problems, or impaired liver or kidney function may be more susceptible to the effects of the substance.

### ***Emergency and First Aid Procedures***

Inhalation: remove victim to fresh air immediately; perform artificial respiration if breathing has stopped; keep affected victim warm and at rest; seek medical attention immediately.

Eye Contact: wash eyes with copious amounts of water immediately lifting the lower and upper lids occasionally; do not wear contact lenses when working with this chemical; seek medical attention immediately.

Skin Contact: flush the contaminated skin with water immediately; remove the clothing immediately and flush the skin with water; keep skin wet until medical attention is obtained to prevent any remaining WP from burning; seek medical attention immediately.

Ingestion: if victim is conscious, give victim copious amounts of water immediately; induce vomiting after victim has swallowed the water; do not make unconscious person vomit; seek medical attention immediately.

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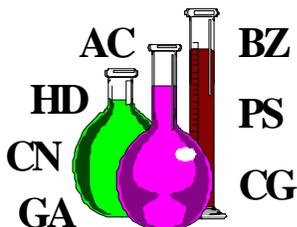
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## U.S. Army Center for Health Promotion and Preventive Medicine



### General Facts About Nerve Agent VX

218-29-1096

#### General

Nerve agent VX is a persistent, nonvolatile agent that is primarily a liquid exposure hazard to the skin or eyes, although small amounts of VX vapor may be generated under extremely high temperatures. VX affects the body by blocking the action of the enzyme acetylcholinesterase. When this enzyme is blocked, large amounts of the chemical acetylcholine build up at critical places within the nervous system, causing hyperactivity of the body organs stimulated by these nerves. The signs and symptoms of exposure to Nerve agent VX depend upon the *route of exposure* and the *amount of exposure*. VX is a lethal anticholinesterase agent. Its toxic hazard is high for inhalation, ingestion, and eye and skin exposure, but due to its low volatility, the primary route of exposure is through ingestion or skin contact. Its rate of detoxification in the body is low.

#### Synonyms

Phosphonothioic acid, methyl-, S-(2-bis(1-methylethylamino)ethyl) O-ethyl ester;  
O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate;  
S-2-Diisopropylaminoethyl O-ethyl methylphosphonothioate;  
S-2(2-Diisopropylamino)ethyl O-ethyl methylphosphonothiolate;  
O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate;  
O-ethyl S-(2-diisopropylaminoethyl) methylthiolphosphonoate;  
VX;  
EA1701;  
TX60.

#### Description

Nerve agent VX is an oily liquid that is clear, odorless, and tasteless. It is amber colored similar in appearance to motor oil.

#### Overexposure Effects

Signs and symptoms of overexposure may occur within minutes or hours depending upon dose. They include: miosis (constriction of

pupils) and visual effects, headache and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking, difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. Signs of severe exposure can progress to convulsions and respiratory failure.

### ***Emergency and First Aid Procedures***

Inhalation: hold breath and don respiratory protection mask; administer immediately, in rapid succession, all three Nerve Agent Antidote Kits, Mark I injectors if severe signs of agent exposure appear; use mouth-to-mouth resuscitation when approved mask-bag or oxygen delivery systems are not available, but do not use mouth-to-mouth resuscitation when facial contamination exists; if breathing is difficult, administer oxygen; seek medical attention immediately.

Eye Contact: flush eyes immediately with water for 10-15 minutes, then don a respiratory protective mask. Although miosis may be an early sign of agent exposure, do not administer an injection when miosis is the only sign present; seek medical attention immediately.

Skin Contact: don respiratory mask and remove contaminated clothing; wash contaminated skin with copious amounts of soap and water immediately using 10 percent sodium carbonate solution, or 5 percent liquid household bleach; rinse well with water to remove decontamination; if local sweating and muscular symptoms occur, administer an intramuscular injection with the MARK I Kit; seek medical attention immediately.

Ingestion: do not induce vomiting; first symptoms are likely to be gastrointestinal; administer immediately 2 milligrams intramuscular injection of the MARK I Kit auto injectors; seek medical attention immediately.

### ***Storage of VX***

Nerve agent VX can be found in ton containers (heavy steel cylinders), artillery shells, mortar projectiles, rockets, and land mines. VX is stockpiled at Anniston Army Depot, AL; Blue Grass Army Depot, KY; Newport Army Ammunition Plant, IN; Pine Bluff Arsenal, AR; Tooele Army Depot, UT; and Umatilla Depot Activity, OR.

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