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# **Analysis of Chemical Warfare Agents by GC-MS: Second Chemical Cluster CRTI Training Exercise**

P. A. D'Agostino, C. R. Jackson Lepage, J. R. Hancock and C. L. Chenier  
Defence R&D Canada – Suffield

## Chemical warfare agent categories

Chemical warfare agents have been classified into nerve, blister, choking, vomiting, blood, tear and incapacitating agent categories based on their effect on humans. The most significant chemical warfare agents in terms of military capacity and past use are the nerve and blister agents. For these reasons the analysis of these compounds will be emphasized over the other groups. The choking, blood and vomiting agents, are for the most, part obsolete chemical agents that were employed during the First World War. The tear agents were used during the Vietnam War but their primary use, because of their inability to produce high casualties, remains in riot control and training. Incapacitating agents have been included in the CWC as the United States did develop an agent in this category.

The compounds listed in Table 1 represent the most common chemical warfare agents, with their Chemical Abstracts registry numbers, and is not intended to be exhaustive. It has been estimated that more than 10,000 compounds are controlled under the CWC, although in practical terms the actual number of chemical warfare agents, precursors and degradation products that are contained in the OPCW database is in the hundreds. The structures of common nerve and blister chemical warfare agents are illustrated in Figure 1.

**Table 1. Common Chemical Warfare Agents**

**a) Nerve** (reacts irreversibly with cholinesterase which results in acetylcholine accumulation, continual stimulation of the body's nervous system and eventual death)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
1-Methylethyl methylphosphonofluoridate (sarin, GB)	107-44-8
1,2,2-Trimethylpropyl methylphosphonofluoridate (soman, GD)	96-64-0
Cyclohexyl methylphosphonofluoridate (GF)	329-99-7
Ethyl dimethylphosphoramidocyanidate (tabun, GA)	77-81-6
O-Ethyl S-(2-diisopropylaminoethyl) methylphosphonothiolate (VX)	50782-69-9

**b) Blister** (affects the lungs, eyes and produces skin blistering)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
Bis(2-chloroethyl)sulfide (mustard, H)	505-60-2
Bis(2-chloroethylthio)ethane (sesquimustard, Q)	3563-36-8
Bis(2-chloroethylthioethyl)ether (T)	63918-89-8
Tris(2-chloroethyl)amine (HN-3)	555-77-1
(2-chloroethenyl)arsonous dichloride (lewisite, L)	541-25-3

**c) Choking** (affects respiratory tract and lungs)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
Chlorine	7782-50-5
Phosgene (CG)	75-44-5

**d) Vomiting** (causes acute pain, nausea and vomiting in victims)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
Diphenylarsinous chloride (DA)	712-48-1
10-Chloro-5,10-dihydrophenarsazine (adamsite, DM)	578-94-9
Diphenylarsinous cyanide (DC)	23525-22-6

**e) Blood** (prevents transfer of oxygen to the body's tissues)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
Hydrogen cyanide (HCN, AC)	74-90-8

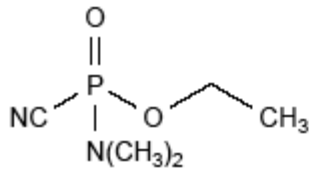
**f) Tear** (causes tearing and irritation of the skin)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
[(2-chlorophenyl)methylene]propanedinitrile (CS)	2698-41-1
2-Chloro-1-phenylethanone (CN)	532-27-4
Dibenz[b,f][1,4]oxazepin (CR)	257-07-8

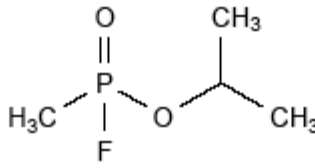
**g) Incapacitating** (prevents normal activity by producing mental or physiological effects)

<u>Full Name (Trivial Name(s))</u>	<u>CAS No.</u>
3-Quinuclidinyl benzilate (BZ)	6581-06-2

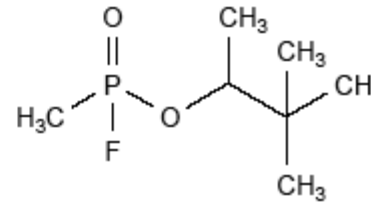
## NERVE AGENTS



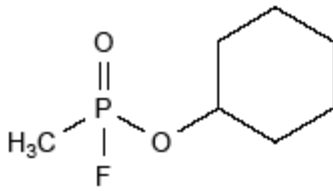
**Tabun (GA)**



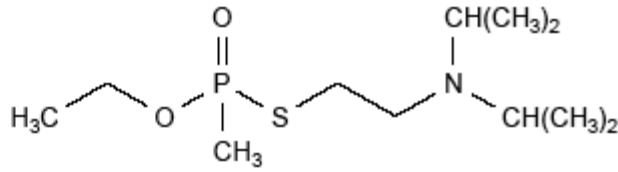
**Sarin (GB)**



**Soman (GD)**

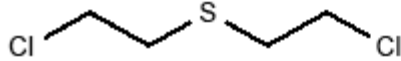


**GF**

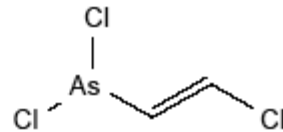


**VX**

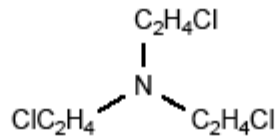
## BLISTER AGENTS



**Mustard (H)**



**Lewisite (L)**



**Nitrogen Mustard (HN-3)**

**Figure 1.** Structures of common chemical warfare agents.