

- (3) O-alkyl (H or $\leq C_{10}$ incl. cycloalkyl) S-2-dialkyl (methyl, ethyl, n- and isopropyl)-aminoethyl alkyl (methyl, ethyl, n- and isopropyl) phosphonothiolates and corresponding alkylated and protonated salts.

The CEFIC calculation suggests that these are 80,040 possible agents of the VX type.

VX, $C_{11}H_{24}NO_2PS$

CAS NO. 50782-69-9

HS NO. 29.31.00

Merck 9948

Synonyms: O-ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate;
phosphonothioc acid, methyl-,
S-(2-(bis(1-methylethyl)amino)ethyl) O-ethyl ester.

Physical properties: MW: 267.37; bp: 298°C; d. 1.0083;
odourless liquid with an amber colour, 1-5% soluble in water,
resistant to hydrolysis and so persistent in the environment.

Synthesis: There are many described pathways to VX. The QL route involves the reaction of O-ethyl-2-diisopropyl aminoethyl methyl phosphonate with sulphur. The thionate route involves the reaction of the potassium salt of ethyl methyl phosphonothionate with diisopropylaminoethyl chloride. The dichloride route involves the reaction of diisopropylaminoethanethiol with ethyl methylphosphonyl chloride. (See S.R. Eckhaus, J.C. Davis, B.M. Zeffert and T.R. Moore, US Patent 3911119, 1960 and R.V. Ley and G.L. Sainsbury, B. Patent 1346409, 1962).

Toxicology: Extremely poisonous by dermal routes, casualty dose (unmasked) 5 mg-min/m³, lethal dose 10 mg-min/d³, LD dermal (human) 0.086 mg/kg, TDLO (oral) 4 mg/kg, it is a long term contact hazard, hydrolysis products (pH7) are almost as toxic.

Key precursors:

QL Route	O-ethyl O-2 diisopropylaminoethyl methylphosphonite (CAS No. 57856-11-8)
Thionite Route	ethyl methylphosphonothionate (CAS No.18005-40-8)
Dichloride Route	ethyl methylphosphonyl chloride (CAS No.5284-09-3)

Precursors:

QL Route	ethyl methylphosphinyl chloride (CAS No.13213-38-2)
	diethyl methylphosphonite (CAS No.15715-41-0)
	methyl phosphinyl dichloride (CAS No.676-83-5)
Thionite Route	diethyl methylphosphonothionate (CAS No.6996-81-2)