



# Most traded scheduled chemicals 2022

OPCW

Organisation for the Prohibition of Chemical Weapons

1 January 2022

## INTRODUCTION

This brochure identifies the 49 most traded Schedule 2 and Schedule 3 chemicals of the Chemical Weapons Convention (hereinafter “the Convention”) based on the declarations submitted by the States Parties under the Article VI of the Convention since 1997 up to 2014.

This 2022 version supersedes the previous 2017 version and includes the updated Harmonized System Codes (HS codes) which have become effective from 1 January 2022. A correlation table between the previous version of the HS 2017 and current version of the HS 2022 has been made available.

This OPCW tool is to assist States Parties in identifying CWC scheduled chemicals. It contains several identifiers for each chemical e.g. Chemical Name, Schedule, Chemical Abstracts Service Registry Numbers (CAS RN), CAS Index Name, HS codes, Chemical Structure, International Union of Pure and Applied Chemistry (IUPAC) Name and synonyms if available. The brochure also gives some examples of commercial applications and industrial uses of the chemicals.

The chemicals in the brochure are indexed twice; the first index is arranged in ascending order of schedule number (Schedule 2 and Schedule 3), entry number in a schedule (e.g. 2B04, 2B05, 2B06, etc.) and CAS RN in each entry. The second index is arranged in ascending order of CAS RN only.

The brochure will be updated and revised on a regular basis to incorporate the new most traded scheduled chemicals and any changes in the identifiers (e.g. CAS RN, HS codes).

## FEEDBACK

The Technical Secretariat encourages States Parties to provide feedback on the brochure “Most Traded Scheduled Chemicals 2022” for consideration for future updates.

Comments and suggestion should be forwarded to: [deb@opcw.org](mailto:deb@opcw.org)

## DEFINITIONS

**Schedule:** Identifies toxic chemicals and their precursors with 3 digits and a letter A or B (e.g. 2B04, 3A01) as indicated in the Annex on Chemicals to the Convention:

- The first digit identifies the Schedule: Schedule 2 or 3
- The letter A means a toxic chemical and B means a precursor
- The last two digits identify the entry number of the chemical in the Schedule

(E.g. 3B17 identifies a chemical which is a precursor listed in the Schedule 3 with the entry number 17 (Chemical Name “Triethanolamine”).

**Chemical Name:** The name of a substance which is created based on the names given in the Annex on Chemicals to the Convention (e.g. Triethanolamine, Dimethyl methylphosphonate). Where a chemical name is not available the other name (e.g. CAS Index name or IUPAC name) is used as a chemical name.

**CAS Index Name:** Chemical name assigned to a substance by the nomenclature of the CAS (e.g. CAS Index name of Triethanolamine is Ethanol, 2,2',2"-nitrilotris-)

**IUPAC Name:** Systematic chemical name based on the nomenclature developed by the International Union of Pure and Applied Chemistry (IUPAC) (e.g. IUPAC name of Triethanolamine is 2,2',2"-Nitrilotriethanol)

**CAS RN** - Chemical Abstracts Service Registry Number is a unique numeric identifier assigned by the Chemical Abstracts Service (CAS) of the American Chemical Society. A CAS RN is separated by hyphens into three parts (e.g. CAS RN of Triethanolamine is 102-71-6).

**HS Code:** Harmonised System Code is the International Harmonized System Nomenclature comprising the headings and subheadings and their numerical codes maintained by the World Customs Organization (WCO) (e.g. HS code (2017) of Thiodiglycol is 2930.70).

**Molecular Formula:** A set of chemical symbols showing the number of atoms of each element within a molecule of a substance (e.g.  $C_6H_{15}NO_3$ ).

**Chemical Structure:** Illustrates the arrangement of atoms in the molecule of a substance (e.g. Chemical structure of Hydrogen Cyanide:  $H - C \equiv N$ ).

**Commercial applications/Industrial uses:** Compiles some examples of commercial applications and industrial uses obtained from the open sources.

## Most Traded Scheduled Chemicals ordered by Schedule

| Schedule 2 | CAS RN      | Chemical Name                                                                                                                                                                                                                 | Page |
|------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2B04       | 129788-86-9 | Product from the reaction of Methylphosphonic acid and 1,3,5-Triazine-2,4,6-triamine                                                                                                                                          | 1    |
| 2B04       | 170836-68-7 | Mixture of (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate (CAS RN 41203-81-0) and Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl]methylphosphonate (CAS RN 42595-45-9) | 2    |
| 2B04       | 18755-43-6  | Dimethyl propylphosphonate                                                                                                                                                                                                    | 3    |
| 2B04       | 294675-51-7 | Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560 TP)                                                                                                                                                                 | 4    |
| 2B04       | 3001-98-7   | 3,9-Dimethyl-2,4,8,10-tetraoxa-3,9-diphosphaspiro[5.5]undecane 3,9-dioxide                                                                                                                                                    | 5    |
| 2B04       | 363626-50-0 | Bis(polyoxyethylene) methylphosphonate                                                                                                                                                                                        | 6    |
| 2B04       | 41203-81-0  | (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate                                                                                                                                          | 7    |
| 2B04       | 42595-45-9  | Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate                                                                                                                                            | 8    |
| 2B04       | 4708-04-7   | Propylphosphonic dichloride                                                                                                                                                                                                   | 9    |
| 2B04       | 63747-58-0  | Poly(1,3-phenylene methyl phosphonate)                                                                                                                                                                                        | 10   |
| 2B04       | 663176-00-9 | Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560)                                                                                                                                                                    | 11   |
| 2B04       | 676-97-1    | Methylphosphonic dichloride                                                                                                                                                                                                   | 12   |
| 2B04       | 68957-94-8  | 2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide                                                                                                                                                               | 13   |
| 2B04       | 70715-06-9  | Dimethylmethylphosphonate, polymer with oxirane and phosphorus oxide                                                                                                                                                          | 14   |
| 2B04       | 7526-26-3   | Diphenyl methylphosphonate                                                                                                                                                                                                    | 15   |
| 2B04       | 756-79-6    | Dimethyl methylphosphonate                                                                                                                                                                                                    | 16   |

| Schedule 2 | CAS RN     | Chemical Name                                                                    | Page |
|------------|------------|----------------------------------------------------------------------------------|------|
| 2B04       | 78-38-6    | Diethyl ethylphosphonate                                                         | 17   |
| 2B04       | 84402-58-4 | Methylphosphonic acid with (aminoiminomethyl)urea (1:1)                          | 18   |
| 2B04       | 849-29-6   | O-(3-chloropropyl) O-[4-nitro-3-(trifluoromethyl)phenyl] methylphosphonothionate | 19   |
| 2B04       | 84962-98-1 | Sodium 3-(trihydroxysilyl)propyl methylphosphonate                               | 20   |
| 2B04       | 993-13-5   | Methylphosphonic acid                                                            | 21   |
| 2B04       | 99580-93-5 | Product from the reaction of Methylphosphonic acid and 1,2-Ethanediamine         | 22   |
| 2B08       | 76-93-7    | 2,2-Diphenyl-2-hydroxyacetic acid                                                | 23   |
| 2B09       | 1619-34-7  | 3-Quinuclidinol                                                                  | 24   |
| 2B09       | 25333-42-0 | R-(-)-3-Quinuclidinol                                                            | 25   |
| 2B10       | 4261-68-1  | 2-(N,N-Diisopropylamino)ethylchloride hydrochloride                              | 26   |
| 2B10       | 4584-46-7  | 2-(N,N-Dimethylamino)ethylchloride hydrochloride                                 | 27   |
| 2B10       | 869-24-9   | 2-(N,N-Diethylamino)ethylchloride hydrochloride                                  | 28   |
| 2B11       | 96-80-0    | 2-(N,N-Diisopropylamino)ethanol                                                  | 29   |
| 2B12       | 100-38-9   | 2-(N,N-Diethylamino)ethanethiol                                                  | 30   |
| 2B12       | 108-02-1   | 2-(N,N-Dimethylamino)ethanethiol                                                 | 31   |
| 2B13       | 111-48-8   | Bis(2-hydroxyethyl)sulfide                                                       | 32   |

| <b>Schedule 3</b> | <b>CAS RN</b> | <b>Chemical Name</b>     | <b>Page</b> |
|-------------------|---------------|--------------------------|-------------|
| 3A01              | 75-44-5       | Carbonyl dichloride      | 33          |
| 3A02              | 506-77-4      | Cyanogen chloride        | 34          |
| 3A03              | 74-90-8       | Hydrogen cyanide         | 35          |
| 3A04              | 76-06-2       | Trichloronitromethane    | 36          |
| 3B05              | 10025-87-3    | Phosphorus oxychloride   | 37          |
| 3B06              | 7719-12-2     | Phosphorus trichloride   | 38          |
| 3B07              | 10026-13-8    | Phosphorus pentachloride | 39          |
| 3B08              | 121-45-9      | Trimethyl phosphite      | 40          |
| 3B09              | 122-52-1      | Triethyl phosphite       | 41          |
| 3B10              | 868-85-9      | Dimethyl phosphite       | 42          |
| 3B11              | 762-04-9      | Diethyl phosphite        | 43          |
| 3B12              | 10025-67-9    | Sulfur monochloride      | 44          |
| 3B13              | 10545-99-0    | Sulfur dichloride        | 45          |
| 3B14              | 7719-09-7     | Thionyl chloride         | 46          |
| 3B15              | 139-87-7      | Ethyldiethanolamine      | 47          |
| 3B16              | 105-59-9      | Methyldiethanolamine     | 48          |
| 3B17              | 102-71-6      | Triethanolamine          | 49          |

## Most Traded Scheduled Chemicals ordered by CAS RN

| CAS RN      | Schedule | Chemical Name                                                                                                                                                                                                                 | Page |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 10025-67-9  | 3B12     | Sulfur monochloride                                                                                                                                                                                                           | 44   |
| 10025-87-3  | 3B05     | Phosphorus oxychloride                                                                                                                                                                                                        | 37   |
| 10026-13-8  | 3B07     | Phosphorus pentachloride                                                                                                                                                                                                      | 39   |
| 100-38-9    | 2B12     | 2-(N,N-Diethylamino)ethanethiol                                                                                                                                                                                               | 30   |
| 102-71-6    | 3B17     | Triethanolamine                                                                                                                                                                                                               | 49   |
| 10545-99-0  | 3B13     | Sulfur dichloride                                                                                                                                                                                                             | 45   |
| 105-59-9    | 3B16     | Methyldiethanolamine                                                                                                                                                                                                          | 48   |
| 108-02-1    | 2B12     | 2-(N,N-Dimethylamino)ethanethiol                                                                                                                                                                                              | 31   |
| 111-48-8    | 2B13     | Bis(2-hydroxyethyl)sulfide                                                                                                                                                                                                    | 32   |
| 121-45-9    | 3B08     | Trimethyl phosphite                                                                                                                                                                                                           | 40   |
| 122-52-1    | 3B09     | Triethyl phosphite                                                                                                                                                                                                            | 41   |
| 129788-86-9 | 2B04     | Product from the reaction of Methylphosphonic acid and 1,3,5-Triazine-2,4,6-triamine                                                                                                                                          | 1    |
| 139-87-7    | 3B15     | Ethyldiethanolamine                                                                                                                                                                                                           | 47   |
| 1619-34-7   | 2B09     | 3-Quinuclidinol                                                                                                                                                                                                               | 24   |
| 170836-68-7 | 2B04     | Mixture of (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate (CAS RN 41203-81-0) and Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl]methylphosphonate (CAS RN 42595-45-9) | 2    |

| CAS RN      | Schedule | Chemical Name                                                                        | Page |
|-------------|----------|--------------------------------------------------------------------------------------|------|
| 18755-43-6  | 2B04     | Dimethyl propylphosphonate                                                           | 3    |
| 25333-42-0  | 2B09     | R-(-)-3-Quinuclidinol                                                                | 25   |
| 294675-51-7 | 2B04     | Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560 TP)                        | 4    |
| 3001-98-7   | 2B04     | 3,9-Dimethyl-2,4,8,10-tetraoxa-3,9-diphosphaspiro[5.5]undecane 3,9-dioxide           | 5    |
| 363626-50-0 | 2B04     | Bis(polyoxyethylene) methylphosphonate                                               | 6    |
| 41203-81-0  | 2B04     | (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate | 7    |
| 42595-45-9  | 2B04     | Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate   | 8    |
| 4261-68-1   | 2B10     | 2-(N,N-Diisopropylamino)ethylchloride hydrochloride                                  | 26   |
| 4584-46-7   | 2B10     | 2-(N,N-Dimethylamino)ethylchloride hydrochloride                                     | 27   |
| 4708-04-7   | 2B04     | Propylphosphonic dichloride                                                          | 9    |
| 506-77-4    | 3A02     | Cyanogen chloride                                                                    | 34   |
| 63747-58-0  | 2B04     | Poly(1,3-phenylene methyl phosphonate)                                               | 10   |
| 663176-00-9 | 2B04     | Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560)                           | 11   |
| 676-97-1    | 2B04     | Methylphosphonic dichloride                                                          | 12   |
| 68957-94-8  | 2B04     | 2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide                      | 13   |
| 70715-06-9  | 2B04     | Dimethylmethylphosphonate, polymer with oxirane and phosphorus oxide                 | 14   |
| 74-90-8     | 3A03     | Hydrogen cyanide                                                                     | 35   |

| CAS RN     | Schedule | Chemical Name                                                                    | Page |
|------------|----------|----------------------------------------------------------------------------------|------|
| 7526-26-3  | 2B04     | Diphenyl methylphosphonate                                                       | 15   |
| 75-44-5    | 3A01     | Carbonyl dichloride                                                              | 33   |
| 756-79-6   | 2B04     | Dimethyl methylphosphonate                                                       | 16   |
| 76-06-2    | 3A04     | Trichloronitromethane                                                            | 36   |
| 762-04-9   | 3B11     | Diethyl phosphite                                                                | 43   |
| 76-93-7    | 2B08     | 2,2-Diphenyl-2-hydroxyacetic acid                                                | 23   |
| 7719-09-7  | 3B14     | Thionyl chloride                                                                 | 46   |
| 7719-12-2  | 3B06     | Phosphorus trichloride                                                           | 38   |
| 78-38-6    | 2B04     | Diethyl ethylphosphonate                                                         | 17   |
| 84402-58-4 | 2B04     | Methylphosphonic acid with (aminoiminomethyl)urea (1:1)                          | 18   |
| 849-29-6   | 2B04     | O-(3-chloropropyl) O-[4-nitro-3-(trifluoromethyl)phenyl] methylphosphonothionate | 19   |
| 84962-98-1 | 2B04     | Sodium 3-(trihydroxysilyl)propyl methylphosphonate                               | 20   |
| 868-85-9   | 3B10     | Dimethyl phosphite                                                               | 42   |
| 869-24-9   | 2B10     | 2-(N,N-Diethylamino)ethylchloride hydrochloride                                  | 28   |
| 96-80-0    | 2B11     | 2-(N,N-Diisopropylamino)ethanol                                                  | 29   |
| 993-13-5   | 2B04     | Methylphosphonic acid                                                            | 21   |
| 99580-93-5 | 2B04     | Product from the reaction of Methylphosphonic acid and 1,2-Ethanediamine         | 22   |

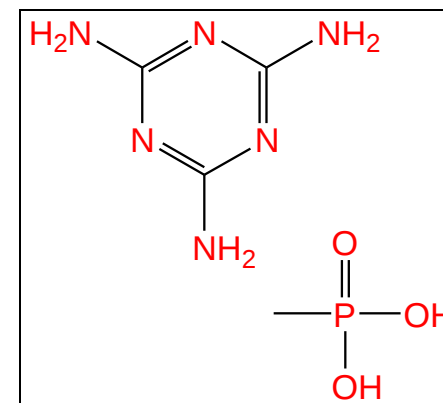
## Correlation table between the previous version of HS 2017 and current version of HS 2022

| N   | CAS         | Chemical Name                                                                                                                                                                                                                  | Schedule | HS 2017 | HS 2022 |
|-----|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|---------|
| 1.  | 170836-68-7 | Mixture of (5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate (CAS RN 41203-81-0) and Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate (CAS RN 42595-45-9) | 2B04     | 3824.91 | 3824.91 |
| 2.  | 18755-43-6  | Dimethyl propylphosphonate                                                                                                                                                                                                     | 2B04     | 2931.32 | 2931.42 |
| 3.  | 41203-81-0  | (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate                                                                                                                                           | 2B04     | 2931.36 | 2931.47 |
| 4.  | 42595-45-9  | Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate                                                                                                                                             | 2B04     | 2931.37 | 2931.49 |
| 5.  | 68957-94-8  | 2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide                                                                                                                                                                | 2B04     | 2931.35 | 2931.46 |
| 6.  | 756-79-6    | Dimethyl methylphosphonate                                                                                                                                                                                                     | 2B04     | 2931.31 | 2931.41 |
| 7.  | 78-38-6     | Diethyl ethylphosphonate                                                                                                                                                                                                       | 2B04     | 2931.33 | 2931.43 |
| 8.  | 84402-58-4  | Methylphosphonic acid with (aminoiminomethyl)urea (1:1)                                                                                                                                                                        | 2B04     | 2931.38 | 2931.45 |
| 9.  | 84962-98-1  | Sodium 3-(trihydroxysilyl)propyl methylphosphonate                                                                                                                                                                             | 2B04     | 2931.34 | 2931.49 |
| 10. | 76-93-7     | 2,2-Diphenyl-2-hydroxyacetic acid                                                                                                                                                                                              | 2B08     | 2918.17 | 2918.17 |
| 11. | 4261-68-1   | 2-(N,N-Diisopropylamino)ethylchloride hydrochloride                                                                                                                                                                            | 2B10     | 2921.14 | 2921.14 |
| 12. | 4584-46-7   | 2-(N,N-Dimethylamino)ethylchloride hydrochloride                                                                                                                                                                               | 2B10     | 2921.12 | 2921.12 |
| 13. | 869-24-9    | 2-(N,N-Diethylamino)ethylchloride hydrochloride                                                                                                                                                                                | 2B10     | 2921.13 | 2921.13 |
| 14. | 96-80-0     | 2-(N,N-Diisopropylamino)ethanol                                                                                                                                                                                                | 2B11     | 2922.18 | 2922.18 |
| 15. | 100-38-9    | 2-(N,N-Diethylamino)ethanethiol                                                                                                                                                                                                | 2B12     | 2930.60 | 2930.60 |
| 16. | 111-48-8    | Bis(2-hydroxyethyl)sulfide                                                                                                                                                                                                     | 2B13     | 2930.70 | 2930.70 |
| 17. | 75-44-5     | Carbonyl dichloride                                                                                                                                                                                                            | 3A01     | 2812.11 | 2812.11 |
| 18. | 506-77-4    | Cyanogen chloride                                                                                                                                                                                                              | 3A02     | 2853.10 | 2853.10 |
| 19. | 74-90-8     | Hydrogen cyanide                                                                                                                                                                                                               | 3A03     | 2811.12 | 2811.12 |
| 20. | 76-06-2     | Trichloronitromethane                                                                                                                                                                                                          | 3A04     | 2904.91 | 2904.91 |
| 21. | 10025-87-3  | Phosphorus oxychloride                                                                                                                                                                                                         | 3B05     | 2812.12 | 2812.12 |
| 22. | 7719-12-2   | Phosphorus trichloride                                                                                                                                                                                                         | 3B06     | 2812.13 | 2812.13 |

|     |             |                                                                                      |      |         |         |
|-----|-------------|--------------------------------------------------------------------------------------|------|---------|---------|
| 23. | 10026-13-8  | Phosphorus pentachloride                                                             | 3B07 | 2812.14 | 2812.14 |
| 24. | 121-45-9    | Trimethyl phosphite                                                                  | 3B08 | 2920.23 | 2920.23 |
| 25. | 122-52-1    | Triethyl phosphite                                                                   | 3B09 | 2920.24 | 2920.24 |
| 26. | 868-85-9    | Dimethyl phosphite                                                                   | 3B10 | 2920.21 | 2920.21 |
| 27. | 762-04-9    | Diethyl phosphite                                                                    | 3B11 | 2920.22 | 2920.22 |
| 28. | 10025-67-9  | Sulfur monochloride                                                                  | 3B12 | 2812.15 | 2812.15 |
| 29. | 10545-99-0  | Sulfur dichloride                                                                    | 3B13 | 2812.16 | 2812.16 |
| 30. | 7719-09-7   | Thionyl chloride                                                                     | 3B14 | 2812.17 | 2812.17 |
| 31. | 139-87-7    | Ethyldiethanolamine                                                                  | 3B15 | 2922.17 | 2922.17 |
| 32. | 105-59-9    | Methyldiethanolamine                                                                 | 3B16 | 2922.17 | 2922.17 |
| 33. | 102-71-6    | Triethanolamine                                                                      | 3B17 | 2922.15 | 2922.15 |
| 34. | 108-02-1    | 2-(N,N-Dimethylamino)ethanethiol                                                     | 2B12 | 2930.90 | 2930.10 |
| 35. | 129788-86-9 | Product from the reaction of Methylphosphonic acid and 1,3,5-Triazine-2,4,6-triamine | 2B04 | -----   | -----   |
| 36. | 1619-34-7   | 3-Quinuclidinol                                                                      | 2B09 | 2933.39 | 2933.35 |
| 37. | 25333-42-0  | R-(-)-3-Quinuclidinol                                                                | 2B09 | 2933.39 | 2933.35 |
| 38. | 3001-98-7   | 3,9-Dimethyl-2,4,8,10-tetraoxa-3,9-diphosphaspiro[5.5]undecane 3,9-dioxide           | 2B04 | 2931.39 | 2931.48 |
| 39. | 4708-04-7   | Propylphosphonic dichloride                                                          | 2B04 | 2931.39 | 2931.52 |
| 40. | 676-97-1    | Methylphosphonic dichloride                                                          | 2B04 | 2931.39 | 2931.51 |
| 41. | 7526-26-3   | Diphenyl methylphosphonate                                                           | 2B04 | 2931.39 | 2931.49 |
| 42. | 849-29-6    | O-(3-chloropropyl) O-[4-nitro-3-(trifluoromethyl)phenyl] methylphosphonothionate     | 2B04 | 2931.39 | 2931.53 |
| 43. | 993-13-5    | Methylphosphonic acid                                                                | 2B04 | 2931.39 | 2931.44 |
| 44. | 99580-93-5  | Product from the reaction of methylphosphonic acid and 1,2-ethanediamine             | 2B04 | -----   | -----   |
| 45. | 294675-51-7 | Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560 TP)                        | 2B04 | 3824.99 | 3824.92 |
| 46. | 663176-00-9 | Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560)                           | 2B04 | 3824.99 | 3824.92 |
| 47. | 363626-50-0 | Bis(polyoxyethylene) methylphosphonate                                               | 2B04 | 3907.20 | 3907.21 |
| 48. | 63747-58-0  | Poly(1,3-phenylene methyl phosphonate)                                               | 2B04 | 3911.90 | 3911.20 |
| 49. | 70715-06-9  | Dimethylmethylphosphonate, polymer with oxirane and phosphorus oxide                 | 2B04 | 3824.99 | 3824.99 |

|                          |                                                                                             |
|--------------------------|---------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>    | <b>Product from the reaction of Methylphosphonic acid and 1,3,5-Triazine-2,4,6-triamine</b> |
| <b>CAS RN:</b>           | 129788-86-9                                                                                 |
| <b>Schedule:</b>         | 2B04                                                                                        |
| <b>HS code:</b>          | -----                                                                                       |
| <b>Molecular Formula</b> | $C_3H_6N_6 \cdot CH_5O_3P$                                                                  |
| <b>CAS Index Name:</b>   | Phosphonic acid, P-methyl-, compd. with 1,3,5-triazine-2,4,6-triamine (1:1)                 |
| <b>IUPAC Name:</b>       |                                                                                             |
| <b>Synonyms:</b>         |                                                                                             |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used as flame retardant.

**Chemical Name:** Mixture of (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate (CAS RN 41203-81-0) and Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl]methylphosphonate (CAS RN 42595-45-9)

**CAS RN:** 170836-68-7

**Schedule:** 2B04

**HS code:** 3824.91

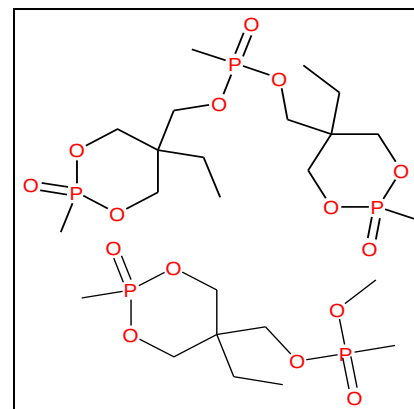
**Molecular Formula**  $C_{15}H_{31}O_9P_3 \cdot C_9H_{20}O_6P_2$

**CAS Index Name:** Phosphonic acid, P-methyl-, bis[(5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphorinan-5-yl)methyl] ester, mixt. with (5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphorinan-5-yl)methyl methyl P-methylphosphonate

**IUPAC Name:**

**Synonyms:** Preflam  
 Pekoflam PES CN Liquid Concentrate  
 Mixture of CAS RN 41203-81-0 and CAS RN 42595-45-9  
 Flacavon  
 Antiblact  
 Antiblance U  
 Amgard 1045  
 Aflammit

### Chemical Structure

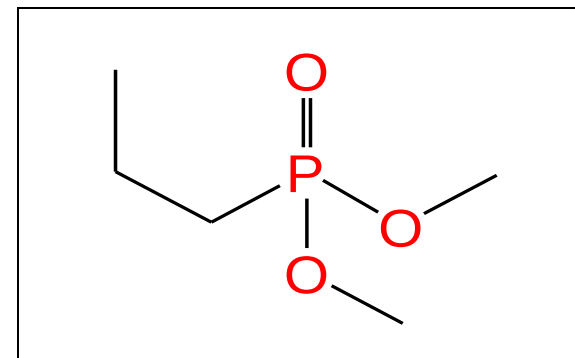


### Commercial Applications & Industrial Uses

Flame retardant used for polyester fabrics and in textile coating applications.

|                          |                                          |
|--------------------------|------------------------------------------|
| <b>Chemical Name:</b>    | <b>Dimethyl propylphosphonate</b>        |
| <b>CAS RN:</b>           | 18755-43-6                               |
| <b>Schedule:</b>         | 2B04                                     |
| <b>HS code:</b>          | 2931.42                                  |
| <b>Molecular Formula</b> | $C_5H_{13}O_3P$                          |
| <b>CAS Index Name:</b>   | Phosphonic acid, propyl-, dimethyl ester |
| <b>IUPAC Name:</b>       | Dimethyl propylphosphonate               |
| <b>Synonyms:</b>         |                                          |

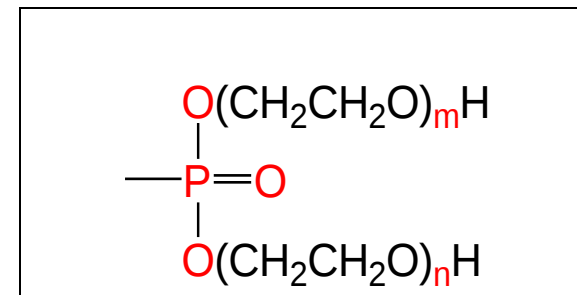
#### Chemical Structure



#### Commercial Applications & Industrial Uses

Flame retardant used for rigid polyurethane (PU) and polyisocyanurate foams.

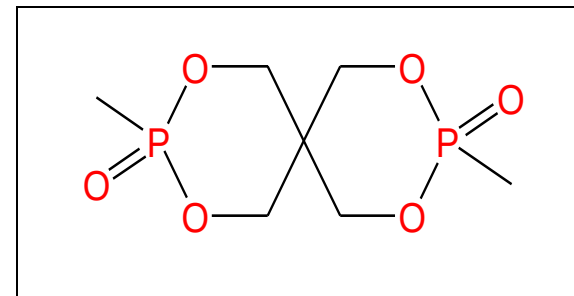
|                          |                                                                      |
|--------------------------|----------------------------------------------------------------------|
| <b>Chemical Name:</b>    | <b>Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560 TP)</b> |
| <b>CAS RN:</b>           | 294675-51-7                                                          |
| <b>Schedule:</b>         | 2B04                                                                 |
| <b>HS code:</b>          | 3824.92                                                              |
| <b>Molecular Formula</b> | Unspecified                                                          |
| <b>CAS Index Name:</b>   | Phosphonic acid, methyl-, polyglycol ester                           |
| <b>IUPAC Name:</b>       |                                                                      |
| <b>Synonyms:</b>         | Exolit OP 560 TP (Test Product)                                      |

**Chemical Structure****Commercial Applications & Industrial Uses**

Flame retardant used in production of polyurethane (PU) foams.

|                           |                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>3,9-Dimethyl-2,4,8,10-tetraoxa-3,9-diphosphaspiro[5.5]undecane 3,9-dioxide</b>                                                                                                                                                                                                             |
| <b>CAS RN:</b>            | 3001-98-7                                                                                                                                                                                                                                                                                     |
| <b>Schedule:</b>          | 2B04                                                                                                                                                                                                                                                                                          |
| <b>HS code:</b>           | 2931.48                                                                                                                                                                                                                                                                                       |
| <b>Molecular Formula:</b> | $C_7H_{14}O_6P_2$                                                                                                                                                                                                                                                                             |
| <b>CAS Index Name:</b>    | 2,4,8,10-Tetraoxa-3,9-diphosphaspiro[5.5]undecane, 3,9-dimethyl-, 3,9-dioxide                                                                                                                                                                                                                 |
| <b>IUPAC Name:</b>        | 3,9-Dimethyl-2,4,8,10-tetraoxa-3,9-diphosphaspiro[5.5]undecane 3,9-dioxide                                                                                                                                                                                                                    |
| <b>Synonyms:</b>          | Phosphonic acid, methyl-, cyclic neopentetetrayl ester<br>Phosphonic acid, methyl-, cyclic diester with pentaerythritol<br>Pentaerythritol spirobis(methylphosphonate)<br>Pentaerythritol bis(methanephosphonate)<br>3,9-Dimethyl-3,9-dioxa-2,4,8,10-tetraoxa-3,9-diphosphaspiro-5,5 undecane |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used as flame retardant and moulding material.

**Chemical Name:** Bis(polyoxyethylene) methylphosphonate

**CAS RN:** 363626-50-0

**Schedule:** 2B04

**HS code:** 3907.21

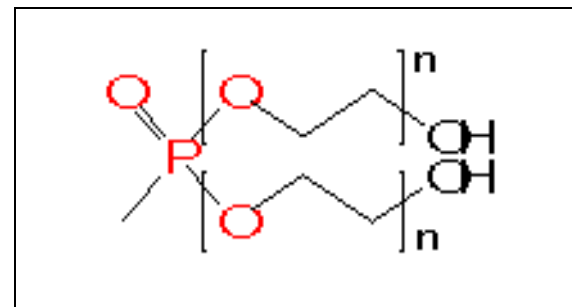
**Molecular Formula:**  $(C_2H_4O)_n (C_2H_4O)_n CH_5O_3P$

**CAS Index Name:** Poly(oxy-1,2-ethanediyl),  $\alpha, \alpha'$ -(methylphosphinylidene)bis[ $\omega$ -hydroxy-

**IUPAC Name:**

**Synonyms:** Polyethylene glycol methylphosphonate (2:1)

#### Chemical Structure

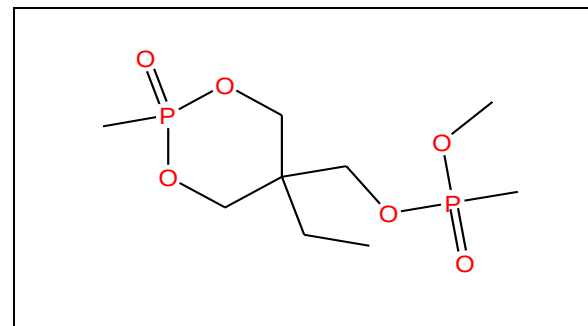


#### Commercial Applications & Industrial Uses

Flame retardant used in the production of polyurethane (PU) foams.

|                           |                                                                                                        |
|---------------------------|--------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate</b>            |
| <b>CAS RN:</b>            | 41203-81-0                                                                                             |
| <b>Schedule:</b>          | 2B04                                                                                                   |
| <b>HS code:</b>           | 2931.47                                                                                                |
| <b>Molecular Formula:</b> | $C_9H_{20}O_6P_2$                                                                                      |
| <b>CAS Index Name:</b>    | Phosphonic acid, methyl-, (5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphorinan-5-yl) methyl methyl ester  |
| <b>IUPAC Name:</b>        | (5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methyl methylphosphonate                   |
| <b>Synonyms:</b>          | Phosphonic acid, methyl-, (5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl) methyl methyl ester, P-oxide |

#### Chemical Structure

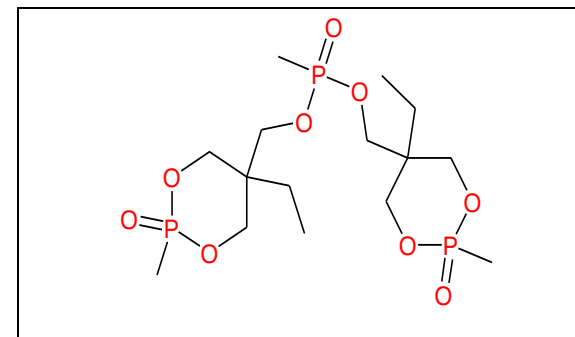


#### Commercial Applications & Industrial Uses

Flame retardant used for: polyester fabrics, furnishing, curtaining, building and automotive applications.

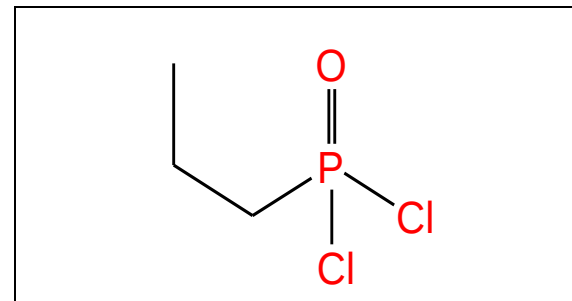
|                           |                                                                                                                                |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Bis[(5-Ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate</b>                                      |
| <b>CAS RN:</b>            | 42595-45-9                                                                                                                     |
| <b>Schedule:</b>          | 2B04                                                                                                                           |
| <b>HS code:</b>           | 2931.49                                                                                                                        |
| <b>Molecular Formula:</b> | C <sub>15</sub> H <sub>31</sub> O <sub>9</sub> P <sub>3</sub>                                                                  |
| <b>CAS Index Name:</b>    | Phosphonic acid, methyl-, bis[(5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphorinan-5-yl)methyl] ester                             |
| <b>IUPAC Name:</b>        | Bis[(5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate                                             |
| <b>Synonyms:</b>          | Phosphonic acid, methyl-, bis[(5-ethyl-2-methyl-1,3,2-dioxaphosphorinan-5-yl)methyl] ester, P,P'-dioxide<br><br>Antiblaze 1045 |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used as flame retardant.

**Chemical Name:** Propylphosphonic dichloride**CAS RN:** 4708-04-7**Schedule:** 2B04**HS code:** 2931.52**Molecular Formula:**  $\text{C}_3\text{H}_7\text{Cl}_2\text{OP}$ **CAS Index Name:** Phosphonic dichloride, propyl-**IUPAC Name:** Propylphosphonic dichloride**Synonyms:** Propylphosphonyl dichloride  
Propanephosphonyl chloride  
Dichloropropylphosphine oxide**Chemical Structure****Commercial Applications & Industrial Uses**

Used as pharmaceutical intermediate and for biochemical research.

**Chemical Name:** Poly(1,3-phenylene methyl phosphonate)

**CAS RN:** 63747-58-0

**Schedule:** 2B04

**HS code:** 3911.20

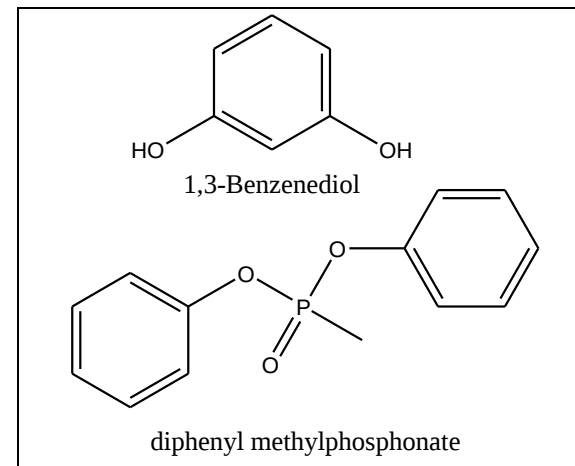
**Molecular Formula:**  $(C_{13}H_{13}O_3P.C_6H_6O_2)_x$

**CAS Index Name:** Phosphonic acid, P-methyl-, diphenyl ester, polymer with 1,3-benzenediol

**IUPAC Name:**

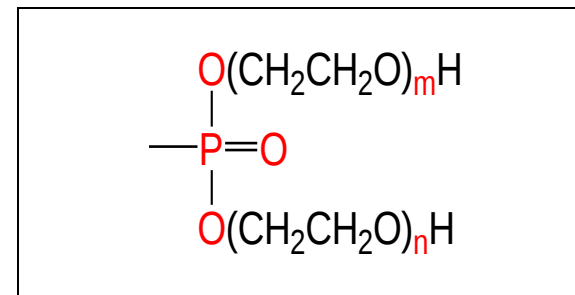
**Synonyms:** Phosphonic acid, methyl-, diphenyl ester, polymer with 1,3-benzenediol  
Diphenyl methylphosphonate-resorcinol copolymer  
1,3-Benzenediol, polymer with diphenyl methylphosphonate

#### Chemical Structure



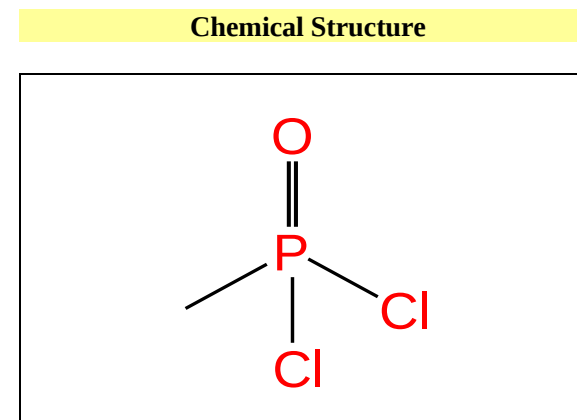
#### Commercial Applications & Industrial Uses

Flame retardant and curing agent for epoxy resin.

**Chemical Name:** Phosphonic acid, methyl-, polyglycol ester (Exolit OP 560)**CAS RN:** 663176-00-9**Schedule:** 2B04**HS code:** 3824.92**Molecular Formula:** Unspecified**CAS Index Name:** Phosphonic acid, methyl-, polyglycol ester**IUPAC Name:****Synonyms:** Exolit OP 560**Chemical Structure****Commercial Applications & Industrial Uses**

Used as flame retardant.

|                           |                                                                                                                                                                                                                                                                          |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Methylphosphonic dichloride</b>                                                                                                                                                                                                                                       |
| <b>CAS RN:</b>            | 676-97-1                                                                                                                                                                                                                                                                 |
| <b>Schedule:</b>          | 2B04                                                                                                                                                                                                                                                                     |
| <b>HS code:</b>           | 2931.51                                                                                                                                                                                                                                                                  |
| <b>Molecular Formula:</b> | $\text{CH}_3\text{Cl}_2\text{OP}$                                                                                                                                                                                                                                        |
| <b>CAS Index Name:</b>    | Phosphonic dichloride, methyl-                                                                                                                                                                                                                                           |
| <b>IUPAC Name:</b>        | Methylphosphonic dichloride                                                                                                                                                                                                                                              |
| <b>Synonyms:</b>          | Methylphosphonyl dichloride<br>Methylphosphonyl chloride<br>Methylphosphonodichloridic acid<br>Methylphosphonic acid dichloride<br>Methanephosphonyl dichloride<br>Methanephosphonyl chloride<br>Methanephosphonodichloridic acid<br>Dichloromethylphosphine oxide<br>DC |

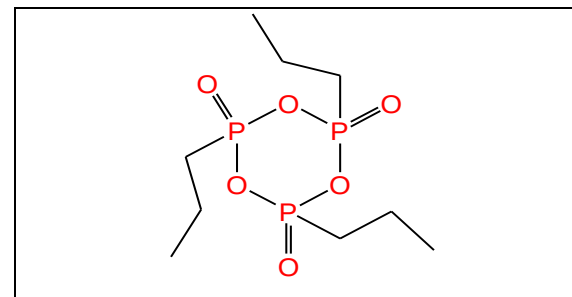


#### Commercial Applications & Industrial Uses

Used as chlorinating agent, chemical intermediate and raw material to produce Phosdiol-A and Phospolyol-2, hydroxilated esters of Methyl phosphonic acid in oligomeric forms used as fire retardants in self-extinguish mixtures in aircraft industry.

|                           |                                                                                                                                                                                   |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide</b>                                                                                                            |
| <b>CAS RN:</b>            | 68957-94-8                                                                                                                                                                        |
| <b>Schedule:</b>          | 2B04                                                                                                                                                                              |
| <b>HS code:</b>           | 2931.46                                                                                                                                                                           |
| <b>Molecular Formula:</b> | $C_9H_{21}O_6P_3$                                                                                                                                                                 |
| <b>CAS Index Name:</b>    | 1,3,5,2,4,6-Trioxatriphosphorinane, 2,4,6-tripropyl-, 2,4,6-trioxide                                                                                                              |
| <b>IUPAC Name:</b>        | 2,4,6-Tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide                                                                                                                   |
| <b>Synonyms:</b>          | Propylphosphonic anhydride<br>n-Propylphosphonic cyclic anhydride<br>1-Propanephosphonic acid cyclic anhydride, 50% in ethyl acetate<br>1-Propanephosphonic acid cyclic anhydride |

#### Chemical Structure



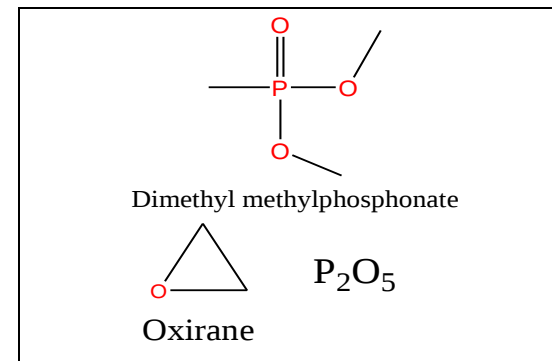
#### Commercial Applications & Industrial Uses

Used in: paper industry, pharmaceutical industry, plastics and synthetic resin industries, and peptide synthesis.

Used as flame retardant and paper making auxiliaries.

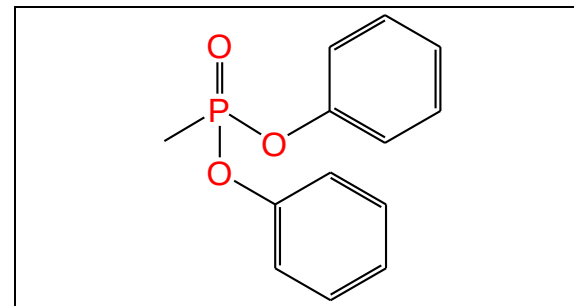
|                           |                                                                                                  |
|---------------------------|--------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Dimethylmethylphosphonate, polymer with oxirane and phosphorus oxide</b>                      |
| <b>CAS RN:</b>            | 70715-06-9                                                                                       |
| <b>Schedule:</b>          | 2B04                                                                                             |
| <b>HS code:</b>           | 3824.99                                                                                          |
| <b>Molecular Formula:</b> | $(C_3H_9O_3P.C_2H_4O.O_5P_2)_x$                                                                  |
| <b>CAS Index Name:</b>    | Phosphonic acid, methyl-, dimethyl ester, polymer with oxirane and phosphorus oxide( $P_2O_5$ )  |
| <b>IUPAC Name:</b>        |                                                                                                  |
| <b>Synonyms:</b>          | Phosphorus oxide, polymer with dimethyl methylphosphonate and oxirane<br>Fyroltex HP<br>Fyrol 51 |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

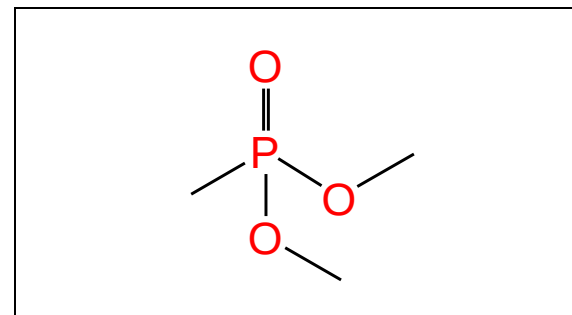
Used as flame retardant.

**Chemical Name:** Diphenyl methylphosphonate**CAS RN:** 7526-26-3**Schedule:** 2B04**HS code:** 2931.49**Molecular Formula:**  $C_{13}H_{13}O_3P$ **CAS Index Name:** Phosphonic acid, methyl-, diphenyl ester**IUPAC Name:** Diphenyl methylphosphonate**Synonyms:** Diphenyl methanephosphonate**Chemical Structure****Commercial Applications & Industrial Uses**

Used as flame retardant.

**Chemical Name:** Dimethyl methylphosphonate**CAS RN:** 756-79-6**Schedule:** 2B04**HS code:** 2931.41**Molecular Formula:**  $C_3H_9O_3P$ **CAS Index Name:** Phosphonic acid, methyl-, dimethyl ester**IUPAC Name:** Dimethyl methylphosphonate

**Synonyms:** Reoflam DMMP  
 O,O-Dimethyl methylphosphonate  
 NSC 62240  
 Methylphosphonic acid dimethyl ester  
 Methanephosphonic acid dimethyl ester  
 Metaran  
 Fyrol DMMP  
 Fran TF 2000  
 DMMP  
 Dimethyl methanephosphonate  
 Dimethoxymethyl phosphine oxide

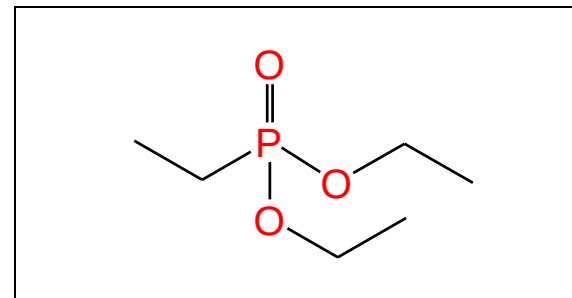
**Chemical Structure****Commercial Applications & Industrial Uses**

Used in production of flame retardants for: resins, building materials, furnishings, transportation equipment and fittings.

Used in electrical industry (cables, housing), upholstery and as a lubricant additive.

**Chemical Name:** Diethyl ethylphosphonate**CAS RN:** 78-38-6**Schedule:** 2B04**HS code:** 2931.43**Molecular Formula:**  $C_6H_{15}O_3P$ **CAS Index Name:** Phosphonic acid, ethyl-, diethyl ester**IUPAC Name:** Diethyl ethylphosphonate

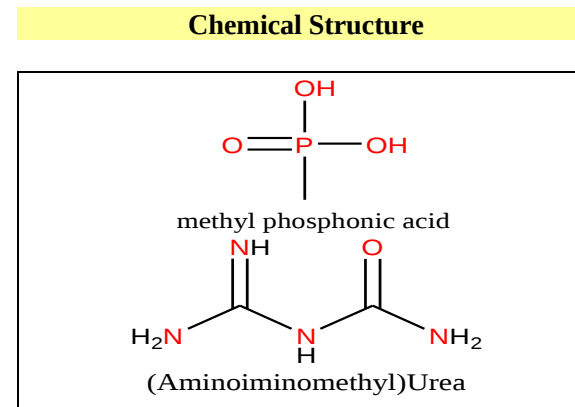
**Synonyms:** Diethyl ethanephosphonate  
Diethoxyethylphosphine oxide  
DEEP  
Amgard V 490  
Antiblaze V 490  
NSC 2671

**Chemical Structure****Commercial Applications & Industrial Uses**

Used as flame retardant, gasoline additive and raw material for insecticides.

Used as stabiliser and antioxidant for plastics.

|                           |                                                                                                                                         |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Methylphosphonic acid with (aminoiminomethyl)urea (1:1)</b>                                                                          |
| <b>CAS RN:</b>            | 84402-58-4                                                                                                                              |
| <b>Schedule:</b>          | 2B04                                                                                                                                    |
| <b>HS code:</b>           | 2931.45                                                                                                                                 |
| <b>Molecular Formula:</b> | $C_2H_6N_4O \cdot CH_5O_3P$                                                                                                             |
| <b>CAS Index Name:</b>    | Phosphonic acid, P-methyl-, compd. with N-(aminoiminomethyl)urea (1:1)                                                                  |
| <b>IUPAC Name:</b>        |                                                                                                                                         |
| <b>Synonyms:</b>          | Methylphosphonic acid/aminoiminomethyl)urea (1:1)<br>Methylphosphonic acid compound with (aminoiminomethyl)urea (1:1)<br>Flammentin MSG |



#### Commercial Applications & Industrial Uses

Used as flame retardant (specifically for polyesters, polyurethane (PU) foams).

Used in production of cleaning agents and emulsifiers; used as textile improver and anti-corrosion agents.

**Chemical Name:** O-(3-chloropropyl) O-[4-nitro-3-(trifluoromethyl)phenyl] methylphosphonothionate

**CAS RN:** 849-29-6

**Schedule:** 2B04

**HS code** 2931.53

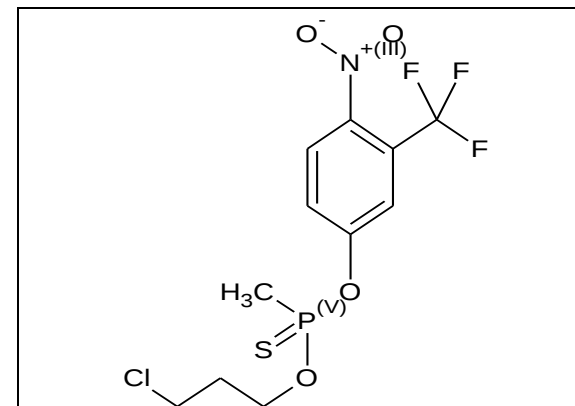
**Molecular Formula:** C<sub>11</sub>H<sub>12</sub>ClF<sub>3</sub>NO<sub>4</sub>PS

**CAS Index Name:** Phosphonothioic acid, methyl-, O-(3-chloropropyl) O-(.alpha.,.alpha.,.alpha.-trifluoro-4-nitro-m-tolyl) ester

**IUPAC Name:**

**Synonyms:**

#### Chemical Structure

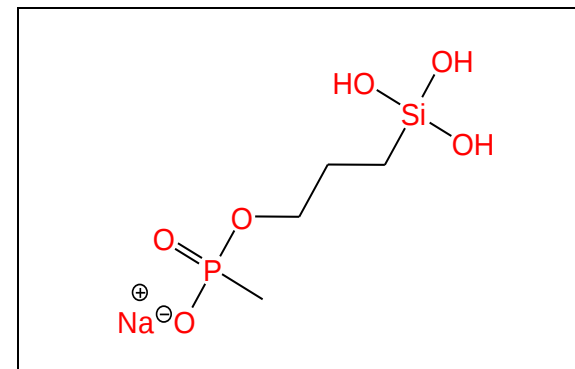


#### Commercial Applications & Industrial Uses

Used as insecticide

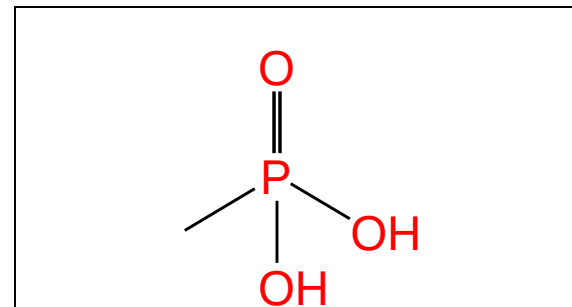
|                           |                                                                                  |
|---------------------------|----------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Sodium 3-(trihydroxysilyl)propyl methylphosphonate</b>                        |
| <b>CAS RN:</b>            | 84962-98-1                                                                       |
| <b>Schedule:</b>          | 2B04                                                                             |
| <b>HS code:</b>           | 2931.49                                                                          |
| <b>Molecular Formula:</b> | $C_4H_{12}NaO_6PSi$                                                              |
| <b>CAS Index Name:</b>    | Phosphonic acid, methyl-, mono[3-(trihydroxysilyl)propyl] ester, monosodium salt |
| <b>IUPAC Name:</b>        | Sodium 3-(trihydroxysilyl)propyl methylphosphonate                               |
| <b>Synonyms:</b>          | Methylphosphonic acid mono[3-(trihydroxysilyl)propyl] ester, monosodium salt     |

#### Chemical Structure



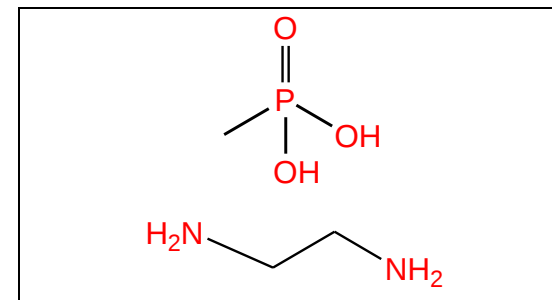
#### Commercial Applications & Industrial Uses

Used as antifreeze additive.

**Chemical Name:** Methylphosphonic acid**CAS RN:** 993-13-5**Schedule:** 2B04**HS code:** 2931.44**Molecular Formula:**  $\text{CH}_5\text{O}_3\text{P}$ **CAS Index Name:** Phosphonic acid, methyl-**IUPAC Name:** Methylphosphonic acid**Synonyms:** Methanephosphonic acid  
Dihydrogen methylphosphonate**Chemical Structure****Commercial Applications & Industrial Uses**

Used in production of flame retardants.

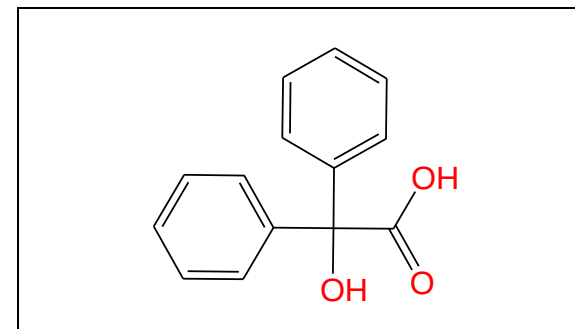
|                           |                                                                                        |
|---------------------------|----------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Product from the reaction of Methylphosphonic acid and 1,2-Ethanediamine</b>        |
| <b>CAS RN:</b>            | 99580-93-5                                                                             |
| <b>Schedule:</b>          | 2B04                                                                                   |
| <b>HS code:</b>           | -----                                                                                  |
| <b>Molecular Formula:</b> | $\text{C}_2\text{H}_8\text{N}_2 \cdot \text{CH}_5\text{O}_3\text{P}$                   |
| <b>CAS Index Name:</b>    | Phosphonic acid, methyl-, compd. with 1,2-ethanediamine (1:1)                          |
| <b>IUPAC Name:</b>        |                                                                                        |
| <b>Synonyms:</b>          | Ethylenediammonium(2+) methylphosphonate<br>1,2-Ethanediamine, methylphosphonate (1:1) |

**Chemical Structure****Commercial Applications & Industrial Uses**

Used as flame retardant.

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>2,2-Diphenyl-2-hydroxyacetic acid</b>                                                                                                                                                                                                                                                                                                                                                                             |
| <b>CAS RN:</b>            | 76-93-7                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Schedule:</b>          | 2B08                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>HS code:</b>           | 2918.17                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Molecular Formula:</b> | C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>                                                                                                                                                                                                                                                                                                                                                                       |
| <b>CAS Index Name:</b>    | Benzeneacetic acid, $\alpha$ -hydroxy- $\alpha$ -phenyl-                                                                                                                                                                                                                                                                                                                                                             |
| <b>IUPAC Name:</b>        | 2,2-Diphenyl-2-hydroxyacetic acid                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Synonyms:</b>          | NSC 2830<br>Hydroxydiphenylacetic acid<br>Hydroxy(diphenyl)acetic acid<br>Diphenylhydroxyacetic acid<br>Diphenylglycolic acid<br>Benzilic acid<br>$\alpha$ -Hydroxydiphenylacetic acid<br>$\alpha$ -Hydroxy-a-phenylbenzeneacetic acid<br>$\alpha$ -Hydroxy-2,2-diphenylacetic acid<br>$\alpha,\alpha$ -Diphenylglycolic acid<br>$\alpha,\alpha$ -Diphenyl-a-hydroxyacetic acid<br>2-Hydroxy-2,2-diphenylacetic acid |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used in broad spectrum of organic synthesis, especially as an intermediate in preparation of pharmaceuticals.

Precursor for Schedule 2A\* chemical BZ (3-Quinclidinyl benzilate).

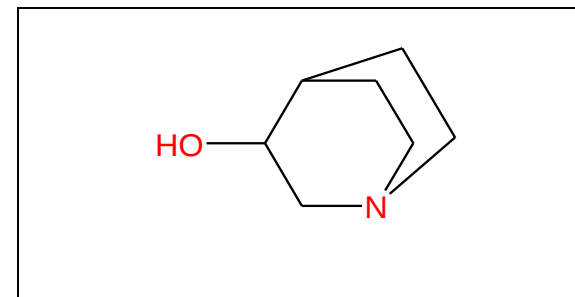
Used in the preparation of pharmaceuticals for: treatment of urinary incontinence, anticholinergics, antidepressants, antispasmodic drugs and bronchodilator, including preparation of Clinidinium bromide (via the Schedule 2A\* chemical BZ) which is used in treatment of peptic ulcers.

Used in industry of dyestuff and acaricides.

Used as precursor for Aluminium benzilic acid (ingredient of the toner).

|                           |                                                                              |
|---------------------------|------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>3-Quinuclidinol</b>                                                       |
| <b>CAS RN:</b>            | 1619-34-7                                                                    |
| <b>Schedule:</b>          | 2B09                                                                         |
| <b>HS code</b>            | 2933.35                                                                      |
| <b>Molecular Formula:</b> | C <sub>7</sub> H <sub>13</sub> NO                                            |
| <b>CAS Index Name:</b>    | 1-Azabicyclo[2.2.2]octan-3-ol                                                |
| <b>IUPAC Name:</b>        | 1-Azabicyclo[2.2.2]octan-3-ol                                                |
| <b>Synonyms:</b>          | Quinuclidin-3-ol<br>NSC-93905<br>DL-3-Quinuclidinol<br>3-Hydroxyquinuclidine |

#### Chemical Structure



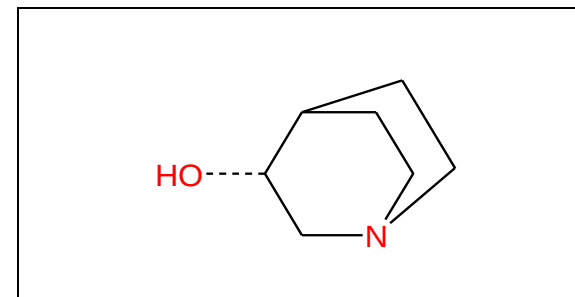
#### Commercial Applications & Industrial Uses

Used in production of pharmaceuticals including synthesis of drugs with wide range of applications such as production of Quinupramine (antidepressant), Quinupristin (antibacterial) and Clidinium bromide (via Schedule 2A\* chemical BZ).

Used as corrosion inhibitor.

|                           |                                                                                                                                                                                                                                  |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>R-(-)-3-Quinuclidinol</b>                                                                                                                                                                                                     |
| <b>CAS RN:</b>            | 25333-42-0                                                                                                                                                                                                                       |
| <b>Schedule:</b>          | 2B09                                                                                                                                                                                                                             |
| <b>HS code:</b>           | 2933.35                                                                                                                                                                                                                          |
| <b>Molecular Formula:</b> | C <sub>7</sub> H <sub>13</sub> NO                                                                                                                                                                                                |
| <b>CAS Index Name:</b>    | 1-Azabicyclo[2.2.2]octan-3-ol, (3R)-                                                                                                                                                                                             |
| <b>IUPAC Name:</b>        | (3R)-1-Azabicyclo[2.2.2]octan-3-ol                                                                                                                                                                                               |
| <b>Synonyms:</b>          | (R)-3-Quinuclidinol<br>(R)-3-Hydroxyquinuclidine<br>(R)-1-Azabicyclo[2.2.2]octan-3-ol<br>(R)-(-)-3-Quinuclidinol<br>(R)-(-)-1-Azabicyclo[2.2.2]octan-3-ol<br>(3R)-Quinuclidin-3-ol<br>(3R)-3-Quinuclidol<br>(3R)-3-Quinuclidinol |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used in production of pharmaceuticals including synthesis of drugs with wide range of applications such as production of Quinupramine (antidepressant), Quinupristin (antibacterial) and Clidinium bromide (via Schedule 2A\* chemical BZ).

Used as corrosion inhibitor.

**Chemical Name:** 2-(N,N-Diisopropylamino)ethylchloride hydrochloride

**CAS RN:** 4261-68-1

**Schedule:** 2B10

**HS code:** 2921.14

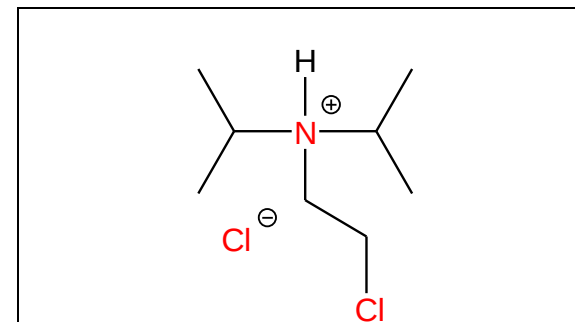
**Molecular Formula:** C<sub>8</sub>H<sub>18</sub>ClN.HCl

**CAS Index Name:** 2-Propanamine, N-(2-chloroethyl)-N-(1-methylethyl)-, hydrochloride

**IUPAC Name:** N-(2-Chloroethyl)-N-isopropylpropan-2-aminium chloride

**Synonyms:** Triethylamine, 2''-chloro-1,1'-dimethyl-, hydrochloride  
N-(2-Chloroethyl)diisopropylamine hydrochloride  
N,N-Diisopropylaminoethyl-2-chloride hydrochloride  
2-(Diisopropylamino)ethyl chloride hydrochloride  
(β-Chloroethyl)diisopropylamine hydrochloride

#### Chemical Structure

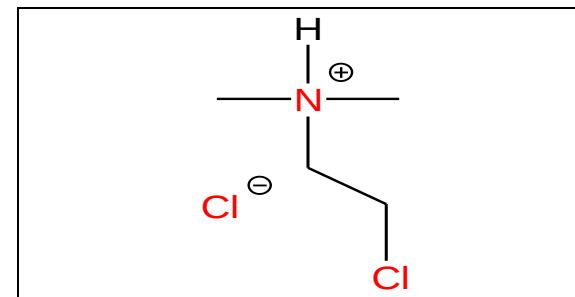


#### Commercial Applications & Industrial Uses

Used for synthesis of pharmaceutical intermediates such as anticancer flavanone-analogue preparations.

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>2-(N,N-Dimethylamino)ethylchloride hydrochloride</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>CAS RN:</b>            | 4584-46-7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Schedule:</b>          | 2B10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>HS code:</b>           | 2921.12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Molecular Formula:</b> | C <sub>4</sub> H <sub>11</sub> Cl <sub>2</sub> N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>CAS Index Name:</b>    | Ethanamine, 2-chloro-N,N-dimethyl-, hydrochloride                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>IUPAC Name:</b>        | 2-Chloro-N,N-dimethylethanaminium chloride                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Synonyms:</b>          | Chloroethyldimethylamine hydrochloride<br>(β-Chloroethyl)dimethylamine-hydrochloride<br>1-Chloro-2-(dimethylamino)ethane hydrochloride<br>2-(Dimethylamino)chloroethane hydrochloride<br>2-(Dimethylamino)ethyl chloride hydrochloride<br>2-Chloro-N,N-dimethylethanamine hydrochloride<br>2-Chloro-N,N-dimethylethylamine hydrochloride<br>2-Chloroethyl dimethyl ammonium chloride<br>(2-Chloroethyl)dimethylamine hydrochloride<br>Chloro(dimethylamino)ethane hydrochloride<br>β-Dimethylaminoethyl chloride hydrochloride<br>Dimethylaminoethyl chloride hydrochloride<br>Ethylamine, 2-chloro-N,N-dimethyl-, hydrochloride<br>N,N-Dimethyl-2-chloroethylamine hydrochloride<br>N,N-Dimethyl-N-(2-chloroethyl)amine hydrochloride<br>N,N-Dimethylaminoethyl-2-chloride hydrochloride<br>N-(2-Chloroethyl)-N,N-dimethylammonium chloride<br>N-(2-Chloroethyl)dimethylamine hydrochloride<br>2-Chloroethyldimethylamine monohydrochloride |

### Chemical Structure

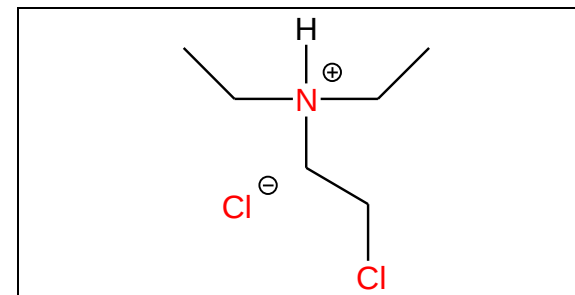


### Commercial Applications & Industrial Uses

Used in production of speciality surfactants, flocculants, agricultural chemicals, pharmaceuticals such as Iltiazem and Pyrrolopyridine (antiinflammatory), Brompheniramine aleate (antihistaminic), Chlorphenoxamine HCl (anticholinergic), Doxilamine succinate antihistaminic), Orphenadrine hydrochloride (muscle relaxant), Orphenadrine citrate (muscle relaxant), Phenyltoloxamine citrate ntihistaminic) and Chloropiramine hydrochloride antipsychotic).

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>2-(N,N-Diethylamino)ethylchloride hydrochloride</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>CAS RN:</b>            | 869-24-9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Schedule:</b>          | 2B10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>HS code:</b>           | 2921.13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Molecular Formula:</b> | C <sub>6</sub> H <sub>15</sub> Cl <sub>2</sub> N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>CAS Index Name:</b>    | Ethanamine, 2-chloro-N,N-diethyl-, hydrochloride                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>IUPAC Name:</b>        | 2-Chloro-N,N-diethylethanaminium chloride                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Synonyms:</b>          | N,N-Diethyl-2-chloroethylamine hydrochloride<br>1-Chloro-2-(diethylamino)ethane hydrochloride<br>2-(Diethylamino)ethyl chloride hydrochloric acid salt<br>2-(Diethylamino)ethyl chloride hydrochloride<br>2-(N,N-Diethylamino)ethyl chloride hydrochloride<br>2-Chloro-N,N-diethylethylamine hydrochloride<br>2-Chloroethyl-N,N-diethylamine hydrochloride<br>(2-Chloroethyl)diethylamine monohydrochloride<br>2-Chlorotriethylamine hydrochloride<br>Triethylamine, 2-chloro-, hydrochloride<br>N,N-Diethyl-β-chloroethylamine hydrochloride<br>N,N-Diethylaminoethyl chloride hydrochloride<br>N-(2-Chloroethyl)diethylamine hydrochloride<br>N-2-Chloroethyl-N,N-diethylammonium hydrochloride<br>β-(Diethylamino)ethyl chloride hydrochloride<br>β -Chloroethyldiethylamine hydrochloride<br>2-Chloroethyldiethylammonium chloride |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Gasoline additive for removal of acids from solutions.

Used in production of cationic modified starch.

Used in production of pharmaceuticals including: product DEAE-Dextran, active ingredient for a cardiovascular medicament, tiamulin derivatives for veterinarian purposes, Nafronil Oxalate and Drofenine hydrochloride.

**Chemical Name:** 2-(N,N-Diisopropylamino)ethanol

**CAS RN:** 96-80-0

**Schedule:** 2B11

**HS code:** 2922.18

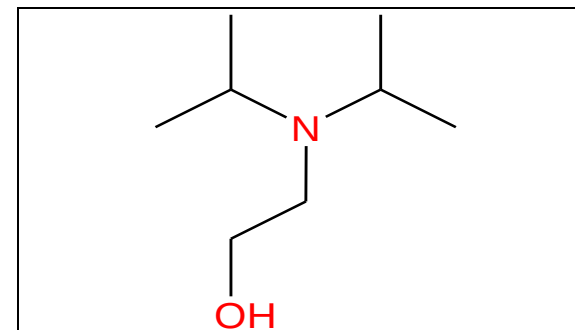
**Molecular Formula:** C<sub>8</sub>H<sub>19</sub>NO

**CAS Index Name:** Ethanol, 2-[bis(1-methylethyl)amino]-

**IUPAC Name:** 2-Diisopropylaminoethanol

**Synonyms:** N,N-Diisopropylethanolamine  
N,N-Diisopropylaminoethane-2-ol  
N,N-Diisopropyl-2-aminoethanol  
Ethanol, 2-(diisopropylamino)-  
2-(Diisopropylamino)ethyl alcohol  
2-(Diisopropylamino)ethanol  
(N,N-Diisopropylamino)ethanol

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used in production of pharmaceuticals: preparations of substituted benzamides and pharmaceuticals for treatment of digestive tract disorder.

**Chemical Name:** 2-(N,N-Diethylamino)ethanethiol

**CAS RN:** 100-38-9

**Schedule:** 2B12

**HS code:** 2930.60

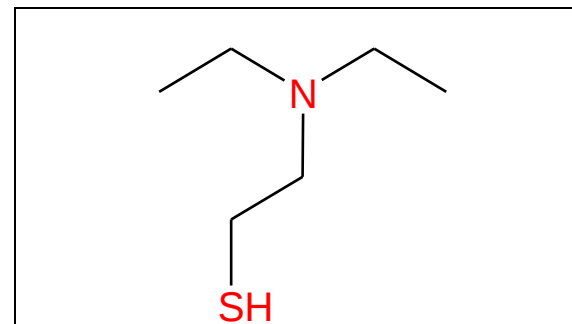
**Molecular Formula:** C<sub>6</sub>H<sub>15</sub>NS

**CAS Index Name:** Ethanethiol, 2-(diethylamino)-

**IUPAC Name:** 2-(Diethylamino)ethanethiol

**Synonyms:** N,N-Diethylcysteamine  
N,N-Diethylaminoethane-2-thiol  
Diethylcysteamine  
Diethyl(2-mercaptoethyl)amine  
2-N,N-(Diethylamino)ethanethiol  
2-(Diethylamino)ethyl mercaptan  
2-(Diethylamino)ethyl hydrosulfide

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used in production of pharmaceuticals such as Tiamulin Hydrogen Fumarate and antibiotic used for veterinarian application.

**Chemical Name:** 2-(N,N-Dimethylamino)ethanethiol

**CAS RN:** 108-02-1

**Schedule:** 2B12

**HS code:** 2930.10

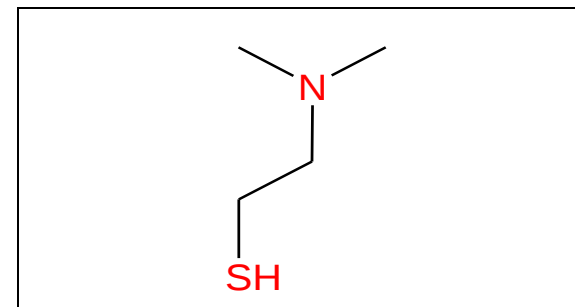
**Molecular Formula:** C<sub>4</sub>H<sub>11</sub>NS

**CAS Index Name:** Ethanethiol, 2-(dimethylamino)-

**IUPAC Name:** 2-(Dimethylamino)ethanethiol

**Synonyms:** N-(2-Mercaptoethyl)-N,N-dimethylamine  
N,N-Dimethylcysteamine  
N,N-Dimethylaminoethane-2-thiol  
Captamine  
2-Mercapto-N,N-dimethylaminoethane  
(Dimethylamino)ethyl mercaptan  
(2-Mercaptoethyl)dimethylamine

#### Chemical Structure

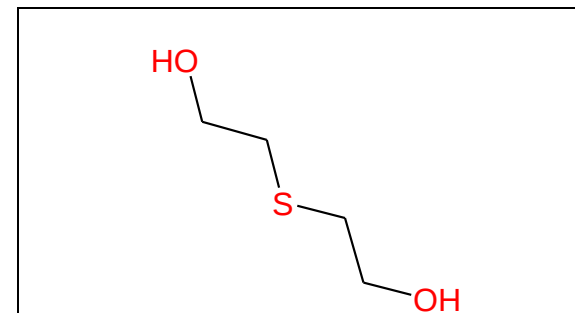


#### Commercial Applications & Industrial Uses

Used in production of drugs, food flavourings and antibacterial agents.

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Bis(2-hydroxyethyl)sulfide</b>                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>CAS RN:</b>            | 111-48-8                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Schedule:</b>          | 2B13                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>HS code:</b>           | 2930.70                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Molecular Formula:</b> | C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>CAS Index Name:</b>    | Ethanol, 2,2'-thiobis-                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>IUPAC Name:</b>        | 2,2'-Thiodiethanol                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Synonyms:</b>          | Ethanol, 2,2'-thiodi-<br>2,2'-Thiodiglycol<br>3-Thiapentane-1,5-diol<br>Bis(2-hydroxyethyl) sulfide<br>Bis(2-hydroxyethyl) thioether<br>Bis( $\beta$ -hydroxyethyl) sulfide<br>2,2'-Thiobisethanol<br>Diethanol sulfide<br>Thiodiglycol<br>Kromfax Solvent<br>$\beta,\beta'$ -Dihydroxydiethyl sulfide<br>$\beta,\beta$ -Dihydroxyethyl sulphide<br>$\beta$ -Thiodiglycol<br>Tedegyl<br>Thiodiethylene glycol<br>Di(2-hydroxyethyl) sulphide |

#### Chemical Structure



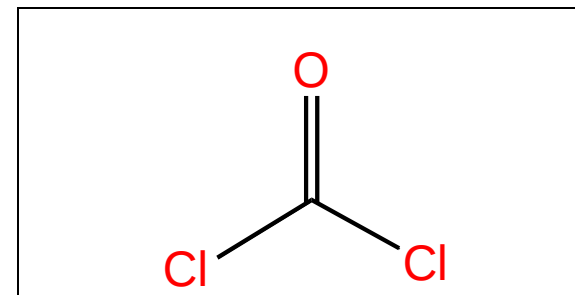
#### Commercial Applications & Industrial Uses

Used in textile industry (dye carrier and fabric softener).

Used in production of solvents, cosmetics, plastics, elastomers, lubricants, stabilizers, antioxidants, inks, dyes, photography, copying, antistatic agent, epoxides, coatings, cosmetics, metal plating and pharmaceuticals (anti-arthritis drugs).

|                           |                                                                                                                                                            |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Carbonyl dichloride</b>                                                                                                                                 |
| <b>CAS RN:</b>            | 75-44-5                                                                                                                                                    |
| <b>Schedule:</b>          | 3A01                                                                                                                                                       |
| <b>HS code:</b>           | 2812.11                                                                                                                                                    |
| <b>Molecular Formula:</b> | $\text{CCl}_2\text{O}$                                                                                                                                     |
| <b>CAS Index Name:</b>    | Carbonic dichloride                                                                                                                                        |
| <b>IUPAC Name:</b>        | Carbonyl dichloride                                                                                                                                        |
| <b>Synonyms:</b>          | UN1076<br>Phosgene<br>Phosgen<br>Dichloroformaldehyde<br>Chloroformyl chloride<br>CG<br>Carbonyl chloride<br>Carbon oxychloride<br>Carbon dichloride oxide |

#### Chemical Structure



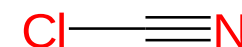
#### Commercial Applications & Industrial Uses

Used in production of intermediates in many branches of large-scale industrial chemistry.

Used in production of di-isocyanates as starting materials for polyurethanes, polycarbonate resins, polyurethane coatings, cholinergic medicines and chloroformates. Reaction of Phosgene with alcohols to form chloroformic esters is widely used in industry. These esters are exceptionally versatile intermediates in pharmaceutical industry for the production of e.g. carbonic esters and carbamate insecticides.

Used in inorganic chemistry, e.g. Phosgene is used as an intermediate for the large-scale production of Aluminium chloride.

|                           |                                                                                                                             |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | Cyanogen chloride                                                                                                           |
| <b>CAS RN:</b>            | 506-77-4                                                                                                                    |
| <b>Schedule:</b>          | 3A02                                                                                                                        |
| <b>HS code:</b>           | 2853.10                                                                                                                     |
| <b>Molecular Formula:</b> | CClN                                                                                                                        |
| <b>CAS Index Name:</b>    | Cyanogen chloride ((CN)Cl)                                                                                                  |
| <b>IUPAC Name:</b>        | Cyanogen chloride                                                                                                           |
| <b>Synonyms:</b>          | UN1589 (Cyanogen chloride stabilized)<br>Cyanochloride<br>Chlorocyanogen<br>Chlorocyanide<br>Chlorocyan<br>Chlorine cyanide |

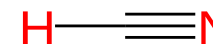
**Chemical Structure****Commercial Applications & Industrial Uses**

Used for: synthesis, metal cleaners, ore refining, in production of triazine herbicides (e.g. Atrazine), insecticides (e.g. Menazon), optical brighteners, dyestuffs and synthetic rubber.

Used in production of Diphenyl guanidine.

|                           |                                                                                                                                      |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Hydrogen cyanide</b>                                                                                                              |
| <b>CAS RN:</b>            | 74-90-8                                                                                                                              |
| <b>Schedule:</b>          | 3A03                                                                                                                                 |
| <b>HS code:</b>           | 2811.12                                                                                                                              |
| <b>Molecular Formula:</b> | HCN                                                                                                                                  |
| <b>CAS Index Name:</b>    | Hydrocyanic acid                                                                                                                     |
| <b>IUPAC Name:</b>        | Nitrilomethane                                                                                                                       |
| <b>Synonyms:</b>          | UN1614 Hydrogen cyanide (STABILIZED)<br>Prussic acid<br>Formonitrile<br>Formic anammonide<br>Evercyn<br>Carbon hydride nitride (CHN) |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Major end uses of Hydrogen cyanide include production of: Adiponitrile, Methyl methacrylate, Cyanuric chloride, Sodium cyanide and Methionine.

Used in production of metal polishes, Acrylates, Cyanide salts, dyes, rodenticides, pesticides, synthetic fibres, plastics and electroplating solutions.

Used in metallurgical and photographic processes and for production of Cyanuric acid.

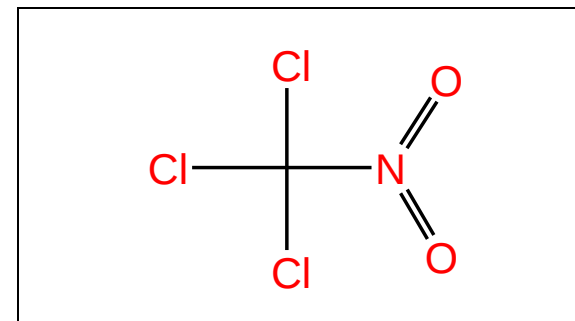
Used as a starting material for nylon 66.

Used for fumigation of ships and warehouses and for ore-extracting processes.

Intermediate for Aminopolycarboxylic acid; Chelating agents and a raw material for nitrile acids.

|                           |                                                                                                                                                    |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Trichloronitromethane</b>                                                                                                                       |
| <b>CAS RN:</b>            | 76-06-2                                                                                                                                            |
| <b>Schedule:</b>          | 3A04                                                                                                                                               |
| <b>HS code:</b>           | 2904.91                                                                                                                                            |
| <b>Molecular Formula:</b> | $\text{CCl}_3\text{NO}_2$                                                                                                                          |
| <b>CAS Index Name:</b>    | Methane, trichloronitro-                                                                                                                           |
| <b>IUPAC Name:</b>        | Trichloro(nitro)methane                                                                                                                            |
| <b>Synonyms:</b>          | UN1580<br>PS<br>Picfume<br>Nitrotrichloromethane<br>Nitrochloroform<br>Microlysin<br>Larvacide<br>G 25<br>Chlorpocrin<br>Chloropicrin<br>Acquinite |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Mainly used as a soil disinfectant for control of nematodes, soil insects, soil fungi and weed seeds.

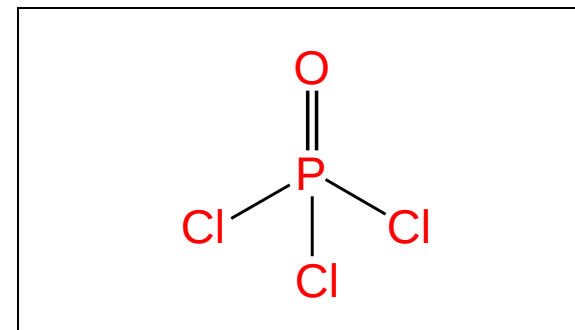
Used for fumigation of stored grain to control insects and rodents and for glass houses and mushroom house fumigation.

Used in combination with Methyl bromide and other fumigants.

Raw material in organic synthesis, e.g. in production of dyes.

|                           |                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Phosphorus oxychloride</b>                                                                                                                                                                                                                                                                                                                                |
| <b>CAS RN:</b>            | 10025-87-3                                                                                                                                                                                                                                                                                                                                                   |
| <b>Schedule:</b>          | 3B05                                                                                                                                                                                                                                                                                                                                                         |
| <b>HS code:</b>           | 2812.12                                                                                                                                                                                                                                                                                                                                                      |
| <b>Molecular Formula:</b> | Cl <sub>3</sub> OP                                                                                                                                                                                                                                                                                                                                           |
| <b>CAS Index Name:</b>    | Phosphoric trichloride                                                                                                                                                                                                                                                                                                                                       |
| <b>IUPAC Name:</b>        | Phosphoric trichloride                                                                                                                                                                                                                                                                                                                                       |
| <b>Synonyms:</b>          | UN1810<br>Trichlorophosphorus oxide<br>Trichlorophosphine oxide<br>Phosphoryl trichloride<br>Phosphorus trichloride oxide<br>Phosphorus oxytrichloride<br>Phosphorus oxide trichloride<br>Phosphorus monoxide trichloride<br>Phosphorus chloride oxide<br>Phosphoroxytrichloride<br>Phosphoroxychloride<br>Phosphorous oxychloride<br>Phosphonyl trichloride |

#### Chemical Structure



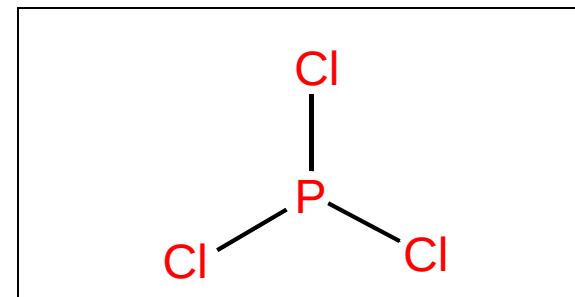
#### Commercial Applications & Industrial Uses

Precursor for organophosphorus pesticides, phosphates, plasticizers, flame retarding agents, medicines and dye intermediates.

Used as chlorinating agent and catalyst in organic synthesis to produce alkyl and aryl orthophosphate tri-esters which are used in the production of hydraulic fluids, plastic and elastomeric additives, flame retardants, oil stabilisers, pesticides, pharmaceutical intermediates and metal extraction solvents.

|                           |                                                                                                                                                                            |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Phosphorus trichloride</b>                                                                                                                                              |
| <b>CAS RN:</b>            | 7719-12-2                                                                                                                                                                  |
| <b>Schedule:</b>          | 3B06                                                                                                                                                                       |
| <b>HS code:</b>           | 2812.13                                                                                                                                                                    |
| <b>Molecular Formula:</b> | $\text{Cl}_3\text{P}$                                                                                                                                                      |
| <b>CAS Index Name:</b>    | Phosphorus trichloride                                                                                                                                                     |
| <b>IUPAC Name:</b>        | Phosphorous trichloride                                                                                                                                                    |
| <b>Synonyms:</b>          | UN1809<br>Trichlorophosphine<br>Phosphorus chloride ( $\text{PCl}_3$ )<br>Phosphorus chloride ( $\text{Cl}_6\text{P}_2$ )<br>Phosphorous chloride<br>Phosphine, trichloro- |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used as chlorinating agent and catalyst.

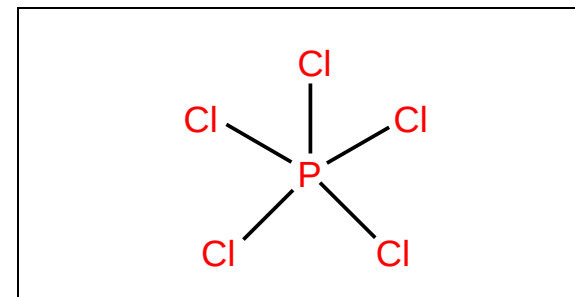
Used as starting material in production of organophosphorus and inorganic phosphorus compounds such as Phosphoryl chloride, Phosphorus pentachloride and Phosphoric acid.

Reacts with pure Oxygen to produce another Schedule 3 chemical (Phosphorus oxychloride (see page 37)).

Used as a common intermediate for production of: synthetic colourants, pharmaceutical products (sulfadiazine and sulfamethoxydiazine), organic phosphates (insecticides, flame retardants, plasticisers, metal extraction solvents), pesticides such as trichlorfon, methamidophos, acephate and EBP.

|                           |                                                                                        |
|---------------------------|----------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Phosphorus pentachloride</b>                                                        |
| <b>CAS RN:</b>            | 10026-13-8                                                                             |
| <b>Schedule:</b>          | 3B07                                                                                   |
| <b>HS code:</b>           | 2812.14                                                                                |
| <b>Molecular Formula:</b> | Cl <sub>5</sub> P                                                                      |
| <b>CAS Index Name:</b>    | Phosphorane, pentachloro-                                                              |
| <b>IUPAC Name:</b>        | Pentachlorophosphorane                                                                 |
| <b>Synonyms:</b>          | UN1806<br>Phosphorus perchloride<br>Phosphorous pentachloride<br>Pentachlorophosphorus |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

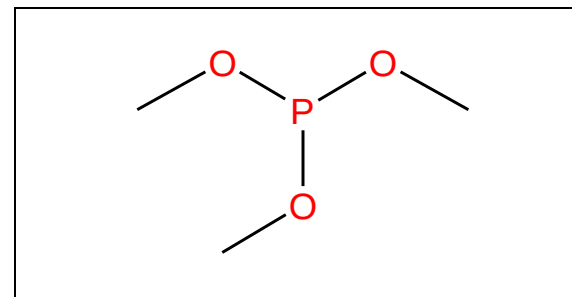
Used as a chlorinating agent for the synthesis of a variety of inorganic and organic phosphorous derivatives which are used as: pesticides, water treatment chemicals, flame-retardants, plasticizers, lithium-based batteries and stabilizers for plastics and elastomers; lube oil and paint additive. It is also used as a catalyst in cyclization reactions.

Used in pharmaceutical industry in production of penicillin and cephalosporin antibiotics.

Used in aluminium metallurgy as a grain refiner for Al-Si alloys and as a grain structure improver in metal casting.

|                           |                                                            |
|---------------------------|------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Trimethyl phosphite</b>                                 |
| <b>CAS RN:</b>            | 121-45-9                                                   |
| <b>Schedule:</b>          | 3B08                                                       |
| <b>HS code:</b>           | 2920.23                                                    |
| <b>Molecular Formula:</b> | $C_3H_9O_3P$                                               |
| <b>CAS Index Name:</b>    | Phosphorous acid, trimethyl ester                          |
| <b>IUPAC Name:</b>        | Trimethyl phosphite                                        |
| <b>Synonyms:</b>          | UN2329<br>Trimethoxyphosphine<br>O,O,O Trimethyl phosphite |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used as a key intermediate in the production of organophosphorus pesticides and herbicide (glyphosate).

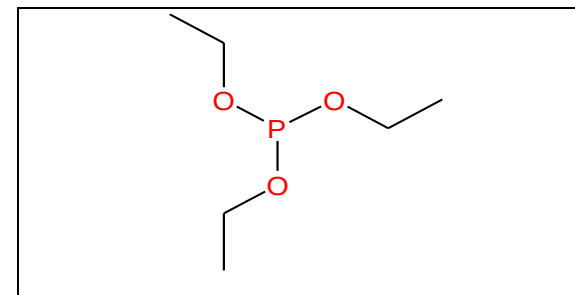
Used as a stabilizer for PVC neoprene and as a raw material in the production of fire resistant and flame retardant materials for plastics and wood products.

Used as a plasticizer in nylons, as a catalyst in polymerization reactions and as coating additives.

Used in dyestuffs, optical brighteners, plasticizers and lubricants.

|                           |                                                       |
|---------------------------|-------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Triethyl phosphite</b>                             |
| <b>CAS RN:</b>            | 122-52-1                                              |
| <b>Schedule:</b>          | 3B09                                                  |
| <b>HS code:</b>           | 2920.24                                               |
| <b>Molecular Formula:</b> | $C_6H_{15}O_3P$                                       |
| <b>CAS Index Name:</b>    | Phosphorous acid, triethyl ester                      |
| <b>IUPAC Name:</b>        | Triethyl phosphite                                    |
| <b>Synonyms:</b>          | UN2323<br>Tris(ethoxy)phosphine<br>Triethoxyphosphine |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

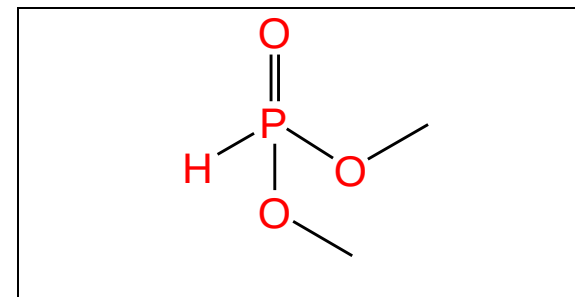
Widely used in organic synthesis as organophosphorus reagent.

Used in production of flame-retardants for rigid polyurethane foam, fluorescent whitening agents, insecticides, and active ingredients for pharmaceuticals (e.g. synthetic penicillin and cephalosporin,).

Used as: plasticizers, lubricant additives, whitening agents for dyes, stabilizers and lube oil additives (long-chained derivatives are mainly used as antioxidants for plastics).

|                           |                                                                                                                                                                                                                                                                                                                                  |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Dimethyl phosphite</b>                                                                                                                                                                                                                                                                                                        |
| <b>CAS RN:</b>            | 868-85-9                                                                                                                                                                                                                                                                                                                         |
| <b>Schedule:</b>          | 3B10                                                                                                                                                                                                                                                                                                                             |
| <b>HS code:</b>           | 2920.21                                                                                                                                                                                                                                                                                                                          |
| <b>Molecular Formula:</b> | $C_2H_7O_3P$                                                                                                                                                                                                                                                                                                                     |
| <b>CAS Index Name:</b>    | Phosphonic acid, dimethyl ester                                                                                                                                                                                                                                                                                                  |
| <b>IUPAC Name:</b>        | Dimethyl phosphite                                                                                                                                                                                                                                                                                                               |
| <b>Synonyms:</b>          | Phosphorous acid dimethyl ester<br>O,O-Dimethyl phosphonate<br>NCI-C54773<br>Methyl phosphonate $((MeO)_2HPO)$<br>Hydrogen dimethyl phosphite<br>Dimethylester kyseliny fosforite<br>Dimethyl phosphonate<br>Dimethyl hydrogen phosphonate<br>Dimethyl hydrogen phosphite<br>Dimethyl acid phosphite<br>Dimethoxyphosphine oxide |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

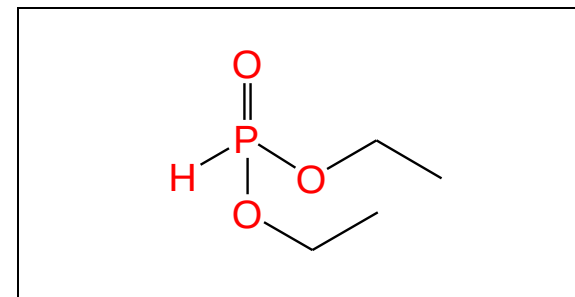
Mainly used in the production of phosphonic acid derivatives, insecticides and plastic additives.

Used in production of phosphonates, crop protection agents, flame retardants (e.g. for textile fibres and lubricant additives).

Used as intermediate to produce: pesticides (e.g. Glyphosate, Trichlorfon and EBP), organic corrosion inhibitors, dye additives, plastic auxiliaries, flame-retarding agents, lube oil additives and adhesives.

|                           |                                                                                                                                                  |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Diethyl phosphite</b>                                                                                                                         |
| <b>CAS RN:</b>            | 762-04-9                                                                                                                                         |
| <b>Schedule:</b>          | 3B11                                                                                                                                             |
| <b>HS code:</b>           | 2920.22                                                                                                                                          |
| <b>Molecular Formula:</b> | $C_4H_{11}O_3P$                                                                                                                                  |
| <b>CAS Index Name:</b>    | Phosphonic acid, diethyl ester                                                                                                                   |
| <b>IUPAC Name:</b>        | Diethyl phosphite                                                                                                                                |
| <b>Synonyms:</b>          | Hydrogen diethyl phosphite<br>Diethyl phosphonate<br>Diethyl hydrogen phosphite<br>Diethyl acid phosphite<br>Diethoxyphosphine oxide<br>CGI 1700 |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used as: paint solvent, lubricant additives, antioxidant for plastics, reducing agent, intermediate in flame retardants (e.g. in the manufacture of rigid polyurethane foams), flame-retarding agents for textile fibres.

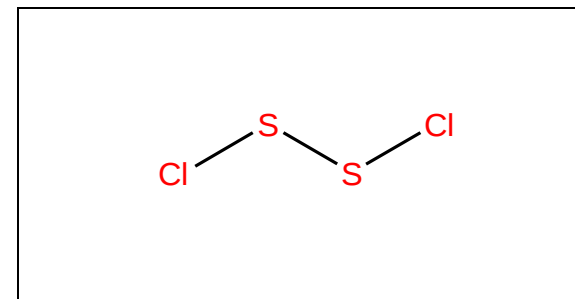
Used for production of crop protection agents (insecticides).

Used as a phosphorylating agent and as an intermediate in organic synthesis.

Used for production of insecticides and fungicides, plasticizers and extracting agents.

|                           |                                                                                                                                                                                           |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Sulfur monochloride</b>                                                                                                                                                                |
| <b>CAS RN:</b>            | 10025-67-9                                                                                                                                                                                |
| <b>Schedule:</b>          | 3B12                                                                                                                                                                                      |
| <b>HS code:</b>           | 2812.15                                                                                                                                                                                   |
| <b>Molecular Formula:</b> | $\text{Cl}_2\text{S}_2$                                                                                                                                                                   |
| <b>CAS Index Name:</b>    | Sulfur chloride ( $\text{S}_2\text{Cl}_2$ )                                                                                                                                               |
| <b>IUPAC Name:</b>        | Disulfur dichloride                                                                                                                                                                       |
| <b>Synonyms:</b>          | UN1828 (Sulfur chlorides)<br>Thiosulfurous dichloride<br>Sulphur chloride (mono)<br>Sulfur subchloride<br>Sulfur monochloride<br>Dichlorodisulfane<br>Chlorosulfane<br>Chloride of sulfur |

#### Chemical Structure



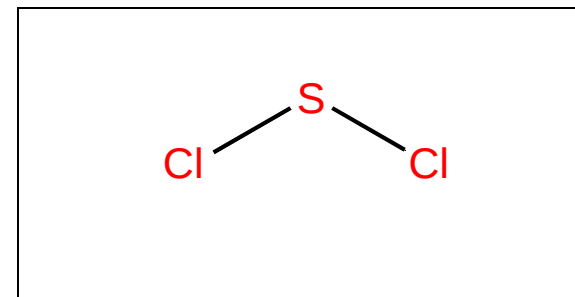
#### Commercial Applications & Industrial Uses

Used in organic synthesis and in production of wide range of chemical products: vulcanising agents for rubber, lubricant additives, gum erasers, rubber additives, rubber substitutes, sulfur dyes, antioxidants, pesticides, herbicides, insecticides, pharmaceuticals, paper, textile auxiliaries and plastics.

Principal commercial uses are: vulcanising agent for rubber and for production of lubricant additives.

|                           |                                                                                                                                                        |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Sulfur dichloride</b>                                                                                                                               |
| <b>CAS RN:</b>            | 10545-99-0                                                                                                                                             |
| <b>Schedule:</b>          | 3B13                                                                                                                                                   |
| <b>HS code:</b>           | 2812.16                                                                                                                                                |
| <b>Molecular Formula:</b> | Cl <sub>2</sub> S                                                                                                                                      |
| <b>CAS Index Name:</b>    | Sulfur chloride (SCL2)                                                                                                                                 |
| <b>IUPAC Name:</b>        | Sulfur dichloride                                                                                                                                      |
| <b>Synonyms:</b>          | UN1828 (Sulfur chlorides)<br>Sulfur dichloride (SCl <sub>2</sub> )<br>Monosulfur dichloride<br>Dichlorosulfane<br>Chlorine sulfide (Cl <sub>2</sub> S) |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Uses are similar to that of Sulfur monochloride (see page 44). Used in organic synthesis.

Large quantities are used in production of lubricating oil additives.

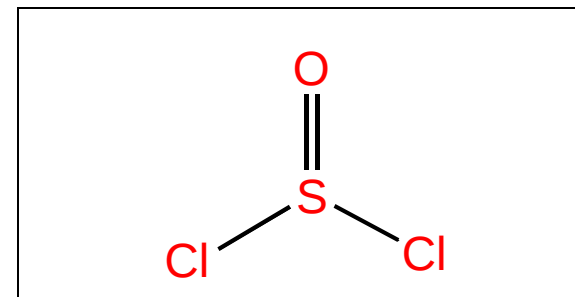
Used in the rapid vulcanisation of rubber. Smaller amounts are used in production of antioxidants and organic-sulfur compounds. The cross-linking ability of Sulfur dichloride is also utilized to modify drying oils for varnishes and inks.

Used to make an insecticide intermediate (4,4'-thiobisphenol and it is also an ingredient in the production of fungicide captafol (defoliant).

Used as a chlorinating agent in production of parathion insecticide intermediates.

Used in the food industry in the purification of sugar juices.

|                           |                                                                                                                                                                                                                                                                                                           |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Thionyl chloride</b>                                                                                                                                                                                                                                                                                   |
| <b>CAS RN:</b>            | 7719-09-7                                                                                                                                                                                                                                                                                                 |
| <b>Schedule:</b>          | 3B14                                                                                                                                                                                                                                                                                                      |
| <b>HS code:</b>           | 2812.17                                                                                                                                                                                                                                                                                                   |
| <b>Molecular Formula:</b> | Cl <sub>2</sub> OS                                                                                                                                                                                                                                                                                        |
| <b>CAS Index Name:</b>    | Thionyl chloride                                                                                                                                                                                                                                                                                          |
| <b>IUPAC Name:</b>        | Thionyl dichloride                                                                                                                                                                                                                                                                                        |
| <b>Synonyms:</b>          | UN1836<br>Thionyl chloride (SOCl <sub>2</sub> )<br>Sulfurous oxychloride<br>Sulfurous dichloride<br>Sulfur oxychloride (SOCl <sub>2</sub> )<br>Sulfur oxychloride<br>Sulfur chloride oxide (SCl <sub>2</sub> O)<br>Sulfur chloride oxide (Cl <sub>2</sub> SO)<br>Sulfinyl dichloride<br>Sulfinyl chloride |

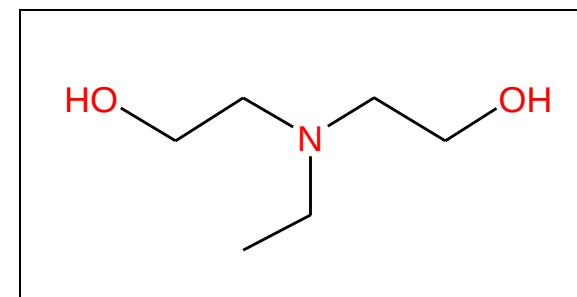
**Chemical Structure****Commercial Applications & Industrial Uses**

One of the most important chlorinating agents in organic chemistry.

Used in production of crop-protection agents (herbicides and insecticides), pharmaceuticals (drugs and vitamins), dyes, paper and textile auxiliaries.

|                           |                                                                                                                                                                                    |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Ethyldiethanolamine</b>                                                                                                                                                         |
| <b>CAS RN:</b>            | 139-87-7                                                                                                                                                                           |
| <b>Schedule:</b>          | 3B15                                                                                                                                                                               |
| <b>HS code:</b>           | 2922.17                                                                                                                                                                            |
| <b>Molecular Formula:</b> | $C_6H_{15}NO_2$                                                                                                                                                                    |
| <b>CAS Index Name:</b>    | Ethanol, 2,2'-(ethylimino)bis-                                                                                                                                                     |
| <b>IUPAC Name:</b>        | 2,2'-(Ethylimino)diethanol                                                                                                                                                         |
| <b>Synonyms:</b>          | N-Ethyldiethanolamine<br>N-Ethyl-2,2'-iminodiethanol<br>N,N-Bis(2-hydroxyethyl)ethylamine<br>Ethylbis(2-hydroxyethyl)amine<br>Ethanol, 2,2'-(ethylimino)di-<br>Diethanolethylamine |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used in production of pharmaceuticals, agricultural, textile, detergent, cosmetic and metallurgic industries.

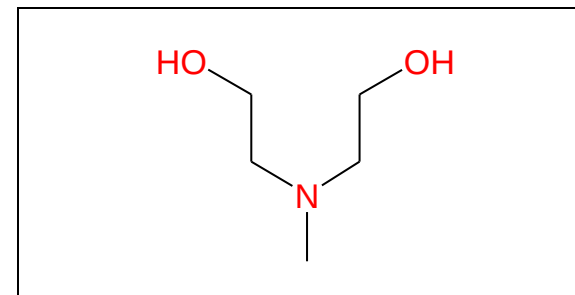
Used as: intermediates (especially in production of pharmaceuticals), crop protection agents and flocculants.

Used in preparation of chemicals for paper, plastic and leather industries.

Direct uses include gas purification methods for removing acidic gases.

|                           |                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Methyldiethanolamine</b>                                                                                                                                                                                                                                                                                                                                         |
| <b>CAS RN:</b>            | 105-59-9                                                                                                                                                                                                                                                                                                                                                            |
| <b>Schedule:</b>          | 3B16                                                                                                                                                                                                                                                                                                                                                                |
| <b>HS code:</b>           | 2922.17                                                                                                                                                                                                                                                                                                                                                             |
| <b>Molecular Formula:</b> | C <sub>5</sub> H <sub>13</sub> NO <sub>2</sub>                                                                                                                                                                                                                                                                                                                      |
| <b>CAS Index Name:</b>    | Ethanol, 2,2'-(methylimino)bis-                                                                                                                                                                                                                                                                                                                                     |
| <b>IUPAC Name:</b>        | 2,2'-(Methylimino)diethanol                                                                                                                                                                                                                                                                                                                                         |
| <b>Synonyms:</b>          | N-Methyliminodiethanol<br>N-Methyldiethanolamine<br>N-Methylaminodiglycol<br>N-methyl-2,2'-iminodiethanol<br>N-(2-Hydroxyethyl)-N-methylethanolamine<br>N,N-Bis(2-hydroxyethyl)methylamine<br>Methyiminodiethanol<br>Methyldiethanolamine<br>Methylbis(2-hydroxyethyl)amine<br>MDEA<br>Eve<br>Ethanol, 2,2'-(methylimino)di-<br>Diethanolmethylamine<br>Amietol M12 |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

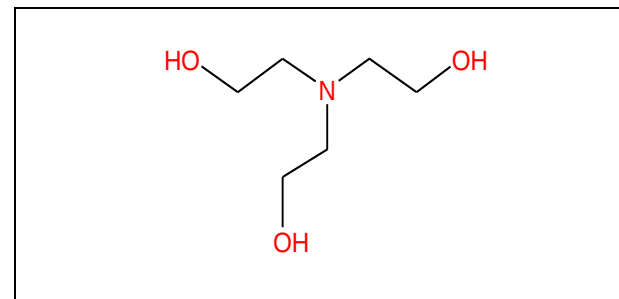
Widely used in oil refinery for treating of natural gas (removal of acidic components or sweetening).

Used in the following areas: coatings, textile lubricants, polishes, detergents, pesticides, personal care products and pharmaceuticals such as intermediate in the production of analgesics with sedative and antispasmodic effects.

Applications also include: gas scrubbing, dyes, lubrication oils, plasticizer, fabric softener, paints, agricultural chemicals, emulsifiers, corrosion inhibitors and catalyst for polyurethane foam production.

|                           |                                                                                                                                                                                                                                                                                |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chemical Name:</b>     | <b>Triethanolamine</b>                                                                                                                                                                                                                                                         |
| <b>CAS RN:</b>            | 102-71-6                                                                                                                                                                                                                                                                       |
| <b>Schedule:</b>          | 3B17                                                                                                                                                                                                                                                                           |
| <b>HS code:</b>           | 2922.15                                                                                                                                                                                                                                                                        |
| <b>Molecular Formula:</b> | $C_6H_{15}NO_3$                                                                                                                                                                                                                                                                |
| <b>CAS Index Name:</b>    | Ethanol, 2,2',2''-nitrilotris-                                                                                                                                                                                                                                                 |
| <b>IUPAC Name:</b>        | 2,2',2''-Nitrilotriethanol                                                                                                                                                                                                                                                     |
| <b>Synonyms:</b>          | Trolamine<br>Tis-(2-Hydroxyethyl)amine<br>Tris(beta-hydroxyethyl)amine<br>Tris(2-hydroxyethyl)amine<br>Triethanolamin<br>TEOA<br>TEA (amino alcohol)<br>TEA<br>Sting-Kill<br>Sterolamide<br>Nitrilotriethanol<br>Daltogen<br>Alkanolamine 244<br>2,2',2''-Nitrilotris[ethanol] |

#### Chemical Structure



#### Commercial Applications & Industrial Uses

Used in production of emulsifiers, detergents, textile and leather chemicals, drilling and cutting oils (impregnating materials, soaps, cosmetics and toiletries, agricultural products, pharmaceuticals).

Used in production of: cleaners (all-purpose cleaners, cleaners that involve skin contact because of mildness of this chemical, waterless hand cleaners), cement and concrete (as s milling additive) and adhesives.

Used in wax formulations: cream waxes and polishes used for furniture, floors and automotive car wax.

Used as corrosion inhibitor; used in gas purification processes, metal working, mining, petroleum and coal, polymers, textiles, pigment dispersion, pesticides and herbicides.

Applications include: coating technology, metal coating preparations, glass coating (shatter proofing, anti-frosting, antifogging and-dirt resistant films on glass and plastics); also used as accelerator for photo-polymerisation coating (improves thermal properties and reduces cracking in prepared wire coatings).