# Polyphosphoric acids: Human health tier II assessment

**05 February 2016**



## Chemicals in this assessment

| Chemical Name in the Inventory | CAS Number |
|---|---|
| **Diphosphoric acid** | 2466-09-3 |
| **Polyphosphoric acids** | 8017-16-1 |
| **Triphosphoric acid** | 10380-08-2 |
| **Tetraphosphoric acid** | 13813-62-2 |

## Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using

Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health or the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has three tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit:**www.nicnas.gov.au**



ACRONYMS & ABBREVIATIONS

# Grouping Rationale

The chemicals in this group are oligomers of phosphoric acid (CAS No. 7664-38-2), and are also collectively called polyphosphates. Inorganic polyphosphates are made up of linear polymers with a number of orthophosphate residues connected by energy-rich phosphoanhydride bonds. Polyphosphates have physiological functions including phosphorus storage in the cells of living organisms, regulation of mitochondrial functions, blood coagulation and inflammation, bone tissue development, metastasis regulation and regulation of brain functions (Kuleav & Kulakovskaya, 2000; Kulakovskaya, 2012).

# Import, Manufacture and Use

## Australian

Polyphosphoric acids (CAS No. 8017-16-1) was reported under previous mandatory and/or voluntary calls for information as having industrial use in Australia.

## International

The following international uses have been identified through the European Union (EU) Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) dossiers; Galleria Chemica; the Substances and Preparations in Nordic countries (SPIN) database; the Organisation for Economic Co-operation and Development (OECD) High Production Volume chemical program (HPV); the US Environmental Protection Agency's Aggregated Computer Toxicology Resource (ACToR); the US National Library of Medicine's Household Products Database; and the US National Library of Medicine's Hazardous Substances Data Bank (HSDB).

The chemicals have reported domestic uses including:

- as chelating agents in cleaning and washing products;
- as additives in cleaning and washing agents;
- in adhesives; and
- in paints, lacquers and varnishes.

The chemicals have reported site-limited uses, including:

- as dehydrating agents in dye and pigment production;
- in organic synthesis;
- as corrosion inhibitors; and
- as bitumen additives.

The chemicals have the following reported non-industrial uses:

- as food additives;
- as stabilisers in skimmed condensed and dry milk; and
- as intermediates in the production of liquid fertilisers.

## Restrictions

### Australian

No known restrictions have been identified.

### International

No known restrictions have been identified.

## Existing Worker Health and Safety Controls

### Hazard Classification

The chemicals are not listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia).

### Exposure Standards

#### Australian

No specific exposure standards are available.

#### International

The following exposure standards are identified for polyphophoric acids, diphosphoric acid and triphosphoric acid (Galleria Chemica):

An exposure limit of 10 mg/$m^3$ maximum allowed concentrations as occupational exposure limit (OEL) in Russia.

Temporary Emergency Exposure limits (TEELs) defined by the US Department of Energy (DOE) for polyphosphoric acids are reported as:

- TEEL-1 = 3.6 mg/$m^3$;
- TEEL-2 = 40 mg/$m^3$; and
- TEEL-3 = 240 mg/$m^3$.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 1 mg/$m^3$ TWA.

# Health Hazard Information

Limited information is available for all the chemicals in this group. On dilution, such as in systemic circulation, the chemicals enzymatically and abiotically hydrolyse to a range of phosphate ions. Data for relevant phosphate ions are used to address systemic toxicity in this assessment. For local effects, phosphoric acid, which is considered to have similar acid strength, is used as an analogue where needed.

Phosphoric acid dissociates into the orthophosphate, monohydrogen phosphate, and dihydrogen phosphate ions in aqueous solution depending on pH. Aqueous phosphate ions are abundant normal physiological components of living things. The monohydrogen and dihydrogen phosphate ions, which are the main hydrolysis products of the polyphosphoric acids at physiological pH, were identified as being of low concern to human health (NICNAS, 2012).

Systemic health effects from repeated exposure to phosphoric acid are not expected following exposure to the chemical at non-irritating concentrations, which were supported by the negative results from the available animal data for repeated dose toxicity, genotoxicity, and reproductive toxicity (NICNAS). Additionally, phosphoric acid is a permitted food additive for processed foods in Australia (FSANZ, 2014), an indication of the low systemic toxicity potential of phosphates. Several polyphosphate anions were also identified by NICNAS to be of low concern to human health (NICNAS, 2012). Therefore, systemic toxicity such as repeated dose toxicity, genotoxicity, carcinogenicity, and reproductive toxicity are not expected for these chemicals.

## Toxicokinetics

Phosphoric acid is readily absorbed by the oral, inhalation, and dermal routes. Once absorbed, phosphoric acid is widely distributed in the body as a range of phosphate ions. Phosphate filtration occurs in the kidney where around 80 % of the plasma phosphate is reabsorbed. Elimination is mainly through urine and to a lesser extent through faeces (WHO, 1964; NICNAS; REACH). Polyphosphate ions are subject to enzymatic and abiotic hydrolysis to phosphate ions (WHO, 1970).

## Acute Toxicity

### Oral

The chemicals in this group are expected to have low acute toxicity. The median lethal dose (LD50) in Sprague-Dawley (SD) rats administered 20 % phosphoric acid by gavage is >2000 mg/kg bw/day (OECD, 2009; NICNAS).

### Dermal

The chemicals in this group are expected to have low to moderate acute toxicity. Following the occlusive application of 85 % phosphoric acid to the skin of New Zealand White rabbits, the LD50 is >1260 mg/kg bw (OECD, 2009; NICNAS; REACH).

### Inhalation

The chemicals in this group are expected to have moderate to high acute inhalation toxicity based on results from animal tests following inhalation exposure to phosphoric acid. The median lethal concentrations (LC50s) in guinea pigs, mice, rats and rabbits exposed to phosphoric acid were reported to be 193, 856, 3846 and 5337 $mg/m^3$, respectively. As the LC50 value for the preferred species (rat) is in the range to indicate moderate acute inhalation toxicity, the chemicals in this group warrant hazard classification (see **Recommendation**).

In an inhalation toxicity study, male New Zealand White rabbits (10 animals/dose), male Porton-strain rats (12 animals/dose), male Porton-strain mice (20-50 animals/dose), and male Dunkin-Hartley guinea pigs (10-20 animals/dose) were exposed for one hour to phosphoric acid smoke at the concentration range of 111 to 6731 $mg/m^3$. The LC50 values were 5337 $mg/m^3$ (rabbit), 3846 $mg/m^3$ (rat), 856 $mg/m^3$ (mice), and 193 $mg/m^3$ (guinea pig). Marked species difference in the susceptibility to the phosphoric acid smoke was seen, based on the one-hour LC50 values (OECD, 2009; REACH).

## Corrosion / Irritation

## Corrosivity

No data are available for the chemicals. Based on the available information for phosphoric acid, the chemicals are expected to be corrosive, warranting hazard classification (see **Recommendation**).

Phosphoric acid is classified as hazardous with the risk phrase 'Causes burns' (C; R34) in the HSIS (Safe Work Australia). The available data for phosphoric acid supported this classification (NICNAS). Polyphosphoric acid solutions with pH <2.5 should be regarded as corrosive based on conclusions for phosphoric acid (OECD, 2009; NICNAS; REACH).

### Respiratory Irritation

Based on the available data (see **Corrosivity**), the chemicals may be irritating to the respiratory tract depending on the concentration.

### Skin Irritation

Based on the available data (see **Corrosivity**), the chemicals may be irritating to the skin depending on the concentration.

### Eye Irritation

Based on the available data (see **Corrosivity**), the chemicals may be irritating to the eye depending on the concentration.

## Sensitisation

### Skin Sensitisation

No data are available.

# Risk Characterisation

## Critical Health Effects

The chemicals are corrosive or irritating to the skin, eyes, gastrointestinal and respiratory tracts, depending on the concentration. Inhalation exposure to the chemicals may also cause harmful effects.

## Public Risk Characterisation

The general public could be exposed through the skin or inhalation when using domestic products containing the chemicals. However, based on limited US information derived from the National Library of Medicine (NLM) Household Products Database (see **Import, Manufacture & Use (International)**), the concentrations in domestic products are not considered to be sufficiently high to cause corrosive effects, and the products are not expected to have pH in the extremely low range. Therefore, the risk to public health is not considered to be unreasonable and further risk management is not considered necessary for public safety.

## Occupational Risk Characterisation

During product formulation, dermal, inhalation, and ocular exposure might occur, particularly where manual or open processes are used. These could include transfer and blending activities, quality control analysis, and cleaning and maintaining equipment. Worker exposure to the chemicals at lower concentrations could also occur while using formulated products containing the chemicals. The level and route of exposure will vary depending on the method of application and work practices employed.

Given the critical systemic acute inhalation and local health effects, the chemicals could pose an unreasonable risk to workers unless adequate control measures to minimise dermal, inhalation and ocular exposure are implemented. The chemicals should be appropriately classified and labelled to ensure that a person conducting a business or undertaking (PCBU) at a workplace (such as an employer) has adequate information to determine the appropriate controls.

The data available support an amendment to the hazard classification in the HSIS (Safe Work Australia) (see **Recommendation**).

# NICNAS Recommendation

Assessment of these chemicals are considered to be sufficient, provided that the recommended amendment to the classification is adopted, and labelling and all other requirements are met under workplace health and safety and poisons legislation as adopted by the relevant state or territory.

## Regulatory Control

### Work Health and Safety

The chemicals are recommended for classification and labelling under the current approved criteria and adopted GHS as below. This assessment does not consider classification of physical and environmental hazards.

| Hazard | Approved Criteria (HSIS)[a] | GHS Classification (HCIS)[b] |
|---|---|---|
| Acute Toxicity | Harmful by inhalation (Xn; R20) | Harmful if inhaled - Cat. 4 (H332) |

| Hazard | Approved Criteria (HSIS)[a] | GHS Classification (HCIS)[b] |
|---|---|---|
| Irritation / Corrosivity | Causes burns (C; R34) | Causes severe skin burns and eye damage - Cat. 1 (H314) |

[a] Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)].

[b] Globally Harmonized System of Classification and Labelling of Chemicals (GHS) United Nations, 2009. Third Edition.

[*] Existing Hazard Classification. No change recommended to this classification

## Advice for industry

### *Control measures*

Control measures to minimise the risk from oral, dermal, ocular and inhalation exposure to the chemicals should be implemented in accordance with the hierarchy of controls. Approaches to minimise risk include substitution, isolation and engineering controls. Measures required to eliminate, or minimise risk arising from storing, handling and using a hazardous chemical depend on the physical form and the manner in which the chemicals are used. Examples of control measures that could minimise the risk include, but are not limited to:

- using closed systems or isolating operations;
- using local exhaust ventilation to prevent the chemicals from entering the breathing zone of any worker;
- minimising manual processes and work tasks through automating processes;
- work procedures that minimise splashes and spills;
- regularly cleaning equipment and work areas; and
- using protective equipment that is designed, constructed, and operated to ensure that the worker does not come into contact with the chemicals.

Guidance on managing risks from hazardous chemicals are provided in the *Managing risks of hazardous chemicals in the workplace—Code of practice* available on the Safe Work Australia website.

Personal protective equipment should not solely be relied upon to control risk and should only be used when all other reasonably practicable control measures do not eliminate or sufficiently minimise risk. Guidance in selecting personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

### *Obligations under workplace health and safety legislation*

Information in this report should be taken into account to help meet obligations under workplace health and safety legislation as adopted by the relevant state or territory. This includes, but is not limited to:

- ensuring that hazardous chemicals are correctly classified and labelled;
- ensuring that (material) safety data sheets ((M)SDS) containing accurate information about the hazards (relating to both health hazards and physicochemical (physical) hazards) of the chemicals are prepared; and
- managing risks arising from storing, handling and using a hazardous chemical.

Your work health and safety regulator should be contacted for information on the work health and safety laws in your jurisdiction.

Information on how to prepare an (M)SDS and how to label containers of hazardous chemicals are provided in relevant codes of practice such as the *Preparation of safety data sheets for hazardous chemicals—Code of practice* and *Labelling of workplace* *hazardous chemicals—Code of practice*, respectively. These codes of practice are available from the Safe Work Australia website.

A review of the physical hazards of these chemicals has not been undertaken as part of this assessment.

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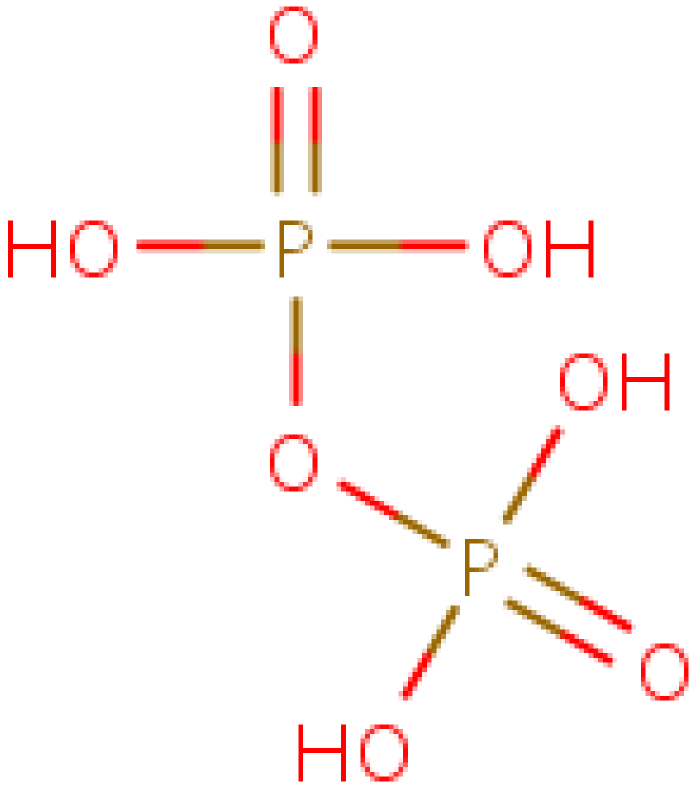
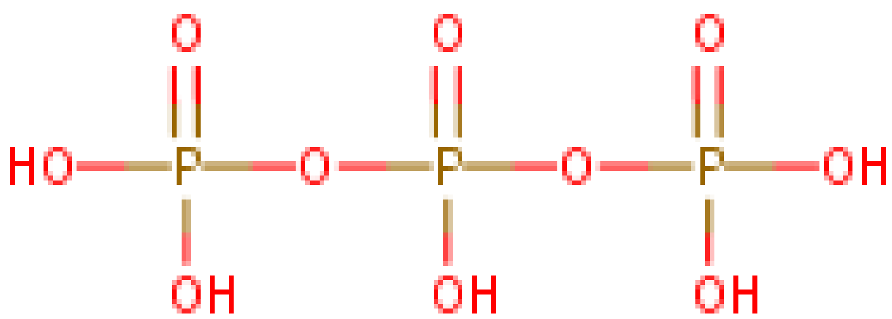
## Chemical Identities

| | |
|---|---|
| Chemical Name in the Inventory and Synonyms | **Diphosphoric acid**<br>pyrophosphoric acid |
| CAS Number | 2466-09-3 |
| Structural Formula |  |
| Molecular Formula | H4O7P2 |
| Molecular Weight | 177.9 |

| | |
|---|---|
| Chemical Name in the Inventory and Synonyms | **Polyphosphoric acids**<br>superphosphoric acid<br>phospholeum<br>condensed phosphoric acid<br>tetraphosphoric acid |
| CAS Number | 8017-16-1 |

| | |
|---|---|
| Structural Formula | No Structural Diagram Available |
| Molecular Formula | Unspecified |
| Molecular Weight | N/A |

| | |
|---|---|
| Chemical Name in the Inventory and Synonyms | **Triphosphoric acid**<br>polyphosphoric acid |
| CAS Number | 10380-08-2 |
| Structural Formula |  |

| | |
|---|---|
| Molecular Formula | H5O10P3 |
| Molecular Weight | 257.9 |

| | |
|---|---|
| Chemical Name in the Inventory and Synonyms | **Tetraphosphoric acid** |
| CAS Number | 13813-62-2 |
| Structural Formula | No Structural Diagram Available |
| Molecular Formula | H6O13P4 |
| Molecular Weight | NA |

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