



# Aluminium Phosphide

## Incident Management

### Key Points

#### Fire

- non-flammable, but forms an extremely flammable gas (phosphine) with water or damp air
- reacts violently on contact with water; explosive reaction on contact with mineral acids
- decomposes on contact with water to form highly flammable and toxic phosphine
- in the event of a fire involving aluminium phosphide, use dry agent and chemical protective clothing with liquid-tight connections in combination with breathing apparatus; water **MUST NOT** be allowed to come into contact with substance

#### Health

- highly toxic by ingestion (phosphine is released in the stomach) or by inhalation of liberated phosphine; see compendium entry for phosphine for more information
- the onset of symptoms is usually very rapid; early symptoms include nausea, vomiting, retrosternal and epigastric pain, dyspnoea and haematemesis (due to corrosive lesions of the oesophagus and stomach)
- there is often a smell of garlic on the breath due to the presence of impurities
- pulmonary oedema occurs frequently and usually 4–48 hours after ingestion but it is not always clear whether it is cardiogenic or non-cardiogenic in aetiology


#### Environment

- hazardous to the aquatic environment; inform the Environment Agency of substantial incidents



## Hazard Identification

### Standard (UK) dangerous goods emergency action codes






#### Aluminium phosphide pesticide

<b>UN</b>		3048	Aluminium phosphide pesticide	
<b>EAC</b>		4W	Use dry agent – water MUST NOT be allowed to come into contact with substance. Wear chemical protective clothing with liquid tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and watercourses.	
<b>APP</b>		-	-	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	-	-	
<b>HIN</b>		642	Toxic solid, which reacts with water, emitting flammable gases	

## Aluminium phosphide

<b>UN</b>		1397	Aluminium phosphide	
<b>EAC</b>		4WE <sup>(1)</sup>	Use dry agent – water <b>MUST NOT</b> be allowed to come into contact with substance. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and watercourses. There may be a public safety hazard outside the immediate area of the incident <sup>†</sup> .	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	4.3	Substances which in contact with water emit flammable gases	
	<b>Sub-risks</b>	6.1	Toxic substances	
<b>HIN</b>		–	–	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p><sup>(1)</sup> Not applicable to carriage of dangerous goods under RD or ADR</p> <p>* Chemical protective clothing with liquid-tight connections for whole body (Type 3) conforming to relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137</p> <p><sup>†</sup> People should stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250 m away from the incident.</p> <p><b>Reference</b></p> <p>Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA, The Stationery Office, 2015</p>				

**Classification, labelling and packaging (CLP)\***

<b>Hazard class and category</b>	Water-react. 1	Substances and mixtures, which in contact with water, emit flammable gases, category 1	
	Acute Tox. 2	Acute toxicity category 2 (oral)	
	Acute Tox. 3	Acute toxicity category 3 (dermal)	
	Acute Tox. 1	Acute toxicity category 1 (inhalation)	
	Aquatic Acute 1	Acute hazards to the aquatic environment, category 1	
<b>Hazard statement</b>	H260	In contact with water releases flammable gases which may ignite spontaneously	
	H300	Fatal if swallowed	
	H311	Toxic in contact with skin	
	H330	Fatal if inhaled	
	H400	Very toxic to aquatic life	
<b>Supplemental hazard statement</b>	EUH029	Contact with water liberates toxic gas	
	EUH032	Contact with acids liberates very toxic gas	
<b>Signal words</b>	DANGER		
* Implemented in the EU on 20 January 2009			
<b>Reference</b>			
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <a href="http://echa.europa.eu/information-on-chemicals/cl-inventory-database">http://echa.europa.eu/information-on-chemicals/cl-inventory-database</a> (accessed 12/2015).			

## Physicochemical Properties

<b>CAS number</b>	20859-73-8
<b>Molecular weight</b>	57.96
<b>Formula</b>	Al-P
<b>Common synonyms</b>	Aluminum phosphide, AIP, Al-Phos, Aluminium monophosphide, Celphide, Celphine, Celphos, Delicia, Delicia gastoxin, Detia, Detia gas Ex-B, Fumitoxin, Gastion, Phostoxin, Phostoxin-A, Quickphos.
<b>State at room temperature</b>	Crystals (various colours including green, brown, dark grey or dark yellow). Commonly encountered as pellets or tablets for pest control varying in colour from dark grey, through brown to a light tan/yellow.
<b>Volatility</b>	No data available
<b>Specific gravity</b>	2.9 g/cm <sup>3</sup> (water = 1)
<b>Flammability</b>	Non-flammable, but forms extremely flammable gas on contact with water or damp air
<b>Lower explosive limit</b>	1.6% (phosphine gas)
<b>Upper explosive limit</b>	98% (phosphine gas)
<b>Water solubility</b>	Reacts with water to form <a href="#">phosphine gas</a>
<b>Reactivity</b>	Explosive reaction on contact with mineral acids
<b>Reaction or degradation products</b>	Decomposes on contact with water, moist air and acids producing highly flammable and toxic gases (phosphine)
<b>Odour</b>	Garlic odour (due to impurities and is associated with the generation of phosphine)
<b>Structure</b>	Al≡P
<b>References</b>	<p>Aluminium Phosphide (HAZARTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System, Truven Healthcare Analytics Inc, Greenwood Village CO, US (electronic version). RightAnswer.com, Inc, Midland MI, US, Available at <a href="http://www.rightanswerknowledge.com">http://www.rightanswerknowledge.com</a> (assessed 05/2015).</p> <p>International Programme for Chemical Safety (IPCS). International Chemical Safety Card (ICSC) entry for Aluminium Phosphide. ISCS 0472, 2005. World Health Organization: Geneva.</p> <p>Hazardous Substances Data Bank. Aluminium Phosphide HSDB No. 6035 (last revision date 23/06/2005) US: National Library of Medicine: Bethesda MD. <a href="http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB">http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB</a> (as accessed 05/2015)</p>

## Reported Effect Levels from Authoritative Sources

### Exposure by inhalation (see note)

ppm	mg/m <sup>3</sup>	Duration	Signs and symptoms	Reference
100–190	140–260	30–60 min	Serious effects	a, b
290–430	400–600	30–60 min	Dangerous to life	a
400–600	560–840	30–60 min	Potentially fatal	a, b
2000	2800	Acute	Rapidly fatal	a

Values relate to phosphine gas which is liberated when aluminium phosphide reacts with water or moisture in air. These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values.

#### References

a International Programme on Chemical Safety (IPCS) (1988). Phosphine and selected metal phosphides. Environmental Health Criteria 73. World Health Organization: Geneva.

b TOXBASE: Phosphine, 2012. <http://www.toxbase.org> (accessed 06/2015).

## Published Emergency Response Guidelines

### Emergency response planning guideline (ERPG) values (see note)

	Listed value (ppm)	Calculated value (mg/m <sup>3</sup> )
ERPG-1*	Not appropriate	-
ERPG-2 <sup>†</sup>	0.5	0.7
ERPG-3 <sup>‡</sup>	5	7

**Note:** Values relate to phosphine gas which is liberated when aluminium phosphide reacts with water or moisture in air

\* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour

<sup>†</sup> Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action

<sup>‡</sup> Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects

**Reference**  
American Industrial Hygiene Association (AIHA). 2015 Emergency Response Planning Guideline Values.  
<https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2015%20ERPG%20Levels.pdf> (accessed 09/2015).

### Acute exposure guideline levels (AEGLs) (see note)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2 <sup>†</sup>	4.0	4.0	2.0	0.50	0.25
AEGL-3 <sup>‡</sup>	7.2	7.2	3.6	0.90	0.45

**Note:** Values relate to phosphine gas which is liberated when aluminium phosphide reacts with water or moisture in air

\* Level of the chemical in air at or above which the general population could experience notable discomfort

<sup>†</sup> Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or an impaired ability to escape

<sup>‡</sup> Level of the chemical in air at or above which the general population could experience life-threatening health effects or death

NR Not recommended due to insufficient data

**Reference**  
US Environmental Protection Agency. Acute Exposure Guideline Levels.  
<http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 05/2015).

## Exposure Standards, Guidelines or Regulations

### Occupational standards (see note)

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>
<b>WEL</b>	0.1	0.14	0.2	0.28

**Note:** Values relate to phosphine gas which is liberated when aluminium phosphide reacts with water or moisture in air  
WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit

**Reference**  
EH40/2005 Workplace Exposure Limits (second edition, published 2011).

### Public health guidelines

<b>Drinking water standard</b>	No guideline values specified
<b>Air quality guideline</b>	No guideline values specified
<b>Soil guideline values and health criteria values</b>	No guideline values specified



## Health Effects

**Aluminium phosphide reacts with water or moisture in the air and with acids to liberate phosphine gas.**

### Major route of exposure

- **highly toxic** by ingestion (phosphine is released in the stomach), or by inhalation of liberated phosphine; see compendium entry for phosphine for more information

### Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
<b>Ingestion</b>	<p>The onset of symptoms is usually very rapid. Early symptoms include nausea, vomiting, retrosternal and epigastric pain and dyspnoea. Haematemesis due to corrosive lesions of the oesophagus and stomach may occur and lead to the development of oesophageal stricture</p> <p>There is often a smell of garlic on the breath due to the presence of impurities</p> <p>Shock and circulatory failure are important early signs of severe poisoning and are frequent causes of death. ECG abnormalities include ST- and T-wave changes; rarely, the ECG changes resemble those of myocardial infarction. Supraventricular and ventricular tachycardia are common in severe cases</p> <p>Acute renal injury is a frequent complication.</p> <p>Pulmonary oedema with tachypnoea, dyspnoea, crepitations and rhonchi occur frequently and usually 4-48 hours after ingestion.</p> <p>Hypokalaemia and hypoglycaemia are common, hypocalcaemia has been reported. Metabolic acidosis, mixed metabolic acidosis and respiratory alkalosis are observed frequently</p>
<p><b>References</b></p> <p>TOXBASE. Aluminium Phosphide, 06/2015. <a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 11/2016).</p>	

## Decontamination at the Scene

### Summary

The approach used for decontamination at the scene will depend upon the incident, location of the casualties and the chemicals involved. Therefore, a risk assessment should be conducted to decide on the most appropriate method of decontamination.

**Aluminium phosphide reacts with water or moisture to liberate phosphine gas.**

Following disrobe, improvised dry decontamination should be considered for an incident involving aluminium phosphide **unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances.**

People who are processed through improvised decontamination should subsequently be moved to a safe location, triaged and subject to health and scientific advice. Based on the outcome of the assessment, they may require further decontamination.

Emergency services and public health professionals can obtain further advice from Public Health England (Centre for Radiation, Chemical and Environmental Hazards) using the 24-hour chemical hotline number: 0344 892 0555.

### Disrobe

The disrobe process is highly effective at reducing exposure to HAZMAT/CBRN material when performed within 15 minutes of exposure.

**Therefore, disrobe must be considered the primary action following evacuation from a contaminated area.**

Where possible, disrobe at the scene should be conducted by the casualty themselves and should be systematic to avoid transferring any contamination from clothing to the skin. Consideration should be given to ensuring the welfare and dignity of casualties as far as possible.

### Improvised decontamination

Improvised decontamination is an immediate method of decontamination prior to the use of specialised resources. This should be performed on all contaminated casualties, unless medical advice is received to the contrary. Improvised dry decontamination should be considered for an incident involving chemicals **unless the agent appears to be corrosive or caustic.**

### Improvised dry decontamination

- any available dry absorbent material can be used such as kitchen towel, paper tissues (eg blue roll) and clean cloth etc

- exposed skin surfaces should be blotted and rubbed, starting with the face, head and neck and moving down and away from the body
- rubbing and blotting should not be too aggressive, or it could drive contamination further into the skin
- all waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage

### Improvised wet decontamination

- water should only be used for decontamination where casualty signs and symptoms are consistent with exposure to caustic or corrosive substances such as acids or alkalis
- wet decontamination may be performed using any available source of water such as taps, showers, fixed installation hose-reels and sprinklers
- when using water, it is important to try and limit the duration of decontamination to between 45 and 90 seconds and, ideally, to use a washing aid such as cloth or sponge
- improvised decontamination should not involve overly aggressive methods to remove contamination as this could drive the contamination further into the skin
- where appropriate, seek professional advice on how to dispose of contaminated water and prevent run-off going into the water system

### Additional notes

- following improvised decontamination, remain cautious and observe for signs and symptoms in the decontaminated person and in unprotected staff
- if water is used to decontaminate casualties this may be contaminated, and therefore hazardous, and a potential source of further contamination spread
- all materials (paper tissues etc) used in this process may also be contaminated and, where possible, should not be used on a new casualties
- the risk from hypothermia should be considered when disrobe and any form of wet decontamination is carried out
- people who are contaminated should not eat, drink or smoke before or during the decontamination process and should avoid touching their face
- consideration should be given to ensuring the welfare and dignity of casualties as far as possible. Immediately after decontamination the opportunity should be provided to dry and dress in clean robes/clothes

### Interim wet decontamination

Interim decontamination is the use of standard fire and rescue service (FRS) equipment to provide a planned and structured decontamination process prior to the availability of purpose designed decontamination equipment.

## Decontamination at the scene references

National Ambulance Resilience Unit. Joint Emergency Services Interoperability Programme (JESIP). Initial operational response to a CBRN incident. Version 1.0, September 2013.

NHS England. Emergency Preparedness, Resilience and Response (EPRR). Chemical incidents: planning for the management of self-presenting patients in healthcare settings. April 2015.

## Clinical Decontamination and First Aid

Clinical decontamination is the process where trained healthcare professionals using purpose-designed decontamination equipment treat contaminated people individually.

Detailed information on clinical management can be found on TOXBASE – [www.toxbase.org](http://www.toxbase.org).

### Important notes

- **aluminium phosphide reacts with water or moisture to liberate phosphine gas**
- if the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves, the area should be well ventilated

### Clinical decontamination following surface contamination

- carry out decontamination in a well-ventilated area, preferably with its own ventilation system
- contaminated clothing should be removed, double-bagged, sealed and stored safely
- decontaminate open wounds first and avoid contamination of unexposed skin
- **any particulate matter adherent to skin should be removed**
- **toxic fumes (phosphine) may be released after exposure to water or moisture. If essential wash in a well-ventilated area and minimise risk of inhalation of toxic fumes**
- pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears

### Dermal exposure

- decontaminate (as above) the patient following surface contamination
- other supportive measures as indicated by the patient's clinical conditions

### Ocular exposure

- if symptomatic, immediately irrigate the affected eye thoroughly with water or 0.9% saline 1000 mL (for example via an infusion bag with a giving set). A Morgan Lens may be used if anaesthetic has been given. Irrigate for 10-15 minutes
- **ensure that the area is well ventilated as aluminium phosphide will liberate phosphine gas when in contact with water**
- if symptoms persist: corneal damage may be detected by instillation of fluorescein (either as drops or moistened strips to the conjunctival sac) and examination under the cobalt blue light of the slit lamp or ophthalmoscope

- refer for ophthalmological assessment if necessary
- other measures as indicated by the patient's clinical condition

### Inhalation/ingestion

- maintain a clear airway and ensure adequate ventilation
- give oxygen if required
- perform a 12 lead ECG and monitor cardiac rhythm and blood pressure
- other measures as indicated by the patient's clinical condition

### Clinical decontamination and first aid references

- TOXBASE <http://www.toxbase.org> (accessed 11/2016)
- TOXBASE: Aluminium phosphide, 06/2015
- TOXBASE: Phosphide – ingestion, 06/2015
- TOXBASE: Phosphine – features and management, 06/2015

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

© Crown copyright 2016, [www.gov.uk/phe](http://www.gov.uk/phe)

Re-use of Crown copyright material (excluding logos) is allowed under the terms of the Open Government Licence, visit [www.nationalarchives.gov.uk/doc/open-government-licence/version/3/](http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/) for terms and conditions.

For queries relating to this document, please contact: [generaltox@phe.gov.uk](mailto:generaltox@phe.gov.uk)

First published: October 2015

Update: November 2016 Health Effects, Decontamination at the Scene & Clinical Decontamination and First Aid