Public Health England

Protecting and improving the nation's health

Phosphine

Incident Management

Key Points

Fire

- gas, extremely flammable; reacts violently with air, oxygen, halogens and other oxidants causing fire and explosion hazard
- reacts violently with air, oxygen, halogens and other oxidants causing fire and explosion hazard
- decomposes on heating or burning, releasing toxic phosphorus oxides fumes
- in the event of a fire involving phosphine, use fine water spray and wear chemical protective clothing with liquid tight connections for whole body and breathing apparatus

Health

- very highly toxic by inhalation
- initial onset of nausea, vomiting, diarrhoea and abdominal pain may be striking
- phosphine is cardiotoxic following inhalation
- there may also be irritation of the mucous membranes, weakness, chest pain and tightness, breathlessness, dry mouth, cough, headache, fever, tremor, dizziness and ataxia
- sweating, irritation, and paraesthesiae have been reported following dermal exposure
- irritation, diplopia, blurred vision and xanthopsia may develop following ocular exposure

Environment

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

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Hazard Identification

Standard (UK) dangerous goods emergency action codes

Phosphine

UN		2199	Phosphine	
EAC		2PE(1)	Use fine water spray. 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 may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(cf)	Gas-tight chemical protective suit with breathing apparatus‡ Liquefied gas with a boiling point below -20°C	
Hazards	**Class**	2.3	Toxic gases	
	Sub-risks	2.1	Flammable gases	
HIN		-	-	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

† 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

‡ Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2

(1) not applicable to the carriage of dangerous goods under RID or ADR

Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.

Phosphine, absorbed

UN		3525	Phosphine, absorbed	
EAC		2PE(1)	Use fine water spray. 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 may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(fg)	Gas-tight chemical protective suit with breathing apparatus‡ Flammable gas	
Hazards	**Class**	2.3	Toxic gases	
	Sub-risks	2.1	Flammable gases	
HIN		-	-	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

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Classification, labelling and packaging (CLP)*

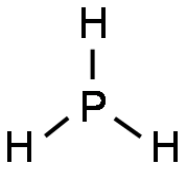
Hazard class and category	Press. Gas	Compressed gas	
	Flam. Gas 1	Flammable gas, category 1	
	Skin Corr. 1B	Skin corrosion, category 1B	
	Acute Tox. 2	Acute toxicity (inhalation), category 2	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
Hazard statement	H220	Extremely flammable gas	
	H314	Causes severe skin burns and eye damage	
	H330	Fatal if inhaled	
	H400	Very toxic to aquatic life	
Signal words	Danger		

* Implemented in the EU on 20 January 2009

Reference

European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 05/2018).

Physicochemical Properties

CAS number	7803-51-2
Molecular weight	34
Formula	PH_3
Common synonyms	-
State at room temperature	Gas
Volatility	Vapour pressure 3,488 kPa at 20°C
Vapour density	1.17 (air = 1)
Flammability	Extremely flammable
Lower explosive limit	1.8 %
Upper explosive limit	Data not available
Water solubility	Very poor
Reactivity	Reacts violently with air, oxygen, oxidants such as chlorine and nitrogen oxides, metal nitrates, halogens and many other substances causing fire and explosion hazard. Attacks many metals
Reaction or degradation products	Decomposes on heating or burning producing fumes including phosphorus oxides. Liberates hydrogen when passed over heated metal. Forms phosphonium salts when bought into contact with halogen acids
Odour	Pure phosphine is odourless. Commercial grade phosphine has the odour of garlic or decaying fish
Structure	

References

Hazardous Substances Data Bank. Phosphine HSDB No. 1233 (last revision date 04/06/2007). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 06/2018)

International Programme on Chemical Safety. International Chemical Safety Card entry for Phosphine. ICSC 0694, 2013. World Health Organization: Geneva.

Phosphine (IBM HAZARDTEXT ®) In: IBM Micromedex® TOMES® System (electronic version). Truven Health Analytics, Greenwood Village, Colorado, USA. Available at: http://www.micromedexsolutions.com/ (accessed 05/2018).

Reported Effect Levels from Authoritative Sources

Exposure by ingestion

ppm	mg/m^3	Signs and symptoms	Reference
7	10	No serious effects after 30 – 60 minutes	a
100 – 190	140 – 260	Serious effects after 30 – 60 minutes	a
290 – 430	400 – 600	Dangerous to life after 30 – 60 minutes	a
400 – 600	560 – 840	Death after 30 – 60 minutes	a
2,000	2,800	Short exposure rapidly fatal	a

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). Environmental Health Criteria 73, Phosphine and selected metal phosphides. World Health Organisation. Geneva

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m^3)
ERPG-1*	NA	-
ERPG-2†	0.5	0.695
ERPG-3‡	5	6.95

* 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

† 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

‡ 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

NA Not appropriate

Reference

American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values. https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf (accessed 05/2018).

Acute exposure guideline levels (AEGLs)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2†	4	4	2	0.5	0.25
AEGL-3‡	7.2	7.2	3.6	0.9	0.45

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

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

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

NR Not recommended

Reference

US Environmental Protection Agency. Acute Exposure Guideline Levels. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 05/2018).

Exposure Standards, Guidelines or Regulations

Occupational standards

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

WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit

Reference

Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 3rd Edition, 2018.

Public health guidelines

Drinking water standard **WHO guideline value**	Guideline values given
Air quality guideline	Guideline value not given
Soil guideline values and health criteria values	Guideline value not given

Health Effects

Major route of exposure

- very highly toxic by inhalation

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	The initial symptoms of toxicity from inhalation of phosphine are alimentary rather than respiratory. Nausea, vomiting, diarrhoea and abdominal may be so striking that clinicians may be misled into making a diagnosis of acute gastroenteritis. Consciousness is usually only mildly depressed Inhaled phosphine is cardiotoxic. Palpitations, sinus tachycardia/bradycardia, hypotension, acute heart failure, pulmonary oedema (sometimes non-cardiogenic) and ventricular arrhythmias have been observed, particularly in children. Cardiovascular shock results in metabolic acidosis, hyperlactataemia and hyperglycaemia Irritation of the mucous membranes of the nose, mouth, throat and respiratory tract occurs following inhalation. Weakness, chest pain and tightness, breathlessness, dry mouth, cough, headache, fever, tremor, dizziness and ataxia have been reported Methaemoglobinaemia has also been reported as a very rare complication
Dermal	Sweating, irritation, and paraesthesiae have been reported
Ocular	Irritation, diplopia, blurred vision and xanthopsia may develop

Reference

TOXBASE. Phosphine, 06/2015. http://www.toxbase.org (accessed 05/2018).

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.

Decontamination may not be necessary following exposure to phosphine as it exists as a gas a room temperature. Phosphine may be stored as a liquid under pressure in cylinders for industrial use, this liquid will rapidly volatilise on release, though it may cause thermal burns on contact with skin.

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.

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.

Important note

Once body surface contaminants have been removed or if your patient was exposed by ingestion or inhalation the risk that secondary care givers may become contaminated is very low. Secondary carers should wear standard hospital PPE as a precaution against secondary contamination from vomit and body fluids. Care should be given in a well ventilated area.

Clinical decontamination following surface contamination

- carry out decontamination after resuscitation
- this should be performed 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 and the patient washed with soap and water under low pressure for at least 10-15 minutes
- pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears

Dermal exposure

- if required decontaminate the patient (as above) following surface contamination
- following decontamination, apply a soothing cream if there is any residual skin irritation
- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- if symptomatic - Immediately irrigate the affected eye thoroughly with 1000 mL 0.9% saline or equivalent crystalloid (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
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- maintain a clear airway and ensure adequate ventilation

- give oxygen if required
- monitor pulse, blood pressure, conscious level and cardiac rhythm
- in the presence of methaemoglobinaemia pulse oximetry is unreliable
- perform a 12-lead ECG in all patients who require assessment
- other supportive measures as indicated by the patient's clinical condition

Health effects and decontamination references

TOXBASE http://www.toxbase.org (accessed 05/2018)

TOXBASE Phosphine, 06/2015

TOXBASE Skin decontamination – irritants, 01/2018

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.

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For queries relating to this document, please contact generaltox@phe.gov.uk