UK Health Security Agency

Phosphine

Incident management

Contents

Main points

General

Phosphine is an extremely flammable, colourless, gas with an odour of garlic/rotten fish.

It reacts violently with air, oxygen, halogens and other oxidants causing fire and explosion hazard

Phosphine decomposes on heating or burning, releasing toxic phosphorus oxides fumes

Health

Phosphine is highly toxic by inhalation

Exposure may result in onset of nausea, vomiting, diarrhoea and abdominal pain

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

Casualty decontamination at the scene

Decontamination may not be necessary following exposure to phosphine as it exists as a gas at 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.

Environment

Inform the Environment Agency where appropriate and avoid release into the environment.

Hazard identification

Table 1a. Standard (UK) dangerous goods emergency action codes for phosphine

UN		2199	Phosphine	
EAC		2PE [note 1]	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 2]. Substance can be violently or explosively reactive. There is an immediate threat to people, spillages and decontamination run-off may be washed to drains with large quantities of water [note 3]. There may be a public safety hazard outside the immediate area of the incident [note 4].	
APP		A(cf)	Normal fire kit in combination with gas tight chemical protective suit with breathing apparatus [note 5].	
Hazards	**Class**	2.3	Toxic gases	
	Sub-risks	2.1	Flammable gases	
HIN		-		

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Note to Table 1a

[note 1] Not applicable for the carriage of dangerous good under the International Carriage of Dangerous Goods by Rail (RID) and the International Carriage of Dangerous Goods by Road (ADR)

[note 2] 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 conforming to BS EN 137.

[note 3] In such cases due care must be exercised to avoid unnecessary pollution of surface and groundwaters and wherever possible control measures such as the sealing of drains should be employed.
[note 4] People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and ventilation stopped Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 m away from the incident.
[note 5] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137. Suitable thermal resistant gloves should be worn, such as those conforming to BS EN511 or BS EN407.

Reference

‘Dangerous Goods Emergency Action Code List’. National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. The Stationery Office (2023). (Viewed March 2024)

Table 1b. Standard (UK) dangerous goods emergency action codes for phosphine, adsorbed

UN		3525	Phosphine, adsorbed	
EAC		2PE [note 1]	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 2]. Substance can be violently or explosively reactive. There is an immediate threat to people, spillages and decontamination run-off may be washed to drains with large quantities of water [note 3]. There may be a public safety hazard outside the immediate area of the incident [note 4].	
APP		A(fg)	Normal fire kit in combination with gas tight chemical protective suit with breathing apparatus [note 5].	
Hazards	**Class**	2.3	Toxic gases	
	Sub-risks	2.1	Flammable gases	
HIN		-		

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Note to Table 1b

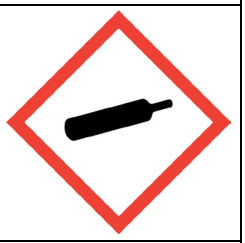
[note 1] Not applicable for the carriage of dangerous good under the International Carriage of Dangerous Goods by Rail (RID) and the International Carriage of Dangerous Goods by Road (ADR).
[note 2] Chemical protective clothing with liquid tight connections for whole body (Type 3) conforming to the relevant standards such as BS 8428 or EN 14605 in combination with breathing apparatus conforming to BS EN 137.
[note 3] In such cases due care must be exercised to avoid unnecessary pollution of surface and groundwaters and wherever possible control measures such as the sealing of drains should be employed.

[note 4] People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and ventilation stopped Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 m away from the incident.
[note 5] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137.

Reference

'Dangerous Goods Emergency Action Code List'. National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. The Stationery Office (2023).
(viewed March 2024)

Table 2. The GB classification, labelling and packaging (CLP) regulation for phosphine

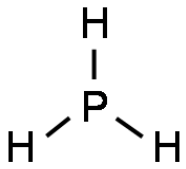
Hazard class and category	Flam. Gas 1	Flammable gas, category 1	
	Press. Gas	Compressed gas	
	Acute Tox. 1	Acute toxicity, category 1	
	Skin Corr. 1B	Skin corrosion, category 1B	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
Hazard statement	H220	Extremely flammable gas	
	H330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

Reference

The Health and Safety Executive (HSE). 'GB CLP Regulation' (viewed March 2024)

Physicochemical properties

Table 3. Physicochemical properties

CAS number	7803-51-2
Molecular weight	34
Formula	PH_3
Common synonyms	Phosphine, phosphane, hydrogen phosphide, phosphorous (tri)hydride
State at room temperature	Colourless gas
Volatility	Vapour pressure = 3488 kPa at 20 °C
Relative density	(Water = 1) 0.8 (Air = 1) 1.18
Flammability	Flammable, explosive
Lower explosive limit	1.79%
Upper explosive limit	Dangerous fire hazard from spontaneous chemical reaction
Water solubility	Slightly solube
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. Decomposes on heating or burning producing fumes including phosphorus oxides. Liberates hydrogen when passed over heated metal. Forms phosphonium salts when brought into contact with halogen acids
Odour	Pure phosphine is odourless. Industrial phosphine has a garlic or decaying fish-like odour
Structure	

References

International Programme on Chemical Safety. International Chemical Safety Card entry for Phosphine. ICSC 0694, 2013. World Health Organization: Geneva. (viewed March 2024)

PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2004-. PubChem Compound Summary for CID 24404, Phosphine. (viewed March 2024)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation

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

Reference

International Programme on Chemical Safety (IPCS). Phosphine and selected metal phosphides (EHC 73, 1988). (viewed March 2024).

Published emergency response guidelines

Table 5. Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1 [note 1]	NR	NR	NR	NR	NR
AEGL-2 [note 2]	4.0	4.0	2.0	0.50	0.25
AEGL-3 [note 3]	7.2	7.2	3.6	0.90	0.45

Notes to Table 5

[note 1] Level of the chemical in air at or above which the general population could experience notable discomfort.
[note 2] 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.
[note 3] Level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

Reference

US Environmental Protection Agency (EPA) ‘Acute Exposure Guideline Levels’ (viewed March 2024)

Exposure standards, guidelines or regulations

Table 6. Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	**mg/m³**	**ppm**	**mg/m³**
WEL	0.1	0.14	0.2	0.28

Abbreviations

WEL = workplace exposure limit.
LTEL = long-term exposure limit.
STEL = short-term exposure limit.

Reference

HSE. 'EH40/2005 Workplace Exposure Limits . Fourth Edition' (2020) (viewed March 2024)

Table 7. Public health standards and guidelines

UK drinking water standard	No guideline value specified
WHO guideline for drinking water quality	No guideline value specified
WHO air quality guideline	No guideline value specified

Health effects

Very highly toxic by inhalation

Table 8. Signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	The initial symptoms of toxicity from inhalation of phosphine are gastrointestinal rather than respiratory. GI upset may be so striking that clinicians may diagnose acute gastroenteritis. Consciousness is usually only mildly depressed. Inhaled phosphine is cardiotoxic. Palpitations, sinus tachycardia/bradycardia, conduction disturbances (including RBBB and Brugada syndrome), 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, convulsions and ataxia have been reported. Electrolyte abnormalities may occur but are thought to be secondary to vomiting. Methaemoglobinaemia has also been reported as a rare complication.
Ocular	Irritation, diplopia, blurred vision and xanthopsia may develop.
Dermal	Localised sweating, irritation, and paraesthesiae have been reported.

Reference

TOXBASE. Phosphine. June 2020 (viewed March 2024)

Decontamination at the scene

Chemical specific advice

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 at 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 the UK Health Security Agency (UKHSA) Radiation, Chemicals and Environment Directorate 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 persons individually.

Detailed information on clinical management can be found on TOXBASE.

Important notes

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.

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.

For comprehensive clinical advice consult TOXBASE directly.

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.

Avoid contaminating yourself with this product and wash any exposed area.

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 copious amounts of water under low pressure for at least 10 to 15 minutes.

Pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears.

The earlier irrigation begins, the greater the benefit.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

Following decontamination, apply a soothing cram 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 to 15 minutes.

Amphoteric, hypertonic, chelating solutions may be used if available.

Refer for ophthalmological assessment if necessary.
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.

Check and record pupil size.

In the presence of methaemoglobinaemia pulse oximetry is unreliable

Perform a 12-lead ECG in all patients who require assessment

Other measures as indicated by the patient's clinical condition

For comprehensive advice on clinical first aid, clinicians should consult TOXBASE directly.

Clinical decontamination and first aid references

TOXBASE Phosphine (June 2020) (viewed March 2024).
TOXBASE Skin decontaminations – irritants (May 2019).

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

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339

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