Public Health England

Protecting and improving the nation's health

Phosgene

Incident Management

Key Points

General

- gas at room temperature
- freshly mown or musty hay odour
- non-flammable
- decomposes on contact with water or moisture to produce corrosive hydrogen chloride and carbon monoxide

Health effects

- inhalation and ocular contact are the most likely routes of exposure
- airway and mucous membrane irritation, leading to coughing, choking, tearing, and pain and tightness in the chest follow soon after exposure
- lung damage, pulmonary oedema and respiratory failure may develop following latent phase
- skin contact with phosgene gas can cause irritation and damage to the skin
- eye exposure may cause irritation and delayed features including photophobia and excessive lacrimation

Casualty decontamination at the scene

- direct contact with liquid phosgene under pressure can cause severe irritation and corrosive damage, whilst in the presence of water (sweat), phosgene gas slowly hydrolyses to form hydrochloric acid, which can irritate and damage cells; therefore, following disrobe, improvised wet decontamination should be considered

Environment

- hazardous to the environment; inform the Environment Agency where appropriate
- spillages and decontamination run-off should be prevented from entering watercourses

PHE publications gateway number: 2014790

Published: August 2019

Hazard Identification

Standard (UK) dangerous goods emergency action codes

UN		1076	Phosgene	
EAC		2XE	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. 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†	
APP		B	Gas-tight chemical protective suit with breathing apparatus‡	
Hazards	**Class**	2.3	Toxic gas	
	Sub-risks	8	Corrosive substance	
HIN		268	Toxic gas, corrosive	

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

‡ Chemical protective clothing should be gas tight 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, 2019.

Classification, labelling and packaging (CLP)*

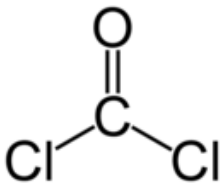
Hazard class and category	Press. Gas	Gas under pressure	
	Skin Corr. 1B	Skin corrosion, category 1B	
	Acute Tox. 2	Acute toxicity (inhalation), category 2	
Hazard statement	H314	Causes severe skin burns and eye damage	
	H330	Fatal if inhaled	
Signal words	DANGER		

* Implemented in the EU on 20 January 2009

Reference

European Commission. Harmonised classification – Annex VI of 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 03/2019).

Physicochemical Properties

CAS number	75-44-5
Molecular weight	99
Formula	CCl_2O
Common synonyms	Carbonyl chloride, chloroformyl chloride
State at room temperature	Gas
Volatility	Vapour pressure = 1420 mmHg at 25°C
Specific gravity **Vapour density**	1.4 at 20°C (water = 1) 3.4 (air = 1)
Flammability	Non-combustible
Lower explosive limit	–
Upper explosive limit	–
Water solubility	Slightly soluble
Reactivity	Decomposes above 300°C. Reacts violently with ethanol, strong oxidants, ammonia, amines and aluminium. Attacks many metals in the presence of water
Reaction or degradation products	Decomposes on contact with water or moisture to produce corrosive hydrogen chloride and carbon monoxide
Odour	Freshly mown or musty hay odour
Structure	

References

Hazardous Substances Data Bank. Phosgene. HSDB No. 113 (last revision date 22/04/2008). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 03/2019).

International Programme on Chemical Safety. International chemical safety card entry for phosgene. ICSC 0007, 2013. World Health Organization: Geneva.

Reported Effect Levels from Authoritative Sources

Exposure by inhalation

ppm	mg/m^3	Signs and symptoms	Reference
> 3	> 12	Discomfort and irritation of the eye, nasopharynx and upper respiratory tract	a
ppm-min*	**mg/m^3-min***	**Signs and symptoms**	**Reference**
> 30	> 120	Beginning of lung damage	b
> 150	> 600	Pulmonary oedema	c
300	1,200	Approximate lethal dose	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

* Dose is usually expressed as the product of the atmospheric concentration in the breathing zone and the exposure duration (or ppm min)

References

a TOXBASE. Phosgene, 02/2019. http://www.toxbase.org (accessed 03/2019).

b International Programme on Chemical Safety. Phosgene. Environmental Health Criteria 193, 1997. World Health Organization: Geneva.

c Scientific Committee on Occupational Exposure. Recommendation from the Scientific Committee on Occupational Exposure Limits for phosgene. 2011.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m3)
ERPG-1*	NA	–
ERPG-2†	0.5	2
ERPG-3‡	1.5	6

* 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 03/2019).

Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2†	0.60	0.60	0.30	0.080	0.040
AEGL-3‡	3.6	1.5	0.75	0.20	0.090

* 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 due to insufficient data

Reference

US Environmental Protection Agency. Acute Exposure Guideline Levels. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 03/2019).

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	0.02	0.08	0.06	0.25

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	No guideline values specified
Air quality guideline	No guideline values specified

Health Effects

Major route of exposure

- inhalation and ocular contact are the most likely routes of exposure; ingestion is unlikely as liquid phosgene rapidly vaporises when released

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Three distinct clinical phases are recognised **Initial phase:** characterised soon after exposure by airway and mucous membrane irritation, leading to coughing, choking, tearing, and pain and tightness in the chest The presence or absence of initial symptoms does not reflect the severity of poisoning as pulmonary oedema may still develop up to 24 hours (rarely 72 hours) later in individuals who show minimal or no immediate effects **Second phase:** may last from 1 to 24 hours and may be without symptoms or there may be non-specific symptoms such as headache, nausea and vomiting. This latent phase is inversely proportional to the dose of phosgene **Third phase:** lung damage from high doses may result in pulmonary oedema and respiratory failure may develop. Rarely, in very severe cases, circulatory collapse may follow the development of pulmonary oedema. The majority of fatal cases die within 48 hours of exposure
Dermal	Direct contact with liquid phosgene under pressure can cause frostbite as well as severe irritation and corrosive damage. In the presence of water (sweat), phosgene slowly hydrolyses to hydrochloric acid, which can irritate and damage cells. Pain, blistering and ulceration have been reported
Ocular	Exposure to phosgene at concentrations greater than 3 ppm can cause eye irritation. Delayed ocular features are also possible with development of photophobia and excessive lacrimation

Reference

TOXBASE. Phosgene, 02/2019. http://www.toxbase.org (accessed 03/2019).

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.

Direct contact with liquid phosgene under pressure can cause severe irritation and corrosive damage. In the presence of water (sweat), phosgene gas slowly hydrolyses to form hydrochloric acid, which can irritate and damage cells. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details).

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.

General advice on disrobe and decontamination

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 (e.g. blue roll) and clean cloth

- 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 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
- 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

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

Home Office. Initial operational response to a CBRN incident. Version 2.0, July 2015.

NHS England. Emergency Preparedness, Resilience and Response (EPRR). Guidance for the initial management of self presenters from incidents involving hazardous materials. February 2019.

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 notes

- in the presence of water (sweat), phosgene gas slowly hydrolyses to hydrochloric acid, which can irritate and damage cells
- **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

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
- do **not** apply neutralising chemicals as heat produced during neutralisation reactions may cause thermal burns, and increase injury
- 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 copious amounts of water under low pressure for at least 10–15 minutes, or until the pH of the skin is normal (pH of the skin is 4.5–6, although it may be closer to 7 in children, or after irrigation). **The earlier irrigation begins, the greater the benefit**
- pay special attention to mucous membranes, moist areas skin folds, fingernails and ears

Dermal exposure

- decontaminate (as above) the patient following surface contamination
- following decontamination recheck the pH of affected areas after a period of 15–20 minutes and repeat irrigation if abnormal; burns with strong solutions may require irrigation for several hours or more
- once the pH is normal and stabilised, treat as for a thermal injury

- burns totalling more than 15% of body surface area in adults (more than 10% in children) will require standard fluid resuscitation as for thermal burns
- moderate/severe chemical burns should be reviewed by a burns specialist
- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- remove contact lenses if present
- anaesthetise the eye with a topical local anaesthetic (e.g. oxybuprocaine, amethocaine or similar); **however, do not delay irrigation if local anaesthetic is not immediately available**
- immediately irrigate the affected eye thoroughly with 1,000 mL 0.9% saline (e.g. by an infusion bag with a giving set) for a minimum of 10-15 minutes irrespective of initial conjunctival pH. Amphoteric solutions are available and may be used. A Morgan Lens may be used if anaesthetic has been given. Aim for a final conjunctival pH of 7.5–8.0. The conjunctivae may be tested with indicator paper. Retest 20 minutes after irrigation and use further irrigation if necessary
- repeated instillation of local anaesthetics may reduce discomfort and help more thorough decontamination; however, prolonged use of concentrated local anaesthetics is damaging to the cornea
- patients with corneal damage or those whose symptoms do not resolve rapidly should be discussed **urgently** with an ophthalmologist
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- maintain a clear airway and ensure adequate ventilation
- monitor vital signs, cardiac rhythm and check capillary blood sugar
- perform 12 lead ECG in all patients that require assessment
- if the oxygen saturation falls below 94%, patients should receive the lowest concentration of supplemental oxygen to maintain their SaO_2 in the normal range
- asymptomatic patients should be observed for 24 hours
- other supportive measures as indicated by the patient's clinical condition

Clinical decontamination and first aid reference

TOXBASE http://www.toxbase.org (accessed 03/2019)

TOXBASE Phenol, 02/2019

TOXBASE Phenol – features and management, 02/2019

TOXBASE Skin decontamination – corrosives, 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.

First published: May 2016

Full document update: August 2019

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

For all other enquiries, please contact: phe.enquiries@phe.gov.uk