UK Health Security Agency

Phosgene

Incident management

This document provides information needed for response to a chemical incident, such as physicochemical properties, health effects and decontamination advice.

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Contents

Incident management 1
Contents 2
Main points 3
- General 3
- Health 3
- Casualty decontamination at the scene 3
- Environment 3

Hazard identification 4
Physicochemical properties 6
Reported effect levels from authoritative sources 7
Published emergency response guidelines 8
Exposure standards, guidelines or regulations 9
Health effects 10
Decontamination at the scene 11
- Chemical specific advice 11
- Disrobe 11
- Improvised decontamination 12
- Improvised dry decontamination 12
- Improvised wet decontamination 12
- Additional notes 13
- Interim wet decontamination 13
- Decontamination at the scene references 13

Clinical decontamination and first aid 15
- Important notes 15
- Clinical decontamination following surface contamination 15
- Dermal exposure 16
- Ocular exposure 16
- Inhalation 17
- Clinical decontamination and first aid references 17

About the UK Health Security Agency 18

Main points

General

Phosgene is gas at room temperature. It has a characteristic freshly mown or musty hay odour. Phosgene is non-flammable. Decomposes on contact with water or moisture to produce corrosive hydrogen chloride and carbon dioxide.

Health

Inhalation and ocular contact are the most likely routes of exposure.

There are three distinct clinical phases following inhalation exposure.

In the initial phase following inhalation airway and mucous membrane irritation, leading to coughing, choking, tearing, and pain and tightness in chest can occur

The presence or absence of initial symptoms does not reflect the severity of poisoning as pulmonary oedema may still develop 24 hours (rarely 72 hours) later in individuals who show minimal or no immediate effects.

The second phase may last from 1 to 24 hours and may be without symptoms or with non-specific symptoms such as headache, nausea and vomiting.

In the third phase, lung damage from high doses may result in pulmonary oedema and respiratory failure may develop.

In the presence of water (sweat), phosgene slowly hydrolyses to hydrochloric acid, which can irritate and damage 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

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

Hazard identification

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

UN		1076	Phosgene	
EAC		2XE	Use fine water spray. Wear chemical protective clothing with liquidtight connections for whole body in combination with breathing apparatus [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters. There may be a public safety hazard outside the immediate area of the incident [note 2].	
APP		B	Gas-tight chemical protective suit with breathing apparatus [note 3]	
Hazards	**Class**	2.3	Toxic gas	
	Sub-risks	8	Corrosive substance	
HIN		268	Toxic gas, corrosive	

Abbreviations

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

Notes to Table 1

Note 1: 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 2: 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 3: Chemical protective clothing should be gas tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137.

References

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

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

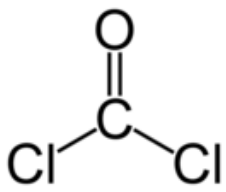
Hazard class and category	Press. gas	Gas under pressure	
	Skin Corr. 1B	Skin corrosion, category 1B	
	Acute Tox. 2	Acute toxicity (inhalation), category 2	
Hazard statement	H314	Causes severe skin burns and eye damage	
	H330	Fatal if inhaled	
Signal words	DANGER		

References

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

Physicochemical properties

Table 3. 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	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 and 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

International Programme on Chemical Safety. International chemical safety card entry for phosgene. ICSC 0007, 2013. World Health Organization: Geneva. (viewed September 2024)

PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2004-. PubChem Compound Summary for CID 6371, Phosgene (viewed September 2024)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation of vapours

ppm	mg/m^3	Signs and symptoms	Reference
> 3	> 12	Discomfort and irritation of the eye, nasopharynx and upper respiratory tract	a
ppm-min [note 1]	**mg/m^3-min [note 1]**	**Signs and symptoms**	**Reference**
> 30	> 120	Beginning of lung damage	b
> 150	> 600	Pulmonary oedema	b
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.

Note 1: The extent of respiratory injury from phosgene exposure is mainly determined by exposure dose rather than concentration. Dose is usually expressed as the product of the atmospheric concentration in the breathing zone and the exposure duration (or ppm-minutes).

References

a. TOXBASE. Phosgene, 06/2024. (viewed September 2024).

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

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]	0.60	0.60	0.30	0.080	0.040
AEGL-3 [note 3]	3.6	1.5	0.75	0.20	0.090

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.

NR = Not recommend due to insufficient data

Reference

US Environmental Protection Agency (EPA) 'Acute Exposure Guideline Levels' (viewed September 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	0.02	0.08	0.06	0.25

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)

Table 7. Public health standards and guidelines

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

Health effects

Inhalation and ocular contact are the most likely routes of exposure, ingestion is unlikely as liquid phosgene rapidly vaporises when released.

Table 8. 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. Most survivors make a complete recovery, although exertional dyspnoea and reduced physical fitness may occur for several months after exposure. Those with chronic lung conditions such as chronic obstructive pulmonary disease are more likely to develop these longer-term effects. Complete recovery after phosgene exposure may take several years.
Eyes	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.
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.

Reference

TOXBASE. Phosgene, February 2019 (viewed June 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.

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.

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 the UK Health Security Agency (UKHSA) Radiation, Chemicals and Environment Directorate 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, disrobing should be conducted at the scene and by the casualty themselves. Disrobing should be systematic to prevent transfer of contaminant from clothing to skin. Clothing should not be pulled over the head if possible.

Clothing stuck to the casualty by the contaminant should not be forcefully removed, as this risks causing further harm.

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 or clothes.

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.

Unprotected first responders and members of the public should not approach casualties incapacitated by exposure to administer improvised decontamination, as they may be exposed to contaminants and become a casualty themselves.

Important note: Improvised decontamination should continue until more structured interventions such as Interim or Specialist Operational Response are present.

Improvised dry decontamination

Any available dry absorbent material can be used such as kitchen towel, paper tissues (for example blue roll) and clean cloth.

Exposed skin surfaces should be blotted first and then rubbed, starting with the face, head, and neck, and moving down and away from the body.

Blotting and rubbing should not be too aggressive, as it could drive contamination further into the skin.

Casualties should also blow their nose to remove contaminants from the nasal cavities.

All waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage.

Improvised wet decontamination

Wet decontamination should be used if contamination with a caustic chemical substance is suspected.

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 copious amounts of water from any available source such as taps, showers, water bottles, fixed installation hose-reels and sprinklers to gently rinse the affected skin. Other natural sources of water may be considered unless this

creates greater risks to the individuals affected. Wet wipes or baby wipes may be used as an effective alternative.

Improvised decontamination should not involve overly aggressive methods to remove contamination as this could further damage affected tissues and 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 and so on) 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.

When vulnerable people are affected by a hazardous substance, they may need additional support to remove themselves, their clothing or the substance.

Casualties should remain in the area and should not leave to seek care at a hospital, as this presents a contamination risk. Further care will be administered on site by the appropriate emergency services.

Interim wet decontamination

Interim decontamination is the use of standard Fire and Rescue Service 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)

JESIP. 'Initial Operational Response IOR to Incidents Suspected to Involve Hazardous Substances or CBRN Materials' (June 2024)

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

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.

For comprehensive clinical advice consult TOXBASE directly.

Clinical decontamination following surface contamination

Avoid contaminating yourself.

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 copious amounts of water under low pressure for at least 10-15 minutes, or until pH of 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 skin folds, fingernails and ears.

Dermal exposure

Recheck 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. Attention should be paid to avoiding hypothermia during prolonged irrigation with cool fluids.
Once the pH is normal and stabilised, treat as per a thermal injury.

Burns totalling more than 15% of body surface area in adults (>10% in children) will require standard fluid resuscitation as for thermal burns.

Moderate/severe chemical burns should be reviewed by a burns specialist.

NB Alkalis in particular may penetrate deeply within a few minutes.

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 (for example, oxybuprocaine, amethocaine or similar). However, do not delay irrigation if local anaesthetic is not immediately available.

Immediately irrigate the affected eye thoroughly with 1,000mL 0.9% saline or equivalent crytalloid (for example, by an infusion bag with a giving set) for a minimum of 10 to 15 minutes irrespective of initial conjunctival pH. A Morgan Lens may be used if anaesthetic has been given.

Aim for a neutral conjunctival pH of 7 to 7.2. The conjunctivae may be tested with indicator paper. Retest at 15 - 30 minutes after irrigation and use further irrigation if necessary.

Any particles lodges in the conjunctival recesses should be removed.

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, those who have been exposed to strong acids or alkalis and 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.

Administer oxygen to achieve adequate oxygenation.

Monitor vital signs and cardiac rhythm; check the capillary blood glucose.

Perform 12 lead ECG in all patients that require assessment.

Monitor oxygen saturation and pulmonary function.

All patients should be observed for 24 hours following exposure.

Other supportive measures as indicated by the patient's clinical condition.

Clinical decontamination and first aid references

TOXBASE (viewed September 2024)

TOXBASE Phosgene, (2024)

TOXBASE Skin decontamination – corrosives, (2000)

TOXBASE Chemicals splashed or sprayed into the eyes, (2020)

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.

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339

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