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
### Hazard Identification

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

<table>
<thead>
<tr>
<th>UN</th>
<th>1076</th>
<th>Phosgene</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAC</td>
<td>2XE</td>
<td>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†</td>
</tr>
<tr>
<td>APP</td>
<td>B</td>
<td>Gas-tight chemical protective suit with breathing apparatus‡</td>
</tr>
<tr>
<td>Hazards</td>
<td>Class</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Sub-risks</td>
<td>8</td>
</tr>
<tr>
<td>HIN</td>
<td>268</td>
<td>Toxic gas, corrosive</td>
</tr>
</tbody>
</table>

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**

## Classification, labelling and packaging (CLP)*

<table>
<thead>
<tr>
<th>Hazard class and category</th>
<th>Press. Gas</th>
<th>Gas under pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Corr. 1B</td>
<td>Skin corrosion, category 1B</td>
<td></td>
</tr>
<tr>
<td>Acute Tox. 2</td>
<td>Acute toxicity (inhalation), category 2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hazard statement</th>
<th>H314</th>
<th>Causes severe skin burns and eye damage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H330</td>
<td>Fatal if inhaled</td>
</tr>
</tbody>
</table>

**Signal words**
- DANGER

* Implemented in the EU on 20 January 2009

**Reference**
**Physicochemical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS number</td>
<td>75-44-5</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>99</td>
</tr>
<tr>
<td>Formula</td>
<td>CCl(_2)O</td>
</tr>
<tr>
<td>Common synonyms</td>
<td>Carbonyl chloride, chloroformyl chloride</td>
</tr>
<tr>
<td>State at room temperature</td>
<td>Gas</td>
</tr>
<tr>
<td>Volatility</td>
<td>Vapour pressure = 1420 mmHg at 25°C</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.4 at 20°C (water = 1)</td>
</tr>
<tr>
<td>Vapour density</td>
<td>3.4 (air = 1)</td>
</tr>
<tr>
<td>Flammability</td>
<td>Non-combustible</td>
</tr>
<tr>
<td>Lower explosive limit</td>
<td>–</td>
</tr>
<tr>
<td>Upper explosive limit</td>
<td>–</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Slightly soluble</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Decomposes above 300°C. Reacts violently with ethanol, strong oxidants, ammonia, amines and aluminium. Attacks many metals in the presence of water</td>
</tr>
<tr>
<td>Reaction or degradation products</td>
<td>Decomposes on contact with water or moisture to produce corrosive hydrogen chloride and carbon monoxide</td>
</tr>
<tr>
<td>Odour</td>
<td>Freshly mown or musty hay odour</td>
</tr>
<tr>
<td>Structure</td>
<td><img src="structure.png" alt="structure" /></td>
</tr>
</tbody>
</table>

**References**


## Reported Effect Levels from Authoritative Sources

### Exposure by inhalation

<table>
<thead>
<tr>
<th>ppm</th>
<th>mg/m³</th>
<th>Signs and symptoms</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 3</td>
<td>&gt; 12</td>
<td>Discomfort and irritation of the eye, nasopharynx and upper respiratory tract</td>
<td>a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ppm-min*</th>
<th>mg/m³-min*</th>
<th>Signs and symptoms</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 30</td>
<td>&gt; 120</td>
<td>Beginning of lung damage</td>
<td>b</td>
</tr>
<tr>
<td>&gt; 150</td>
<td>&gt; 600</td>
<td>Pulmonary oedema</td>
<td>c</td>
</tr>
<tr>
<td>300</td>
<td>1,200</td>
<td>Approximate lethal dose</td>
<td>a</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th></th>
<th>Listed value (ppm)</th>
<th>Calculated value (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERPG-1*</td>
<td>NA</td>
<td>–</td>
</tr>
<tr>
<td>ERPG-2†</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>ERPG-3‡</td>
<td>1.5</td>
<td>6</td>
</tr>
</tbody>
</table>

* 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

**Reference**

#### Acute exposure guideline levels (AEGLs)

<table>
<thead>
<tr>
<th></th>
<th>Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 min</td>
</tr>
<tr>
<td>AEGL-1*</td>
<td>NR</td>
</tr>
<tr>
<td>AEGL-2†</td>
<td>0.60</td>
</tr>
<tr>
<td>AEGL-3‡</td>
<td>3.6</td>
</tr>
</tbody>
</table>

* 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

**Reference**
Exposure Standards, Guidelines or Regulations

**Occupational standards**

<table>
<thead>
<tr>
<th></th>
<th>LTEL (8-hour reference period)</th>
<th>STEL (15-min reference period)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ppm mg/m³</td>
<td>ppm mg/m³</td>
</tr>
<tr>
<td>WEL</td>
<td>0.02 0.08</td>
<td>0.06 0.25</td>
</tr>
</tbody>
</table>

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

**Reference**


**Public health guidelines**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking water standard</td>
<td>No guideline values specified</td>
</tr>
<tr>
<td>Air quality guideline</td>
<td>No guideline values specified</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Route</th>
<th>Signs and symptoms</th>
</tr>
</thead>
</table>
| 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

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


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 hydrolysae 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 $\text{SaO}_2$ 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