



UK Health  
Security  
Agency

# Sulphur Mustard (Mustard Gas)

## 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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## Main points

### General

Sulphur mustard, also known as mustard gas, is a yellow to brown oily liquid. It can have an odour of garlic, leeks or mustard.

It is combustible under specific conditions and reacts vigorously with oxidising agents.

It reacts with water and steam to produce fumes of hydrochloric acid and releases highly toxic fumes of sulphur oxides and hydrogen chloride when heated to decomposition.

### Health

Following exposure there may be a period during which individuals remain asymptomatic. The duration of this asymptomatic period is dependent on the mode of exposure, temperature and individual sensitivity. Features following exposure to sulphur mustard may be delayed by up to two hours.

Inhalation can cause rhinorrhoea, burning in the mouth and throat, nausea, fatigue and headache. Severe exposure may cause superficial damage to the vocal cords leading to hoarseness, cough, pain on coughing and aphonia.

Dermal exposure to the liquid or the vapour can severely blister the skin.

Ocular exposure causes irritation, lacrimation, conjunctival and lid oedema and erythema. In severe cases inflammation, intense pain, blepharospasm, photophobia and corneal damage can occur.

### Casualty decontamination at the scene

Sulphur mustard will cause vesicles and blisters in contact with the skin. Therefore, following disrobe, improvised wet decontamination should be considered.

### Environment

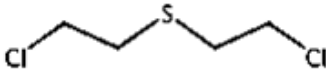
Inform the Environment Agency where appropriate and avoid release into the environment.

## Hazard identification

Mustard gas is not subject to GB classification labelling and packaging (GB CLP) requirements as it is a schedule 1 chemical warfare agent subject to international prohibition under the Chemical Weapons Convention. For more information visit:  
<http://www.opcw.org/chemical-weapons-convention/>

# Physicochemical properties

**Table 1. Physicochemical properties**

<b>CAS number</b>	505-60-2
<b>Molecular weight</b>	159
<b>Formula</b>	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> S
<b>Common synonyms</b>	Mustard gas; HD; Bis(2-Chlorethyl)Sulphide; Dichloroethyl Sulphide
<b>State at room temperature</b>	Yellow-brown oily liquid
<b>Volatility</b>	Vapour pressure: 0.11 mmHg at 25°C
<b>Specific gravity</b> <b>Vapour density</b>	1.27 (water = 1) 5.4 (air = 1) Sulphur mustard readily forms a vapour that is heavier than air that can accumulate in low lying areas.
<b>Flammability</b>	Combustible under specific conditions, flashpoint 105°C
<b>Lower explosive limit</b>	-
<b>Upper explosive limit</b>	-
<b>Water solubility</b>	0.0068 g/100ml at 25°C (very poor), high lipid solubility
<b>Reactivity and reaction or degradation products</b>	Emits highly toxic fumes of sulphur oxide and hydrogen chloride when heated to decomposition or when in contact with acid or acid fumes. Will react with water and steam to produce fumes of hydrochloric acid. Vigorous reaction with oxidising agents.
<b>Odour</b>	Garlic, mustard, leeks
<b>Structure</b>	 <chem>ClCCSCC</chem>

## References

International Programme on Chemical Safety. '[International chemical safety card entry for sulphur mustard](#)'. ICSC 0418, 2005. World Health Organization: Geneva (viewed September 2024)

PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information;. '[PubChem Compound Summary for CID 10461, Mustard gas](#)' 2004 (viewed September 2024)

## Reported effect levels from authoritative sources

**Table 2a. Exposure by skin (liquid exposure)**

$\mu\text{g}/\text{cm}^2$	Time of exposure	Signs and symptoms	Reference
50	5 minutes	Slight erythema	a
250 – 500	5 minutes	Blistering	a

**Table 2b. Exposure by skin (vapour exposure)**

$\text{mg}\cdot\text{min}/\text{m}^3$	Signs and symptoms	Reference
100 – 400	Erythema	a
200 – 1,000	Leads to blistering	a
750 – 1,000	Severe, incapacitating skin burns	a

**Table 2c Effects on the eyes (vapour exposure)**

$\text{mg}\cdot\text{min}/\text{m}^3$	Signs and symptoms	Reference
70	Mild reddening of the eyes	a
100	Partial incapacitation due to eye effects	a
200	Total incapacitation due to eye effects	a

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

### Reference

a. Maynard, R. L. (2007) Chapter 19: Mustard Gas. T.C. Marrs, R.L. Maynard and D.R. Sidell, Chemical warfare agents: toxicology and treatment second edition. John Wiley and Sons Ltd, Chichester.

## Published emergency response guidelines

**Table 3. Acute exposure guideline levels (AEGLs)**

	mg/m <sup>3</sup>				
	10 min	30 min	60 min	4 hours	8 hours
<b>AEGL-1</b> [note 1]	0.4	0.13	0.067	0.017	0.008
<b>AEGL-2</b> [note 2]	0.6	0.2	0.1	0.025	0.013
<b>AEGL-3</b> [note 3]	3.9	2.7	2.1	0.53	0.27

### Notes to Table 3

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 September 2024)

## Exposure standards, guidelines or regulations

There are no occupational standards or guidelines for sulphur mustard as it is a schedule 1 chemical warfare agent subject to international prohibition under the Chemical Weapons Convention. For more information visit: <http://www.opcw.org/chemical-weapons-convention/>



## Health effects

Inhalation and ocular or dermal exposure to sulphur mustard vapour or spray are the most likely routes.

Sulphur mustard vapour can rapidly penetrate clothing to damage the skin beneath.

Following exposure there may be a period during which individuals remain asymptomatic. The duration of this asymptomatic period is dependent on the mode of exposure, temperature and individual sensitivity. Features following exposure to sulphur mustard may be delayed by up to two hours.

**Table 4. Signs or symptoms of acute exposure**

Route	Signs and symptoms
<b>Inhalation</b>	Inhalation of mustard vapour damages mainly the upper respiratory tract, causing damage to the vocal cords leading to hoarseness, cough, pain on coughing, sneezing, loss of smell and taste and aphonia. More extensive exposure may also damage the lungs and predisposes to respiratory tract infections. Pulmonary oedema can be delayed in onset up to 24 to 72 hours in some cases.
<b>Ingestion</b>	Nausea, vomiting, abdominal pain, haematemesis and diarrhoea, and in severe cases cardiovascular shock and prostration, may occur within a few hours. Ocular, dermal and respiratory features may also ensue.
<b>Dermal</b>	Exposure to the liquid or vapour can produce erythema and blisters. Erythema usually appears within 8 hours but may take up to 24 hours; blistering begins 2 to 18 hours after onset of erythema. Mucous membranes and perspiration covered skin (e.g. axillae and genital area) are more sensitive to the effects. Hot, humid temperatures increase the action of mustards.  Development of blisters may be delayed and fresh blisters may appear up to two weeks after exposure. Pigmentation changes may occur as late skin manifestations.
<b>Ocular</b>	Exposure to liquid or vapour causes lacrimation, irritation, burning, redness, and oedema of the eyelids. Damage to the cornea and conjunctivae, photophobia and blindness may occur.
<b>Systemic features</b>	Mustard gas absorption causes bone marrow depression. CNS effects such as confusion, ataxia, hyporeflexia, and amnesia, have been reported.

### Reference

[TOXBASE](#). Sulphur mustard. September 2018 (viewed in September 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.

Sulphur mustard will cause vesicles and blisters in contact with the skin. 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

Improvised wet decontamination should be considered for an incident involving sulphur mustard.

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

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 to 15 minutes, or until pH of skin is normal (pH of the skin is between 4.5 and 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

Decontaminate (as above) the patient following surface contamination.

10% povidone-iodine ointment post-irrigation may protect against skin lesions.

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

Check and record pupil size.

Perform a 12 lead ECG in all patients that require assessment.

Skin lesions should be managed as thermal burns. Do not derroof intact blisters initially as this can increase the risk of infection.

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.

Refer to a specialist Burns Unit.

Although blisters may be extensive and appear severe they tend to be superficial and heal slowly without surgical intervention.

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 crystalloid (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.

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

Any particles lodged 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.

Sterile petroleum jelly applied to the eyelids helps prevent eyelids sticking together.

Symptomatic patient should be referred for urgent ophthalmological assessment.

Patients may develop photophobia and dark glasses may provide symptomatic relief.

Patients with eye damage should be reassured that eye problems should resolve, but this may take several weeks.

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

## Inhalation

Maintain a clear airway and ensure adequate ventilation.

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

Check and record pupil size.

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

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

## Clinical decontamination and first aid references

[TOXBASE](#) (viewed September 2024)

TOXBASE Nitrogen and sulphur mustard - features and management 2023



## 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](#).

This document from the UKHSA Radiation, Chemicals and Environment Directorate reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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