



UK Health
Security
Agency

Ethylene oxide

Incident management

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Key points

General

Colourless gas with a sweet ether-like odour.

Extremely flammable and explosive.

The substance may polymerise due to heating, under the influence of acids, bases, metal chlorides and metal oxides.

Health

Inhalation causes irritation to eyes, nose and respiratory tract, causing coughing, burning sensation in the mouth, dyspnoea, laryngospasm and bronchospasm.

Systemic effects include headache, nausea, vomiting, seizures, extrapyramidal features, myocardial ischaemia and arrhythmias; coma, cardiovascular collapse and respiratory arrest may occur in severe cases.

Dermal exposure causes erythema, blistering and ulceration; systemic features of toxicity may occur.

Ingestion causes irritation to mucous membranes, causing ulceration and pain.

Ocular exposure causes irritation to eyes, resulting in corneal damage and conjunctivitis.

Casualty decontamination at the scene

Ethylene oxide can cause blistering, burns and ulceration of the skin. Following disrobe, improvised wet decontamination should be considered.



Environment

Inform the Environment Agency where appropriate.







Avoid unnecessary pollution to watercourses.




Hazard identification

Standard (UK) dangerous goods emergency action codes

UN		1040	Ethylene oxide or ethylene oxide with nitrogen up to a total pressure of 1 MPa (10 bar) at 50°C	
EAC		2PE	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(fg)	Gas-tight chemical protective suit with breathing apparatus‡ Flammable gas	
Hazards	Class	2.3	Toxic gas	
	Sub-risks	2.1	Flammable gas	
HIN		236	Toxic gas, flammable	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* 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.</p> <p>† People should be warned to stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250m away from the incident.</p> <p>‡ Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2.</p> <p>Reference Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office 2021</p>				


Classification, labelling and packaging (CLP)

Hazard class and category	Press. Gas	Compressed gas	
	Flam. Gas 1	Flammable gas, category 1	
	Acute Tox. 3	Acute toxicity (oral, inhalation)	
	Skin Corr. 1	Skin corrosion, category 1	
	Eye Dam. 1	Eye damage, category 1	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	
	Muta. 1B	Germ cell mutagenicity, category 1B	

	Carc. 1B	Carcinogenicity, category 1B	
	STOT RE 1	Specific target organ toxicity after repeated exposure, category 1	
	Repr. 1B	Reproductive toxicity, category 1B	
Hazard statement	H220	Extremely flammable gas	
	H301	Toxic if swallowed	
	H314	Causes severe skin burns and eye damage	
	H318	Causes serious eye damage	
	H331	Toxic if inhaled	
	H335	May cause respiratory irritation	
	H336	May cause drowsiness or dizziness	
	H340	May cause genetic defects	
	H350	May cause cancer	
	H372	Causes damage to the nervous system through prolonged or repeated exposure	
	H360Fd	May damage fertility. Suspected of damaging the unborn child	

Signal words	DANGER
Reference European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures (viewed December 2021)	

Physicochemical properties

CAS number	75-21-8
Molecular weight	44.1
Formula	C ₂ H ₄ O
Common synonyms	1,2-epoxyethane, oxirane, dimethylene oxide
State at room temperature	Colourless gas
Volatility	Vapour pressure: 1095 mmHg at 20°C
Specific gravity Vapour density	0.9 (water = 1) 1.5 (air = 1)
Flammability	Extremely flammable
Lower explosive limit	3%
Upper explosive limit	100%
Water solubility	Miscible
Reactivity	Ethylene oxide is an extremely flammable gas at room temperature and normal pressure. The substance may polymerise due to heating, under the influence acids, bases, metal chlorides and metal oxides. This generates fire or explosion hazard. Decomposes above 560°C in the absence of air. This generates fire and explosion hazard
Odour	Sweet ether-like odour
Structure	
References	
International Programme on Chemical Safety. International Chemical Safety Card entry for ethylene oxide. ICSC 0155, 2015. World Health Organization: Geneva.	
PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2004-. PubChem Compound Summary for CID 6354, Ethylene oxide ; (viewed December 2021).	

Reported effect levels from authoritative sources

Exposure by inhalation

ppm	mg/m ³	Signs and symptoms	Reference
915–1,281	1,647–2,306	CNS effects (for example seizures)	a

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

References

a. International Programme on Chemical Safety. Ethylene oxide. Concise International Chemical Assessment. Document 54, 2003. World Health Organization: Geneva.

Exposure by skin

%	Duration of exposure	Signs and symptoms	Reference
1	50 minutes	Mild irritation, nausea and vomiting	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. International Programme on Chemical Safety. Ethylene Oxide. Environmental Health Criteria 55, 1985. World Health Organization: Geneva.

Published emergency response guidelines

Acute exposure guideline levels (AEGLs) (interim)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2†	80	80	45	14	7.9
AEGL-3‡	360	360	200	63	35

* 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](#) (viewed in December 2021)

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	1	1.8	No guideline value specified	
<p>WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit</p> <p>Reference HSE. EH40/2005 Workplace Exposure Limits, 4th Edition, 2020</p>				

Public health guidelines

WHO drinking water guideline	No guideline value specified
Air quality guideline	No guideline value specified

Health effects

Major route of exposure

The main routes of toxic exposure are inhalation and dermal exposure.

The odour threshold is 500 to 700 ppm. Toxicity may occur at a concentration below which the odour is detected.

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Inhalation causes irritation to the eyes, nose and respiratory tract, causing coughing, burning sensation in the mouth, dyspnoea, laryngospasm and bronchospasm. Exposure to high concentrations causes acute lung injury and severe hypoxia.
Ingestion	Ingestion causes irritation to mucous membranes, causing ulceration and pain.
Dermal	Dermal exposure causes erythema, blistering and ulceration. Concentrations above 40% may cause severe burns within one minute. Contact with liquid below 10.7°C produces local frostbite. Systemic features of toxicity may occur.
Ocular	Ocular exposure causes irritation to the eyes, resulting in corneal damage and conjunctivitis. Effects may be delayed.
Systemic	Systemic effects include headache, nausea, vomiting, stupor, vertigo, spontaneous nystagmus, impaired hearing, convulsions, extrapyramidal features, bradycardia, myocardial ischaemia ventricular bigeminy and arrhythmias. Loss of consciousness, coma, cardiovascular collapse and respiratory arrest may occur in severe cases.
References	
TOXBASE . Ethylene oxide. October 2018 (viewed December 2021)	

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.

Ethylene oxide can cause blistering and ulceration of the skin, concentrations more than 40% may cause severe burns within one minute. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details).

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 UK Health Security Agency (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, 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 (for example 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 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.

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.

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 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.

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. 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 the pH of the skin is normal (pH of the skin is 4.5 to 6, although it may be closer to 7 in children, or after irrigation). The earlier irrigation begins, the greater the benefit.

Pay particular attention to mucous membranes, moist areas such as 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 to 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 for a thermal injury. Other measures as indicated by the patient's clinical condition.

If features of systemic toxicity present, manage as per inhalation.

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 1,000 mL 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. Aim for a neutral conjunctival pH of 7.5 to 8.0. The conjunctivae may be tested with indicator paper. Retest 20 minutes after irrigation and use further irrigation if necessary.

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.

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.

Give oxygen if required.

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.

Ingestion

Maintain a clear airway and ensure adequate ventilation.

Give oxygen if required.

Consider activated charcoal if the patient presents within one hour of ingestion. Charcoal has been shown to adsorb ethylene oxide in vitro.

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 December 2021)

TOXBASE Ethylene oxide, 2018

TOXBASE Ethylene oxide – features and management, 2018

TOXBASE Skin decontamination – corrosives, 2020

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.

[UKHSA](#) is an executive agency, sponsored by the [Department of Health and Social Care](#).

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