UK Health Security Agency

Ethylene oxide

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

Main points

General

Ethylene oxide is a colourless gas with a sweet ether-like odour at room temperature. It is highly flammable and explosive. Ethylene oxide is miscible in water.

Ethylene oxide may polymerise due to heating and 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 and avoid release into the environment.

Hazard identification

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

UN		1040	Ethylene oxide or ethylene oxide with nitrogen up to a total pressure of 1MPa (10bar) 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 [note 1]. Substance can be violently or explosively reactive. Where there is an immediate threat to people, spillages and decontamination run-off may be washed to drains with large quantities of water [note 2]. There may be a public safety hazard outside the immediate area of the incident [note 3].	
APP		A(fg)	Fire kit with gas-tight chemical protective suit with breathing apparatus [note 4]. Flammable gas	
Hazards	**Class**	2.3	Toxic gases	
	Sub-risks	2.1	Flammable gases	
HIN		263	Toxic gas, flammable	

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: In such cases due care must be exercised to avoid unnecessary pollution of surface and groundwaters and wherever possible control measures such as the sealing of drains should be employed.

Note 3: 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 250m away from the incident.

Note 4: Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List'. 2025 (viewed on 07 March 2025)

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

Hazard class and category	Flam. Gas 1	Flammable gas, category 1	
	Press. Gas	Compressed gas	
	Carc. 1B	Carcinogenicity, category 1B	
	Muta. 1B	Germ cell mutagenicity, category 1B	
	Repr. 1B	Reproductive toxicity, category 1B	

	Acute Tox. 3	Acute toxicity (oral, inhalation)	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	
	STOT RE 1	Specific target organ toxicity after repeated exposure, category 1	
	Skin Corr. 1	Skin corrosion/irritation, category 1	
	Eye Dam. 1	Eye damage, category 1	
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

References

The Health and Safety Executive (HSE). ‘GB CLP Regulation’ (viewed on 07 March 2025)

Physicochemical properties

Table 3. Physicochemical properties

CAS number	75-21-8
Molecular weight	44.1
Formula	C_2H_4O
Common synonyms	1,2-epoxyethane, oxirane, dimethylene oxide
State at room temperature	Colourless gas
Volatility	Vapour pressure: 1095 mmHg at 20°C
Specific gravity	0.9 (water = 1) 1.5 (air = 1)
Flammability	Extremely flammable
Lower explosive limit	3%
Upper explosive limit	100%
Water solubility	Miscible
Reactivity	The substance may polymerise due to heating, under the influence of 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. Reacts violently with many compounds.
Odour	Sweet ether-like odour
Structure	

References

World Health Organization. International Programme on Chemical Safety ‘International Chemical Safety Card entry for Ethylene Oxide’ ICSC 0155, 2015 (viewed on 04 March 2025)

PubChem. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information. ‘PubChem Compound Summary for CID 6354, Ethylene Oxide’ (viewed on 04 March 2025)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation

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

Table 5. Dermal exposure

%	Duration of exposure	Signs and symptoms	Reference
1	50 minutes	Mild irritation, nausea, and vomiting	b

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. World Health Organization. International Programme on Chemical Safety 'Concise International Chemical Assessment for Ethylene Oxide' Document 54, 2003 (viewed on 04 March 2025)

b. World Health Organization. International Programme on Chemical Safety 'Environmental Health Criteria for Ethylene Oxide' EHC 55, 1985 (viewed on 04 March 2025)

Published emergency response guidelines

Table 6. 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]	80	80	45	14	7.9
AEGL-3 [note 3]	360	360	200	63	35

Notes to Table 6

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 recommended

Reference

US Environmental Protection Agency (EPA). ‘Acute Exposure Guideline Levels’ (viewed on 04 March 2025)

Exposure standards, guidelines or regulations

Table 7. Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	**mg/m³**	**ppm**	**mg/m³**
WEL	1	1.8	No values specified	

Abbreviations

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 Fourth Edition' 2020 (viewed on 04 March 2025)

Table 8. Public health standards and guidelines

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

Health effects

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**.**

Children may be at higher risk of toxicity following inhalation due to larger lung surface area to bodyweight ratio.

Table 9. Signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Irritating to eyes, nose and respiratory tract causing cough, burning sensation in the mouth, dyspnoea, laryngospasm, and bronchospasm. Exposure to high concentrations causes acute lung injury and hypoxia.
Ingestion	Irritant to mucous membranes causing ulceration and pain.
Eyes	Irritant to eyes resulting in corneal damage and conjunctivitis. Effects may be delayed.
Dermal	Erythema, blistering and ulceration may occur. Concentrations more than 40% may cause severe burns within 1 minute. Contact with liquid below 10.7°C produces local frostbite. Systemic features of toxicity may occur.
Systemic	Systemic features include headache, nausea, vomiting, hearing loss, stupor, vertigo, nystagmus, and extrapyramidal features. Cardiac effects include impaired hearing, bradycardia, arrhythmias, and myocardial ischaemia. Reduced conscious level, coma, convulsions, cardiovascular collapse and respiratory arrest may occur in severe cases. Reversible cerebral vasoconstriction syndrome with cerebral infarction has been reported. Hypersensitivity reactions have been reported.

Reference

National Poisons Information Service (NPIS). TOXBASE ‘ethylene oxide’ 2023 (viewed on 04 March 2025)

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 the UK Health Security Agency (UKHSA) Radiation, Chemicals, Climate and Environmental Hazards 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 a more structured intervention, such as an Interim Operational Response is conducted, 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.

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 2015 (viewed on 04 March 2025)

National Health Service England. 'Emergency Preparedness, Resilience and Response (EPRR): Guidance for the initial management of self-presenters from incidents involving hazardous materials' 2019 (viewed on 04 March 2025)

Joint Emergency Service Interoperability Programme. 'Initial Operational Response (IOR) to Incidents Suspected to Involve Hazardous Substances or CBRN Materials' 2024 (viewed on 04 March 2025)

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 4.5 to 6 although it may be closer to 7 in children, or after irrigation).

Pay particular attention to mucous membranes, moist areas such as skin folds, fingernails, and ears.

The earlier irrigation begins, the greater the benefit.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

Recheck 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 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.

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

Carry out 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.

Aim for a neutral conjunctival pH of 7 to 7.2. The conjunctivae may be tested with indicator paper. Retest at 15 to 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.

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. See TOXBASE for further information.

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.

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.

Carry out other measures as indicated by the patient's clinical condition.

Clinical decontamination and first aid references

National Poisons Information Service (NPIS). TOXBASE ‘ethylene oxide’ 2023 (viewed on 04 March 2025)

National Poisons Information Service (NPIS). TOXBASE ‘chemicals splashed or sprayed into the eyes - features and clinical management’ 2020 (viewed on 04 March 2025)

National Poisons Information Service (NPIS). TOXBASE ‘skin decontamination - corrosives’ 2019 (viewed on 04 March 2025)

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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