



Ethylene Oxide

Incident Management

Key Points

Fire

- extremely flammable
- reacts with water, strong acids, alkalis and oxidisers; chlorides of iron, tin and aluminium; and oxides of iron and aluminium
- emits toxic fumes of carbon dioxide when heated to decomposition; incomplete combustion releases carbon monoxide
- in the event of a fire involving ethylene oxide, use fine water spray and chemical protective clothing with liquid-tight connections and breathing apparatus

Health



- main routes of exposure are inhalation and skin contact
- 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

Environment








- avoid release to the environment; inform the Environment Agency of substantial incidents


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 gases	
HIN		263	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 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</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, 2015.</p>				

Classification, labelling and packaging (CLP)*

Hazard class and category	Press. Gas	Compressed gas	
	Flam. Gas 1	Flammable gas, category 1	
	Carc. 1B	Carcinogenicity, category 1B	
	Muta. 1B	Germ cell mutagenicity, category 1B	
	Acute Tox. 3	Acute toxicity (oral, dermal, inhalation), category 3	
	Eye Irrit. 2	Eye irritation, category 2	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	

	Skin Irrit. 2	Eye irritation, category 2	
Hazard statement	H220	Extremely flammable gas	
	H350	May cause cancer	
	H340	May cause genetic defects	
	H331	Toxic if inhaled	
	H319	Causes serious eye irritation	
	H335	May cause respiratory irritation	
	H315	Causes skin irritation	
Signal words	DANGER		
* Implemented in the EU on 20 January 2009			
Reference			
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 07/2015).			

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	0.9 (water = 1)
Vapour density	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. Vapours may travel to a source of ignition and flashback. Gas and air mixtures are explosive. Reacts with water, strong acids, alkalis and oxidisers; chlorides of iron, tin and aluminium; and oxides of iron and aluminium
Reaction or degradation products	Carbon dioxide is generated when heated to decomposition. Incomplete combustion releases carbon monoxide
Odour	Sweet, ether-like odour
Structure	
References	
Ethylene Oxide (HAZARDTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System, Truven Healthcare Analytics Inc, Greenwood Village CO, US. RightAnswer.com Inc, Midland MI, US. http://www.rightanswerknowledge.com (accessed 07/2015).	
International Programme on Chemical Safety. International Chemical Safety Card entry for ethylene oxide. ICSC 0155, 2001. World Health Organization: Geneva.	

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 (eg seizures)	a
<p>These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values</p> <p>Reference</p> <p>a International Programme on Chemical Safety. Ethylene Oxide. Concise International Chemical Assessment. Document 54, 2003. World Health Organization: Geneva.</p>			

Exposure by skin

%	Duration of exposure	Signs and symptoms	Reference
1	50 minutes	Mild irritation, nausea and vomiting	a
<p>These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values</p> <p>Reference</p> <p>a International Programme on Chemical Safety. Ethylene Oxide. Environmental Health Criteria 55, 1985. World Health Organization: Geneva.</p>			

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m ³)
ERPG-1*	NA	–
ERPG-2 [†]	50	90
ERPG-3 [‡]	500	900

* 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

NA Not appropriate

Reference
American Industrial Hygiene Association (AIHA). 2015 Emergency Response Planning Guideline Values. <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2015%20ERPG%20Levels.pdf> (accessed 08/2015).

Acute exposure guideline levels (AEGLs)

	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 an 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. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 08/2015).

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	5	9.2	No guideline value specified	
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, 2 nd Edition, 2011.				

Public health guidelines

Drinking water standard	No guideline value specified
Air quality guideline	No guideline value specified
Soil guideline values and health criteria values	No guideline value specified

Health Effects

Major route of exposure

- the main routes of toxic exposure are inhalation and dermal absorption
- 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 1 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 features	Systemic effects include headache, nausea, vomiting, seizures, extrapyramidal features, myocardial ischaemia and arrhythmias. Coma, cardiovascular collapse and respiratory arrest may occur in severe cases
Reference TOXBASE. Ethylene oxide, 05/2013. http://www.toxbase.org (accessed 11/2016).	

Decontamination at the Scene

Summary

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 1 minute. 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.

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 (eg 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

National Ambulance Resilience Unit. Joint Emergency Services Interoperability Programme (JESIP). Initial operational response to a CBRN incident. Version 1.0, September 2013.

NHS England. Emergency Preparedness, Resilience and Response (EPRR). Chemical incidents: planning for the management of self-presenting patients in healthcare settings. April 2015.

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 – www.toxbase.org.

Important notes

- if the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves
- ethylene oxide is associated with spontaneous abortion; pregnant women should consult their obstetric team following significant exposure
- carry out decontamination after resuscitation; resuscitate the patient according to standard guidelines

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 10-15 minutes
- **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
- treat burns conventionally
- monitor BP, pulse and conscious level
- perform a 12 lead ECG
- 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 (eg 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 (eg by an infusion bag with a giving set). A Morgan lens may be used if anaesthetic has been given. Irrigate for 10–15 minutes irrespective of initial conjunctival pH. 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, 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/ingestion

- maintain a clear airway and ensure adequate ventilation
- give oxygen if required
- monitor BP, pulse, oxygen saturation and conscious level
- perform a 12 lead ECG
- this agent may cause delayed onset lung injury following inhalation
- other supportive measures as indicated by the patient's clinical condition

Clinical decontamination and first aid references

- TOXBASE <http://www.toxbase.org> (accessed 11/2016)
- TOXBASE Ethylene oxide, 05/2013
- TOXBASE Chemical splashed or sprayed into the eyes, 02/2014

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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