



Carbon Monoxide

Incident Management

Key Points

Fire

- flammable gas
- may react violently with other substances
- in the event of a fire involving carbon monoxide, use fine water spray with normal firefighting clothing and breathing apparatus

Health



- inhalation is the major route of exposure
- may cause harm to the unborn child
- inhalation of carbon monoxide may lead to headache, nausea and vomiting, irritability, weakness and tachypnoea, followed by dizziness, confusion, ataxia, agitation, syncope, hypotension, seizures, impairment of consciousness and respiratory failure
- in serious cases, cerebral oedema and metabolic acidosis may develop
- reaction with haemoglobin displaces oxygen and leads to the formation of carboxyhaemoglobin
- the link between carboxyhaemoglobin concentration and clinical outcome is weak

Environment






- avoid release to the environment; inform the Environment Agency where appropriate

Hazard Identification

Standard (UK) dangerous goods emergency action codes

UN		1016	Carbon monoxide, compressed	
EAC		2SE	Use fine water spray. Wear normal fire kit 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		–	–	
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>* Normal firefighting clothing is appropriate, ie breathing apparatus conforming to BS EN137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots conforming to Home Office specification A29 or A30</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>Reference</p> <p>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	
	Acute Tox. 3	Acute toxicity (inhalation), category 3	
	Repr. 1A	Reproductive toxicity, category 1A	
	STOT RE 1	Specific target organ toxicity following repeated exposure, category 3	
Hazard statement	H220	Extremely flammable gas	
	H331	Toxic if inhaled	
	H360D	May damage the unborn child	
	H372	Causes damage to organs through prolonged or repeated exposure	
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 11/2015).			

Physicochemical Properties

CAS number	630-08-0
Molecular weight	28
Formula	CO
Common synonyms	–
State at room temperature	Gas
Volatility	Vapour pressure > 760 mmHg at 20°C
Vapour density	0.97 at 20°C (air = 1)
Flammability	Extremely flammable
Lower explosive limit	12.5%
Upper explosive limit	74.2%
Water solubility	Slightly soluble in water
Reactivity	May react vigorously with oxygen, acetylene, chlorine, fluorine or nitrous oxide. Mixes well with air; explosive mixtures are easily formed
Reaction or degradation products	Data not available
Odour	Odourless
Structure	$C \equiv O$
References International Occupational Safety and Health Information Centre. International chemical safety card entry for carbon monoxide. ISCS 0023, 1994. The Dictionary of Substances and their Effects (S Gangolli, Ed), 2 nd Edition, Volume 2, 1999. The Merck Index (14 th Edition). Carbon monoxide, Entry 1816, 2006.	

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m ³)
ERPG-1*	200	230
ERPG-2 [†]	350	403
ERPG-3 [‡]	500	575

* 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
American Industrial Hygiene Association (AIHA). 2015 Emergency Response Planning Guideline Values. <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2014%20ERPG%20Values.pdf> (accessed 11/2015).

Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2 [†]	420	150	83	33	27
AEGL-3 [‡]	1,700	600	330	150	130

* 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. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 11/2015).

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	30	35	200	232
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 values specified
Indoor air quality guideline	100 mg/m ³ (87 ppm) for 15 minutes 35 mg/m ³ (30 ppm) for 1 hour 10 mg/m ³ (8.7 ppm) for 8 hours 7 mg/m ³ (6.1 ppm) for 24 hours
Soil guideline values and health criteria values	No guideline values specified
Reference	
WHO. Guidelines for Indoor Air Quality: Selected Pollutants. 2010. World Health Organization: Geneva.	

Health Effects

Major route of exposure

- inhalation

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	<p>Headache, nausea and vomiting, irritability, weakness and tachypnoea may occur, followed by dizziness, confusion, ataxia, agitation, syncope, hypotension, seizures, impairment of consciousness and respiratory failure. Cerebral oedema and metabolic acidosis may develop in serious cases</p> <p>Less common features include skin blisters, rhabdomyolysis, compartment syndrome, acute renal failure, pulmonary oedema, dysrhythmias, myocardial infarction, retinal haemorrhages, cortical blindness, choreoathetosis and mutism. Cherry red skin colour associated with high carboxyhaemoglobin concentrations is rarely seen</p> <p>Indications of severity, one or more of the following:</p> <ul style="list-style-type: none"> • any new objective acute neurological signs, eg increased tone, upgoing plantars, coma • need for ventilation • ECG indication of infarction or ischaemia • clinically significant acidosis • initial carboxyhaemoglobin greater than 30% <p>The link between carboxyhaemoglobin concentration and clinical outcome is weak. Non-smokers will typically have a baseline carboxyhaemoglobin concentration of 1–2%. In smokers this baseline will be raised (5–10%)</p>
<p>Reference TOXBASE. Carbon monoxide, 10/2013. http://www.toxbase.org (accessed 11/2015).</p>	

Decontamination at the Scene

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.

Decontamination should not be necessary following exposure to carbon monoxide as it exists as a relatively unreactive gas at room temperature. Carbon monoxide may be stored as a liquid under pressure in cylinders for industrial use; this liquid will rapidly volatilise on release, though it may cause thermal burns on contact with skin.

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.

Clinical Decontamination and First Aid

Detailed information on clinical management can be found on TOXBASE – www.toxbase.org.

Important notes

- decontamination is unlikely to be required as carbon monoxide is a gas
- ambulance staff, paramedics and emergency department staff treating chemically contaminated casualties should be equipped with appropriate personal protective equipment (PPE)

Dermal exposure

- treat dermal and cold injuries conventionally
- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- not applicable

Inhalation

- maintain a clear airway and adequate ventilation
- give oxygen in as high a concentration as possible
- most pulse oximeters cannot distinguish between different forms of haemoglobin and are not reliable when carboxyhaemoglobin is present in the blood. It is therefore important to use a CO-pulse oximeter if COHb is to be measured
- perform a 12 lead ECG
- other supportive measures as indicated by the patient's clinical condition

Ingestion

- not applicable

Clinical decontamination and first aid reference

TOXBASE. Carbon monoxide, 10/2013. <http://www.toxbase.org> (accessed 01/2016).

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.

First published: May 2016

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