UK Health Security Agency

Carbon dioxide

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

Carbon dioxide is a non-combustible, colourless, tasteless, odourless gas. It dissolves in water to form carbonic acid. . Dusts of various metals including magnesium, zirconium, titanium, aluminium, chromium and manganese are ignitable and explosive when suspended in carbon dioxide.

Health

Inhalation is the main route of exposure.

Brief exposure to a slightly increased concentration of carbon dioxide is unlikely to cause serious symptoms. At moderately increased concentrations carbon dioxide may act as a respiratory stimulant and can cause agitation and euphoria followed by CNS depression.

At high concentrations loss of consciousness can occur in seconds and hypoxia within minutes.

Irritation of mucous membranes can occur at high concentration. Respiratory features may include coughing, bronchitis, bronchospasm and pneumonitis.

Additional features that may arise due to asphyxiation include: cyanosis, hypotension, respiratory depression, pulmonary oedema, cerebral oedema, hypercapnia, rhabdomyolysis, myocardial ischemia, atrial or ventricular dysrhythmias and asystole.

Eye or skin contact with dry ice can cause thermal burns and frost bite.

Casualty decontamination at the scene

Decontamination should not be necessary following exposure to carbon dioxide. Dermal contact with carbon dioxide may cause thermal injury, but not chemical burns.

Environment

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

Hazard identification

Table 1a. Standard (UK) dangerous goods emergency action codes for carbon dioxide

UN		1013	Carbon dioxide	
EAC		2T	Use fine water spray. Wear normal fire kit in combination with breathing apparatus [note 1]. 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].	
APP		–	–	
Hazards	**Class**	2.2	Non-flammable, non-toxic gases	
	Sub-risks	–	–	
HIN		20	Asphyxiant gas or gas with no subsidiary hazard	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1a

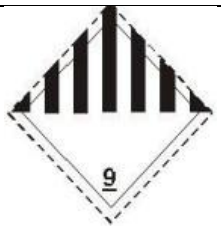
Note 1: Normal firefighting clothing is appropriate i.e., self-contained open circuit positive pressure compressed air breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, fire fighters' gloves conforming to BS EN 659 and firefighters' footwear conforming to BS EN 15090 (Footwear for firefighters) type F3- Hazmat and structural firefighting [CH – marking for chemical resistance] or alternatively firefighters' boots conforming to Home Office Specification A29 (rubber boots) or A30 (leather boots). Leather footwear including those conforming to A30 may not provide adequate chemical resistance therefore caution should be exercised in the use of these boots.

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.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List'. 2023 (viewed on 18 October 2024)

Table 1b. Standard (UK) dangerous goods emergency action codes for carbon dioxide, solid (dry ice)

UN		1845	Carbon dioxide, solid	
EAC		2T [note 1]	Use fine water spray. Wear normal fire kit in combination with breathing apparatus [note 2]. Where there is an immediate threat to people, spillages and decontamination run-off may be washed to drains with large quantities of water [note 3].	
APP		–	–	
Hazards	**Class**	9	Miscellaneous dangerous substances and articles	
	Sub-risks	–	–	
HIN		–	–	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1b

Note 1: Not applicable to the carriage of dangerous goods under the Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID), and the Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR).

Note 2: Normal firefighting clothing is appropriate i.e., self-contained open circuit positive pressure compressed air breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, fire fighters' gloves conforming to BS EN 659 and firefighters' footwear conforming to BS EN 15090 (Footwear for firefighters) type F3- Hazmat and structural firefighting [CH – marking for chemical resistance] or alternatively firefighters' boots conforming to Home Office Specification A29 (rubber boots) or A30 (leather boots). Leather footwear including those conforming to A30 may not provide adequate chemical resistance therefore caution should be exercised in the use of these boots.

Note 3: 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.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List'. 2023 (viewed on 18 October 2024)

Table 1c. Standard (UK) dangerous goods emergency action codes for carbon dioxide, refrigerated liquid

UN		2187	Carbon dioxide, refrigerated liquid	
EAC		2T	Use fine water spray. Wear normal fire kit in combination with breathing apparatus [note 1]. 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].	
APP		–	–	
Hazards	**Class**	2.2	Non-flammable, non-toxic gases	
	Sub-risks	–	–	
HIN		22	Refrigerated liquefied gas, Asphyxiant	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1c

Note 1: Normal firefighting clothing is appropriate i.e., self-contained open circuit positive pressure compressed air breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, fire fighters' gloves conforming to BS EN 659 and firefighters' footwear conforming to BS EN 15090 (Footwear for firefighters) type F3- Hazmat and structural firefighting [CH – marking for chemical resistance] or alternatively firefighters' boots conforming to Home Office Specification A29 (rubber boots) or A30 (leather boots). Leather footwear including those conforming to A30 may not provide adequate chemical resistance therefore caution should be exercised in the use of these boots.

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.

References

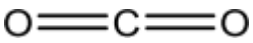
National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List'. 2023 (viewed on 18 October 2024)

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

Hazard class and category	No harmonised classification
Hazard statement	
Signal words	

Physicochemical properties

Table 3. Physicochemical properties

CAS number	124-38-9
Molecular weight	44.01
Formula	CO_2
Common synonyms	Carbonic acid gas, carbonic anhydride
State at room temperature	Colourless gas
Volatility	4.83 x 10^4 mmHg at 25ºC
Specific gravity	1.527 (air = 1)
Flammability	Non-combustible
Lower explosive limit	–
Upper explosive limit	–
Water solubility	Dissolves in water to form carbonic acid
Reactivity	Carbon dioxide does not react with common materials. Dusts of various metals including magnesium, zirconium, titanium, aluminium, chromium and manganese are ignitable and explosive when suspended in carbon dioxide. Carbon dioxide is incompatible with acrylaldehyde, aziridine, metal acetylides and sodium peroxide. Carbon dioxide decomposes above 2000ºC to produce carbon monoxide.
Odour	Odourless
Structure	

References

World Health Organization. International Programme on Chemical Safety 'International Chemical Safety Card entry for Carbon Dioxide' ICSC 0021, 2006 (viewed on 18 October 2024)

PubChem. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information 'PubChem Compound Summary for CID 280, Carbon Dioxide' (viewed on 18 October 2024)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation

%	Signs and symptoms	Reference
2-5	Headache, dizziness, sweating and shortness of breath	a
6-10	Hyperventilation, tachycardia and worsening dizziness	a
11-17	Drowsiness, muscle twitching and loss of consciousness	a
>17	Convulsions, coma and death	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. National Poisons Information Service (NPIS). TOXBASE ‘Carbon dioxide’ 2022 (viewed on 18 October 2024)

Published emergency response guidelines

Table 5. Acute exposure guideline levels (AEGLs)

	Concentration				
	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1 [note 1]	No values specified				
AEGL-2 [note 2]					
AEGL-3 [note 3]					

Notes to Table 5

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.

Exposure standards, guidelines or regulations

Table 6. Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	**mg/m³**	**ppm**	**mg/m³**
WEL	5000	9150	15000	27400

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 18 October 2024)

Table 7. Public health standards and guidelines

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

Health effects

Major route of exposure is via inhalation.

Table 8. Signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Brief exposure to a slightly increased concentration of carbon dioxide is unlikely to cause serious symptoms. At moderately increased concentrations carbon dioxide may act as a respiratory stimulant and can cause agitation and euphoria followed by CNS depression. At high concentrations asphyxiation may occur due to the displacement of oxygen by carbon dioxide in ambient air, though intoxication can also occur with normal atmospheric oxygen concentrations due to the reduced carbon dioxide diffusion gradient at the alveoli. At high concentrations loss of consciousness can occur in seconds and hypoxia within minutes. Deaths have been reported from exposure to carbon dioxide from dry ice within small spaces. Irritation of mucous membranes can occur at high concentration. Respiratory features may include coughing, bronchitis, bronchospasm and pneumonitis. Additional features that may arise due to asphyxiation include: cyanosis, hypotension, respiratory depression, pulmonary oedema, cerebral oedema, hypercapnia, rhabdomyolysis, myocardial ischemia, atrial or ventricular dysrhythmias and asystole.
Eyes and dermal	Eye or skin contact with dry ice can cause thermal burns and frost bite.

Reference

a. National Poisons Information Service (NPIS).TOXBASE ‘Carbon dioxide’ 2022 (viewed on 18 October 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.

Decontamination should not be necessary following exposure to carbon dioxide. Dermal contact with carbon dioxide may cause thermal injury, but not chemical burns.

Emergency services and public health professionals can obtain further advice from UK Health Security Agency (UKHSA) Radiation, Chemicals, Climate, and Environment Directorate using the 24-hour chemical hotline number: 0344 892 0555.

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

Decontamination is unlikely to be required for carbon dioxide.

If the patient is in an enclosed space, carbon dioxide is heavier than air and pockets of gas may persist.

Dermal exposure

Skin contact with dry ice should be treated as for thermal burns.

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

Inhalation

Ensure a clear airway and adequate ventilation.

Administer oxygen to achieve adequate oxygenation.

In the event of cardiac arrest in hospital or witnessed out of hospital cardiac arrest with prompt bystander CPR, resuscitation should be usually continued for at least 1 hour and only stopped after discussion with a senior clinician.

Prolonged resuscitation, even for several hours, may be appropriate following poisoning as recovery with good neurological outcome may occur.

Monitor vital signs and check capillary glucose.

Check and record pupil size.

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

Clinical decontamination and first aid references

National Poisons Information Service (NPIS).TOXBASE ‘Carbon dioxide’ 2022 (viewed on 18 October 2024)

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, Climate, and Environment Directorate reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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