



Hydrogen Cyanide

Incident Management

Key Points

General

- liquid with a boiling point of 26°C
- bitter almond-like odour – not all people can detect the odour
- extremely flammable
- on combustion, forms toxic and corrosive gases including nitrogen oxides

Health effects

- highly toxic
- exposure is usually by inhalation of hydrogen cyanide vapour; toxicity can occur within a few seconds
- toxicity from dermal exposure requires a large surface area to be affected; onset of symptoms may be delayed for several hours
- features of toxicity include headache, nausea, dizziness and anxiety, followed by confusion, drowsiness, tachycardia, palpitations and tachypnoea
- in severe cases deep coma, cardiovascular collapse and respiratory depression can occur

Casualty decontamination at the scene

- following disrobe, improvised dry decontamination should be considered for an incident involving hydrogen cyanide (liquid or vapour), unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances

Environment

- hazardous to the environment; inform the Environment Agency where appropriate
- spillages and decontamination run-off should be prevented from entering watercourses

Hazard Identification

Standard (UK) dangerous goods emergency action codes

Hydrogen cyanide, stabilised containing less than 3% water

UN		1051	Hydrogen cyanide, stabilised containing less than 3% water	
EAC		2WE ⁽¹⁾	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(fl)	Gas tight chemical protective suit with breathing apparatus‡ Flammable liquid	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	3	Flammable liquid	
HIN		–	–	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid-tight connections for whole body (Type 3) conforming to relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

† 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

‡ Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2

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

Reference

Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.

Hydrocyanic acid, aqueous solution (hydrogen cyanide, aqueous solution) with no more than 20% hydrogen cyanide

UN		1613	Hydrocyanic acid, aqueous solution (hydrogen cyanide, aqueous solution) with no more than 20% hydrogen cyanide	
EAC		2WE	Use alcohol-resistant foam but, if not available, fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(fl)	Gas tight chemical protective suit with breathing apparatus‡ Flammable liquid	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	3	Flammable liquid	
HIN		663	Highly toxic substance, flammable (flashpoint not above 60°C inclusive)	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid-tight connections for whole body (Type 3) conforming to relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

† 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

‡ Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2

Reference

Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.

Hydrogen cyanide, stabilised, containing less than 3% water and absorbed in a porous, inert material

UN		1614	Hydrogen cyanide, stabilised, containing less than 3% water and absorbed in a porous, inert material	
EAC		2WE ⁽¹⁾	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(fl)	Gas tight chemical protective suit with breathing apparatus‡ Flammable liquid	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	3	Flammable liquid	
HIN		–	–	
<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 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>⁽¹⁾ Not applicable to the carriage of dangerous goods under Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID) and in the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)</p> <p>Reference</p> <p>Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.</p>				

Hydrogen cyanide, solution in alcohol, with no more than 45% hydrogen cyanide

UN		3294	Hydrogen cyanide, solution in alcohol, with no more than 45% hydrogen cyanide	
EAC		2WE	Use alcohol-resistant foam but, if not available, fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident†	
APP		A(fl)	Gas tight chemical protective suit with breathing apparatus‡ Flammable liquid	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	3	Flammable liquid	
HIN		663	Highly toxic substance, flammable (flashpoint not above 60°C inclusive)	
<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 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</p> <p>Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.</p>				

Classification, labelling and packaging (CLP)***Hydrogen cyanide**

Hazard class and category	Flam. Liq. 1	Flammable liquid, category 1	
	Acute Tox. 2	Acute toxicity (inhalation), category 2	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
	Aquatic Chronic 1	Chronic hazard to the aquatic environment, category 1	
Hazard statement	H224	Extremely flammable liquid and vapour	
	H330	Fatal if inhaled	
	H400	Very toxic to aquatic life	
	H410	Very toxic to aquatic life with long-lasting effects	
Signal words	DANGER		
* Implemented in the EU on 20 January 2009			
Reference			
European Commission. Harmonised classification – Annex VI of 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 03/2019).			

Hydrogen cyanide ...%

Hazard class and category	Acute Tox. 2	Acute toxicity (inhalation, oral), category 2	
	Acute Tox. 1	Acute toxicity (dermal), category 1	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
	Aquatic Chronic 1	Chronic hazard to the aquatic environment, category 1	
Hazard statement	H300	Fatal if swallowed	
	H310	Fatal in contact with skin	
	H330	Fatal if inhaled	
	H400	Very toxic to aquatic life	
	H410	Very toxic to aquatic life with long-lasting effects	
Signal words	DANGER		
* Implemented in the EU on 20 January 2009			
Reference			
European Commission. Harmonised classification – Annex VI of 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 03/2019).			

Physicochemical Properties

CAS number	74-90-8
Molecular weight	27
Formula	HCN
Common synonyms	Hydrocyanic acid; prussic acid
State	Liquid – boiling point 26°C
Volatility	Vapour pressure = 742 mmHg at 25°C
Specific gravity Vapour density	Liquid: 0.69 at 20°C (water = 1) Gas: 0.94 (air = 1)
Flammability	Extremely flammable
Lower explosive limit	5.6%
Upper explosive limit	40%
Water solubility	Miscible with water
Reactivity	May polymerise if it is not stabilised. May polymerize due to heating under the influence of bases, over 2% water, or if not chemically stabilised this generates a fire or explosion hazard. The solution in water is a weak acid. Reacts violently with oxidants and hydrogen chloride in alcoholic mixtures this generates fire and explosion hazard
Reaction or degradation products	On combustion, forms toxic and corrosive gases including nitrogen oxides
Odour	Bitter almond-like odour
Structure	$\text{H}-\text{C}\equiv\text{N}$
References	
<p>Hazardous Substances Data Bank. Hydrogen cyanide. HSDB No. 165 (last revision date 27/09/2018). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 03/2019).</p> <p>International Programme on Chemical Safety. International chemical safety card entry for hydrogen cyanide. ICSC 0492, 2018. World Health Organization: Geneva.</p>	

Reported Effect Levels from Authoritative Sources

Exposure by inhalation

ppm	mg/m ³	Signs and symptoms	Reference
18 – 36	20 – 40	Slight symptoms after several hours	a
45 – 55	50 – 60	Tolerated for 30–60 minutes (with immediate or late effects)	a
181	200	Fatal after 10 min	a
135	150	Fatal after 30 min	a
270	300	Immediately fatal	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 Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cyanide, 2006.

Exposure by skin

mg/kg	Signs and symptoms	Reference
100	Estimated dermal exposure LD ₅₀ in humans	a

This value gives an indication of levels of exposure that can cause adverse effects. It is not a health protective standard or guideline value

Reference

a Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cyanide, 2006.

Exposure by ingestion

mg/kg	Signs and symptoms	Reference
0.7-3.5	Estimated fatal dose	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. Cyanides. Poisons Information Monograph G003, 1997. World Health Organization: Geneva.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m ³)
ERPG-1*	N/A	N/A
ERPG-2†	10	11
ERPG-3‡	25	28

* 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

N/A Not appropriate

Reference

American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values.

[https://www.aiha.org/get-](https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf)

[involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf](https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf)

(accessed 03/2019).

Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	2.5	2.5	2.0	1.3	1.0
AEGL-2†	17	10	7.1	3.5	2.5
AEGL-3‡	27	21	15	8.6	6.6

* 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

Reference

US Environmental Protection Agency. Acute Exposure Guideline Levels. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm>

(accessed 03/2019).

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	0.9	1	4.5	5
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, 3 rd Edition, 2018				

Public health guidelines

Drinking water standard	50 µg/L (cyanide)
Air quality guideline	No guideline values specified
Soil guideline values and health criteria values	No guideline values specified
References The Private Water Supplies (England) Regulations 2016 and The Private Water Supplies (Wales) Regulations 2017. The Water Supply (Water Quality) Regulations 2018 (Water, England and Wales).	

Health Effects

Major route of exposure

- exposure is usually by inhalation of hydrogen cyanide vapour; hydrogen cyanide liquid is also rapidly absorbed through the skin
- toxicity can occur within a few seconds of hydrogen cyanide gas inhalation, with death occurring in minutes
- toxicity from skin exposure requires a large surface area to be affected. Onset of toxicity may be delayed for several hours

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Ingestion/ Inhalation	<p>Early features include headache, nausea, dizziness and anxiety, followed by confusion, drowsiness, tachycardia, palpitations and tachypnoea</p> <p>In cases of moderate toxicity there may be brief episodes of loss of consciousness, convulsions, vomiting and hypotension</p> <p>Cherry red skin and "bitter almond" odour on the patient's breath (due to excretion of hydrocyanic acid) are characteristic features but were only present in 11% and 15% of cases respectively in a systematic review of 102 cases. In addition, it is estimated that 20-40% of people are genetically unable to detect this odour</p> <p>In severe poisoning, clinical features include deep coma fixed unreactive pupils, cardiovascular collapse, respiratory depression, myocardial ischaemia, cardiac arrhythmias and pulmonary oedema may develop. Profound sinus bradycardia or AV dissociation may occur in pre-terminal patients. Cyanosis is often a late sign and may not occur, even in patients with cardiovascular collapse</p> <p>A profound lactic acidosis causing a high anion gap metabolic acidosis is usually seen in cases of moderate and severe cyanide poisoning</p>
Dermal	Systemic toxicity from skin exposure requires a large surface area to be affected. Onset of toxicity may be delayed for several hours
Ocular	May cause pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia
References	
TOXBASE. Hydrogen cyanide, 02/2019. http://www.toxbase.org (accessed 03/2019).	

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.

Liquid hydrogen cyanide is easily absorbed through intact skin and vapours of hydrogen cyanide may also be absorbed through the skin if concentrations are high. Following disrobe, improvised dry decontamination should be considered for an incident involving hydrogen cyanide (liquid or vapour) unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances.

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.

General advice on disrobe and decontamination

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 (e.g. 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

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 people individually.

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

Important note

- **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 10-15 minutes.
- pay special attention to mucous membranes, moist areas such as skin folds, fingernails and ears

Dermal exposure

- maintain a clear airway and ensure adequate ventilation
- give oxygen if required
- decontaminate (as above) following surface contamination
- if features of systemic toxicity are present manage as for ingestion/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 (e.g. 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 (e.g. by an infusion bag with a giving set) for a minimum of 10-15 minutes irrespective of initial conjunctival pH. Amphoteric solutions are available and may be used. A Morgan Lens may be used if anaesthetic has been given. 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**
- if features of systemic toxicity are present manage as for ingestion/inhalation
- other supportive measures as indicated by the patient's clinical condition

Inhalation/ingestion

- maintain a clear airway and ensure adequate ventilation
- administer oxygen to achieve adequate oxygenation
- monitor vital signs, cardiac rhythm and check capillary blood sugar
- perform 12 lead ECG in patient who require assessment
- other supportive measures as indicated by the patient's clinical condition

Antidotes

Several antidotes exist for the treatment of cyanide poisoning. Further information is available on TOXBASE.

Clinical decontamination and first aid references

TOXBASE	http://www.toxbase.org (accessed 03/2019)
TOXBASE	Hydrogen cyanide, 02/2019
TOXBASE	Cyanide – features and management, 02/2019
TOXBASE	Chemicals splashed or sprayed into the eyes, 06/2017
TOXBASE	Skin decontamination – irritants, 01/2018

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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