



Hydrogen Cyanide

Incident Management

Key Points

Fire

- extremely flammable
- incompatible or reactive with amines, oxidisers, acids, sodium hydroxide, calcium hydroxide, sodium carbonate, water, caustics and ammonia
- emits very toxic cyanide fumes when heated to decomposition
- in the event of a fire involving hydrogen cyanide, use alcohol-resistant foam or fine water spray and gas-tight protective clothing with breathing apparatus

Health

- exposure is usually by inhalation of hydrogen cyanide vapour; hydrogen cyanide liquid is rapidly absorbed through the skin
- highly toxic
- exposure to high concentrations may be rapidly fatal



Environment

- hazardous to the environment; inform the Environment Agency where appropriate

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, 2015.



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)	
<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, 2015.</p>				





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, 2015.</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, 2015.</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 – 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).			

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		
<p>* Implemented in the EU on 20 January 2009</p> <p>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).</p>			

Physicochemical Properties

CAS number	74-90-8
Molecular weight	27
Formula	HCN
Common synonyms	Hydrocyanic acid; prussic acid
State	Colourless gas or liquid
Volatility	Vapour pressure = 620 mmHg at 20°C
Specific gravity Vapour density	Liquid: 0.7 at 20°C (water = 1) Gas: 0.9 (air = 1)
Flammability	Extremely flammable
Lower explosive limit	5%
Upper explosive limit	40%
Water solubility	Miscible with water
Reactivity	May polymerise due to heating under the influence of bases, over 2% water, or if not chemically stabilised. It is incompatible or will react with amines, oxidisers, acids, sodium hydroxide, calcium hydroxide, sodium carbonate, water, caustics and ammonia
Reaction or degradation products	Cyanide fumes are released when hydrogen cyanide is heated to decomposition or comes into contact with water, steam, acid or acid fumes. Forms toxic and corrosive gases including nitrogen oxides, on combustion
Odour	Bitter almond-like odour
Structure	$\text{H}-\text{C}\equiv\text{N}$
<p>References</p> <p>Hazardous Substances Data Bank. Hydrogen cyanide. HSDB No. 165 (last revision date 09/09/2015). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 12/2015).</p> <p>Hydrogen cyanide (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 12/2015).</p> <p>International Programme on Chemical Safety. International chemical safety card entry for hydrogen cyanide. ICSC 0492, 2003. World Health Organization: Geneva.</p>	

Reported Effect Levels from Authoritative Sources

Exposure by inhalation

ppm	mg/m ³	Signs and symptoms	Reference
18.2–36.4	20–40	Slight effects	a
110	121	Life threatening (1 hour)	b
263	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 International Programme on Chemical Safety. Hydrogen cyanide and cyanides: human health aspects. Concise International Chemical Assessment Document 61, 2004. World Health Organization: Geneva.
- b 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). 2015 Emergency Response Planning Guideline Values. <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2015%20ERPG%20Levels.pdf> (accessed 11/2015).

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 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	–	–	10	11
<p>WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit</p> <p>Reference Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 2nd Edition, 2011.</p>				

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
<p>References The Private Water Supplies Regulations 2009 and the Private Water Supplies Regulations (Wales) 2010. The Water Supply (Water Quality) Regulations 2000 (England) and the Water Supply (Water Quality) Regulations 2001 (Wales) (accessed 01/2011).</p>	

Health Effects

Major route of exposure

- exposure is usually by inhalation of hydrogen cyanide; hydrogen cyanide is also rapidly absorbed through the skin

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation/ingestion	<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>In severe poisoning by inhalation or ingestion, deep coma, fixed unreactive pupils, cardiovascular collapse, respiratory depression, myocardial ischaemia, cardiac arrhythmias and pulmonary oedema may develop</p> <p>Profound sinus bradycardia or AV dissociation may occur in pre-terminal patients</p> <p>Cyanosis is often a late sign and may not occur, even in patients with cardiovascular collapse. A profound lactic acidosis causing a high anion gap metabolic acidosis is usually seen in cases of moderate and severe cyanide poisoning</p> <p>After ingestion there may be the characteristic “bitter almond” odour on the patient’s breath (due to excretion of hydrocyanic acid); however, it is estimated that 20–40% of people are genetically unable to detect this odour</p>
Dermal	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, 09/2013. http://www.toxbase.org (accessed 01/2016).	
TOXBASE. Cyanide – features and management, 01/2012. http://www.toxbase.org (accessed 01/2016).	

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.

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.

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 people individually.

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

Important note

- if the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves

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 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
- 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 (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
- 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 establish haemodynamic stability**
- maintain a clear airway and ensure adequate ventilation
- give 100% oxygen to all patients through a high flow mask with a rebreather bag or endotracheal tube
- monitor pulse, blood pressure, respiratory rate and oxygen saturation
- in symptomatic patients monitor cardiac rhythm
- 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 01/2016)
- TOXBASE Hydrogen cyanide, 09/2013
- TOXBASE Cyanide – features and management, 01/2012

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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