



Acrylonitrile

Incident Management

Key Points

General

- flammable liquid at room temperature
- pungent/sweet odour
- polymerises when heated and under the influence of light and bases which generates a fire and explosion
- reacts violently with strong acids and oxidants
- releases toxic fumes of hydrogen cyanide and nitrogen oxide when heated to decomposition

Health effects

- highly toxic by ingestion and toxic by inhalation or skin contact
- metabolised by the body to cyanide and thiocyanate
- early features include headache, nausea, dizziness, and anxiety followed by confusion, drowsiness, tachycardia and palpitations
- in severe cases deep coma, cardiovascular collapse and respiratory depression can occur
- onset of symptoms following ingestion or skin contact can be delayed
- eye exposure can cause pain, lacrimation, photophobia and corneal burns

Casualty decontamination at the scene



- following disrobe, improvised dry decontamination should be considered for an incident involving acrylonitrile, 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

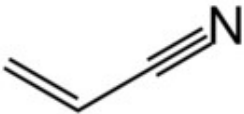
UN		1093	Acrylonitrile, stabilised	
EAC		●3WE	Use alcohol resistant foam but, if not available, normal foam can be used. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and watercourses. 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‡. Fire kit intended to protect against flammable liquid	
Hazards	Class	3	Flammable liquid	
	Sub-risks	6.1	Toxic substance	
HIN		336	Highly flammable liquid, toxic	
<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 be warned to stay indoors with all windows and doors closed, preferably in room upstairs and facing away from the incident. 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 EN943 part 2</p> <p>Reference 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)*

Hazard class and category	Flam. Liq. 2	Flammable liquid, category 2	
	Acute Tox. 3	Acute toxicity (oral, dermal, inhalation), category 3	
	Skin Irrit. 2	Skin irritation, category 2	
	Skin Sens. 1	Skin sensitizer, category 1	
	Eye Dam. 1	Serious eye damage/eye irritation	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	
	Carc. 1B	Carcinogenicity, category 1B	

	Aquatic Chronic 2	Chronic hazard to the aquatic environment, category 2	
Hazard statement	H225	Highly flammable liquid and vapour	
	H301	Toxic if swallowed	
	H311	Toxic in contact with skin	
	H315	Causes skin irritation	
	H317	May cause an allergic skin reaction	
	H318	Causes serious eye damage	
	H331	Toxic if inhaled	
	H335	May cause respiratory irritation	
	H350	May cause cancer	
	H411	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 03/2020).			

Physicochemical Properties

CAS number	107-13-1
Molecular weight	53
Formula	C ₃ H ₃ N
Common synonyms	2-Propenenitrile; Cyanoethylene; Vinyl cyanide
State at room temperature	Liquid
Volatility	Vapour pressure: 109 mm Hg at 25°C
Specific gravity Vapour density	0.8 (water = 1) 1.8 (air = 1)
Flammability	Flammable
Lower explosive limit	3.1%
Upper explosive limit	17.0%
Water solubility	Soluble in water
Reactivity	Polymerises when heated and under the influence of light and bases which generates a fire and explosion. Reacts violently with strong acids and strong oxidants. Attacks plastics and rubber
Reaction or degradation products	Releases toxic fumes including hydrogen cyanide and nitrogen oxides when heated to decomposition
Odour	Pungent/sweet odour
Structure	
References	
International Programme on Chemical Safety. International Chemical Safety Card entry for Acrylonitrile. ICSC 0092, 2001. World Health Organization: Geneva.	
National Center for Biotechnology Information. PubChem Database. Acrylonitrile, CID=7855, https://pubchem.ncbi.nlm.nih.gov/compound/Acrylonitrile (accessed on Mar. 2, 2020).	

Reported Effect Levels from Authoritative Sources

Exposure by ingestion

ppm	mg/m ³	Signs and symptoms	Reference
16-100	35-220	Headache, fullness in the chest and irritation of eyes, nose, throat and skin (20 – 45 minutes)	a
230-921	500-2,000	Presumed to be fatal (0.5 – 3 hour exposure)	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>Note: Simultaneous exposure to organic solvents may significantly enhance toxicity</p> <p>References</p> <p>a International Programme on Chemical Safety. Environmental Health Criteria 28: Acrylonitrile. WHO, Geneva, 1983.</p>			

Published Emergency Response Guidelines

Acute exposure guideline levels (AEGLs)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	1.5	1.5	NR	NR	NR
AEGL-2†	8.6	3.2	1.7	0.48	0.26
AEGL-3‡	130	50	28	9.7	5.2

* Level of the chemical in air at or above which the general public 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 public 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 03/2020).

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	2	4.4	-	-

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, 4th Edition, 2020.

Public health guidelines

UK drinking water standard WHO guideline for drinking water quality	Values not given
WHO air quality guideline	1 µg/m ³ equates to an estimated lifetime cancer risk of 2×10^{-5}

Reference
Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications, European Series, No. 91, Second Edition, 2000.

Health Effects

- highly toxic by ingestion; also toxic by inhalation and skin contact
- metabolised to cyanide and thiocyanate
- toxicity after ingestion of acrylonitrile can be delayed due to slow absorption and slow metabolic release of cyanide

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. 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. 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. 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	Pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema, photophobia and corneal burns
References	
TOXBASE. Acrylonitrile, 02/2019 http://www.toxbase.org (accessed 03/2020).	
TOXBASE. Cyanide and cyanide salts – features and management, 02/2019. http://www.toxbase.org (accessed 03/2020).	

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.

Following disrobe, improvised dry decontamination should be considered for an incident involving acrylonitrile, **unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances.**

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.

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

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

- **there are antidotes available for the treatment of hydrogen cyanide poisoning. Further information is available on TOXBASE**
- **toxic fumes (hydrogen cyanide) may be released after exposure to water, moist air, acids and acid salts; if essential wash in a well-ventilated area and minimise risk of inhalation of toxic fumes**
- **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

- **toxic fumes (hydrogen cyanide) may be released after exposure to water, moist air, acids and acid salts; if essential wash in a well-ventilated area and minimise risk of inhalation of toxic fumes**
- 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. **The earlier irrigation begins, the greater the benefit**

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 (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 or equivalent crystalloid (e.g. by an infusion bag with a giving set) for a minimum of 10-15 minutes irrespective of initial conjunctival pH. A Morgan Lens may be used if anaesthetic has been given. There is experimental evidence that commercially available amphoteric, hypertonic, chelating solutions normalise tissue pH more rapidly than water or saline and may be used if available. 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
- any particles lodged in the conjunctival recesses should be removed
- 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
- administer oxygen to achieve adequate oxygenation
- monitor vital signs, cardiac rhythm and check capillary blood sugar
- perform a 12-lead ECG in all patients who require assessment
- other measures as indicated by the patient's clinical condition

Clinical decontamination and first aid references

- TOXBASE <http://www.toxbase.org> (accessed 03/2020).
- TOXBASE Acrylonitrile, 02/2019.
- TOXBASE Cyanide and cyanide salts – features and management, 02/2019.
- TOXBASE Chemicals splashed or sprayed into the eyes – features and management, 01/2020.

TOXBASE Skin decontamination – irritants, 05/2019.
TOXBASE Personal protective equipment and decontamination at the scene or in hospital, 05/2019.

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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For queries relating to this document, please contact: chemcompendium@phe.gov.uk

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