



# Sodium and Potassium Cyanide

## Incident Management

### Key Points

#### Fire

- non-flammable with an almond-like odour
- sodium and potassium cyanide react with acid, acid salts and nitrates
- emit toxic fumes including hydrogen cyanide and nitrogen oxides when heated to decomposition, see compendium entry for hydrogen cyanide for more information
- liberates fumes of hydrogen cyanide when in contact with acids
- in the event of a fire involving sodium or potassium cyanide, use fine water spray and liquid-tight chemical protective clothing with breathing apparatus

#### Health

- early features following ingestion including headache, nausea, dizziness and anxiety followed by confusion, drowsiness, tachycardia, palpitations and tachypnoea
- loss of consciousness, convulsions, vomiting and hypotension may occur at higher doses; in severe cases, deep coma, cardiovascular collapse, respiratory depression, myocardial ischemia, cardiac arrhythmias and pulmonary oedema may develop
- significant dermal exposure can cause systemic toxicity
- ocular exposure may result in pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema, photophobia and corneal burns

#### Environment

- avoid release to the environment; inform the Environment Agency of substantial incidents

## Hazard Identification

### Standard (UK) dangerous goods emergency action codes

#### *Potassium cyanide, solid*

<b>UN</b>		1680	Potassium cyanide, solid	
<b>EAC</b>		2X	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	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		66	Highly toxic substance	

#### *Potassium cyanide solution, packing group I*

<b>UN</b>		3413	Potassium cyanide solution, packing group I	
<b>EAC</b>		2X	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	
<b>APP</b>		B	Gas-tight chemical protective suit with breathing apparatus <sup>†</sup>	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		66	Highly toxic substance	

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 the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

† Chemical protective clothing should be gas tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN137

#### Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2015.

**Potassium cyanide solution, packing solution II & III**

<b>UN</b>		3413	Potassium cyanide solution, packing solution II and III	
<b>EAC</b>		2X	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	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		60	Toxic or slightly toxic substance	

**Sodium cyanide, solid**

<b>UN</b>		1689	Sodium cyanide, solid	
<b>EAC</b>		2X	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	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		66	Highly toxic substance	

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 the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN137

† Chemical protective clothing should be gas tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN137

**Reference**

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2015.

**Sodium cyanide solution, packing group I**

<b>UN</b>		3414	Sodium cyanide solution, packing group I	
<b>EAC</b>		2X	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	
<b>APP</b>		B	Gas-tight chemical protective suit with breathing apparatus <sup>†</sup>	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		66	Highly toxic substance	

**Sodium cyanide solution, packing solution II & III**

<b>UN</b>		3414	Sodium cyanide solution, packing solution II & III	
<b>EAC</b>		2X	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	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		60	Toxic or slightly toxic substance	

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 the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN137

† Chemical protective clothing should be gas tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN137

**Reference**

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2015.

### Classification, labelling and Packaging (CLP)

<b>Hazard class and category</b>	Data not available
<b>Hazard statement</b>	
<b>Signal words</b>	

## Physicochemical Properties

### Potassium cyanide

<b>CAS number</b>	151-50-8
<b>Molecular weight</b>	65.12
<b>Formula</b>	KCN
<b>Common synonyms</b>	–
<b>State at room temperature</b>	Solid
<b>Volatility</b>	Vapour pressure = 0 mm Hg
<b>Specific gravity</b>	1.55 at 20°C (water = 1)
<b>Flammability</b>	Non-flammable
<b>Lower explosive limit</b>	Not applicable
<b>Upper explosive limit</b>	Not applicable
<b>Water solubility</b>	Soluble to very soluble
<b>Reactivity</b>	Potassium cyanide is incompatible with acids and acid syrups, alkaloids, chloral hydrate, iodine, metallic salts, nitrates permanganates, chlorates and peroxides
<b>Reaction or degradation products</b>	When heated to decomposition, potassium cyanide evolves irritating and very toxic fumes of hydrogen cyanide, nitric oxide, carbon monoxide and potassium oxide. Potassium cyanide decomposes rapidly on contact with acids to release hydrogen cyanide. Decomposes slowly on contact with moisture and carbon dioxide in air to produce hydrogen cyanide
<b>Odour</b>	Almond-like odour
<p><b>References</b></p> <p>Hazardous Substances Data Bank. Potassium cyanide, HSDB No. 118 (last revision date 13/12/2005). US National Library of Medicine: Bethesda MD. <a href="http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB">http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB</a> (as assessed 05/2015).</p> <p>Potassium Cyanide (HAZARDTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System. Truven Healthcare Analytics Inc, Greenwood Village CO, US. RightAnswer.com Inc, Midland MI, US. <a href="http://www.rightanswerknowledge.com">http://www.rightanswerknowledge.com</a> (accessed 05/2015).</p> <p>International Programme for Chemical Safety (IPCS). International Chemical Safety Card entry for potassium cyanide. ISCS 0671, 2003. World Health Organization: Geneva.</p>	

**Sodium cyanide**

<b>CAS number</b>	143-33-9
<b>Molecular weight</b>	49.01
<b>Formula</b>	NaCN
<b>Common synonyms</b>	Cyanogran
<b>State at room temperature</b>	Solid
<b>Volatility</b>	Vapour pressure = 1 mm Hg at 817°C
<b>Specific gravity</b>	1.6 at 20°C (water = 1)
<b>Flammability</b>	Non-flammable
<b>Lower explosive limit</b>	Not applicable
<b>Upper explosive limit</b>	Not applicable
<b>Water solubility</b>	Very soluble
<b>Reactivity</b>	Reacts violently with fluorine, magnesium, nitrates, nitric acid and nitrites
<b>Reaction or degradation products</b>	Sodium cyanide releases toxic oxides of nitrogen and hydrogen cyanide when heated to decomposition. Sodium cyanide powder reacts with carbon dioxide in air to release hydrogen cyanide gas. Sodium cyanide reacts with acids or acid fumes to release hydrogen cyanide gas
<b>Odour</b>	Almond-like odour
<p><b>References</b></p> <p>Hazardous Substances Data Bank. Sodium Cyanide, HSDB No. 734 (last revision date 13/12/2005). US National Library of Medicine: Bethesda MD. <a href="http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB">http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB</a> (as assessed 05/2015).</p> <p>International Programme for Chemical Safety (IPCS). International Chemical Safety Card entry for sodium cyanide. ISCS 1118, 2003. World Health Organization: Geneva.</p> <p>Sodium Cyanide (HAZARDEXTM Hazard Management). In Klasco RK (Ed): TOMES® System. Truven Healthcare Analytics Inc, Greenwood Village CO, US. RightAnswer.com Inc, Midland MI, US. <a href="http://www.rightanswerknowledge.com">http://www.rightanswerknowledge.com</a> (accessed 05/2015).</p>	

## Reported Effect Levels from Authoritative Sources

### Exposure by ingestion

Potassium cyanide		
mg	Signs and symptoms	Reference
>50–100	Near instantaneous collapse and cessation of respiration	a
150–250	Estimated fatal dose	b
<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><b>Reference</b></p> <p>a Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Cyanide. Atlanta, 2006.</p> <p>b International Programme on Chemical Safety. Cyanides, Poisons Information Monograph G003, 1988. World Health Organization: Geneva.</p>		

Sodium cyanide		
mg	Signs and symptoms	Reference
>50–100	Near instantaneous collapse and cessation of respiration	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><b>Reference</b></p> <p>a Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Cyanide. Atlanta, 2006.</p>		

## Published Emergency Response Guidelines

### Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m <sup>3</sup> )
ERPG-1*	Data not available	
ERPG-2†		
ERPG-3‡		
<p>* 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</p> <p>† 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</p> <p>‡ 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</p>		

### Acute exposure guideline levels (AEGLs)

Potassium cyanide	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	6.6	6.6	5.3	3.5	2.7
AEGL-2†	45	27	19	9.3	6.6
AEGL-3‡	72	56	40	23	18

Sodium cyanide	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	5.0	5.0	4.0	2.6	2.0
AEGL-2†	34	20	14	7.0	5.0
AEGL-3‡	54	42	30	17	13

\* 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 an 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 05/2015).

## Exposure Standards, Guidelines or Regulations

### Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>
<b>WEL</b>	-	5*	No guideline value specified	
<p>WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit</p> <p>* All cyanides except HCN, cyanogen and cyanogen chloride</p> <p><b>Reference</b> Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits (second edition, published 2011).</p>				

### Public health guidelines

<b>Drinking water standard</b>	0.05 mg CN/L
<b>Air quality guideline</b>	No guideline value specified
<b>Soil guideline values and health criteria values</b>	No guideline value specified
<p><b>Reference</b> The Water Supply (Water Quality) Regulations 2000 (England) and the Water Supply (Water Quality) Regulations 2001 (Wales).</p>	

## Health Effects

### Major route of exposure

- ingestion of cyanide salts or inhalation of hydrogen cyanide fumes liberated when cyanide salts come into contact with water, moist air and acids
- skin exposure is less important

### Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
<b>Inhalation/ingestion</b>	<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>
<b>Dermal</b>	<p>Toxicity from skin exposure requires a large surface area to be affected. Onset of toxicity may be delayed for several hours</p>
<b>Ocular</b>	<p>Pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia. Acidic and alkaline solutions may cause corneal burns</p> <p>Alkaline solutions in particular may penetrate all layers of the eye and find their way into the chambers causing iritis, anterior and posterior synechia, corneal opacification, cataracts, glaucoma and retinal atrophy. Alkali burns to the eyes should be considered an ophthalmic emergency</p>
<b>Reference</b>	
<p>TOXBASE. Cyanide salts – features and management, 2012. <a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 11/2016).</p>	

## 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.

Sodium and potassium cyanide liberate fumes of hydrogen cyanide after exposure to water, moist air, acids and acid salts. Following disrobe, improvised dry decontamination should be considered for an incident involving sodium or potassium cyanide **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 persons individually.

Detailed information on clinical management can be found on TOXBASE – [www.toxbase.org](http://www.toxbase.org).

### Important notes

- **sodium and potassium cyanide liberate fumes of hydrogen cyanide after exposure to water, moist air, acids and acid salts.**
- 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 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
- 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
- pay particular 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) patient following surface contamination
- if features of systemic toxicity are present manage as per ingestion/inhalation
- other supportive measures as indicated by the patient 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 ensure adequate ventilation
- give 100% oxygen to all patients by a high flow mask with a rebreather bag or endotracheal tube
- monitor pulse, blood pressure, respiratory rate, oxygen saturation and cardiac rhythm
- perform a 12-lead ECG in symptomatic patients
- 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 11/2016)
- TOXBASE Sodium cyanide, 2013
- TOXBASE Potassium cyanide, 2013
- TOXBASE Cyanide salts – features and management, 2012
- TOXBASE Cyanide antidotes index, 2013

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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First published: October 2015

Update: November 2016 Health Effects, Decontamination at the Scene & Clinical Decontamination and First Aid