



Inorganic Arsenic

Incident Management

Key Points

General

- solid at room temperature which does not dissolve in water
- odourless
- combustible; may burn but does not ignite easily
- reacts violently with strong oxidants and halogens, generating a fire and explosion hazard
- reacts with reducing agents, producing the flammable arsine gas

Health effects

- inhalation may cause laryngitis, bronchitis and rhinitis; nausea, vomiting and diarrhoea have also been reported
- ingestion causes abdominal pain, vomiting, diarrhoea and in severe cases it can cause multiorgan toxicity
- dermal contact may cause erythema and swelling
- eye exposure may cause pain, lacrimation, blepharospasm, conjunctivitis, photophobia, visual disturbance and corneal damage

Casualty decontamination at the scene

- following disrobe, improvised dry decontamination should be considered for an incident involving arsenic compounds, unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances


Environment

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


Hazard Identification

Standard (UK) dangerous goods emergency action codes


Arsenic compound, liquid ... packing group I

UN		1556	Arsenic compound, liquid, N.O.S., inorganic, including: arsenates, N.O.S., arsenites, N.O.S., arsenic sulphides, N.O.S., packing group I	
EAC		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	
APP		B	Gas-tight chemical protective suit with breathing apparatus†	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	–	–	
HIN		66	Highly toxic substance	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Normal firefighting clothing is appropriate, i.e. breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots conforming to Home Office specification A29 or A30</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>Reference Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.</p>				


Arsenic compound, liquid ... packing groups II & III

UN		1556	Arsenic compound, liquid, N.O.S., inorganic, including: arsenates, N.O.S., arsenites, N.O.S., arsenic sulphides, N.O.S., packing groups II & III	
EAC		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	
APP		–	–	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	–	–	
HIN		60	Toxic or slightly toxic substance	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Normal firefighting clothing is appropriate, i.e. breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots conforming to Home Office specification A29 or A30</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>				




Arsenic compound, solid...

UN		1557	Arsenic compound, solid, N.O.S., inorganic, including: arsenates, N.O.S., arsenites, N.O.S., arsenic sulphides, N.O.S.	
EAC		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	
APP		–	–	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	–	–	
HIN		66/60	Highly toxic/toxic or slightly toxic substance	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Normal firefighting clothing is appropriate, i.e. breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots conforming to Home Office specification A29 or A30</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>				

Arsenic

UN		1558	Arsenic	
EAC		2Z	Use fine water spray. Wear normal fire kit in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses	
APP		–	–	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	–	–	
HIN		60	Toxic or slightly toxic substance	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Normal firefighting clothing is appropriate, i.e. breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots conforming to Home Office specification A29 or A30</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	Acute Tox. 3	Acute toxicity (inhalation, oral), category 3	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
	Aquatic Chronic 1	Chronic hazard to the aquatic environment, category 1	
Hazard statement	H301	Toxic if swallowed	
	H331	Toxic 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	7440-38-2
Molecular weight	75
Empirical formula	As
Common synonyms	-
State at room temperature	Solid
Volatility	Non-volatile at 20°C
Specific gravity	5.778 at 25°C (water = 1)
Flammability	Combustible – may burn but does not ignite easily
Lower explosive limit	-
Upper explosive limit	-
Water solubility	Insoluble in water
Reactivity	Reacts violently with strong oxidants and halogens, generating a fire and explosion hazard
Reaction or degradation products	Upon heating, toxic fumes are formed. Reacts with reducing agents, this produces arsine gas which is toxic and flammable
Odour	Odourless
References	
<p>Hazardous Substances Data Bank. Arsenic. HSDB No. 509 (last revision date 23/08/2005). 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 arsenic. ICSC 0013, 2011. World Health Organization: Geneva.</p>	

Reported Effect Levels from Authoritative Sources

Exposure by ingestion

mg/kg	Signs and symptoms	Reference
1 – 3	Lethal dose	a
<p>This value gives an indication of levels of exposure that can cause adverse effects. It is not a health protective standard or guideline value</p> <p>Reference</p> <p>a TOXBASE. Arsenic and Arsenic Compounds, 01/2019. http://www.toxbase.org (accessed 03/2019).</p>		

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m ³)
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> <p>Reference American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values. https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf (accessed 03/2019).</p>		

Interim acute exposure guideline levels (AEGs) (see note)

	Concentration (mg/m ³)				
	10 min	30 min	60 min	4 hours	8 hours
AEG-1*	NR	NR	NR	NR	NR
AEG-2†	3.7	3.7	3.0	1.9	1.2
AEG-3‡	11	11	9.1	5.7	3.7
<p>Note These values are for arsenic trioxide</p> <p>* Level of the chemical in air at or above which the general population could experience notable discomfort</p> <p>† 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</p> <p>‡ Level of the chemical in air at or above which the general population could experience life-threatening health effects or death</p> <p>NR Not recommended due to insufficient data</p> <p>Reference US Environmental Protection Agency. Acute Exposure Guideline Levels. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 03/2019).</p>					

Exposure Standards, Guidelines or Regulations

Occupational standards (see note)

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m ³	ppm	mg/m ³
WEL	–	0.1	No guideline value specified	
<p>Note Arsenic and arsenic compounds except arsine (as As) 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, 3rd Edition, 2018.</p>				

Public health guidelines

Drinking water standard	10 µg/L
Air quality guideline	66, 6.6 and 0.66 ng/m ³ for an excess lifetime cancer risk of 1:10,000, 1:100,000 and 1:1,000,000, respectively
<p>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). WHO Regional Office for Europe. Air Quality Guidelines for Europe. European Series, No. 91, 2nd Edition, 2000. World Health Organization Regional Publications: Copenhagen.</p>	

Health Effects

Major route of exposure

- ingestion and inhalation

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	<p>Arsenic compounds are irritant to the upper airways and can produce laryngitis, bronchitis and rhinitis</p> <p>Short-term inhalation of arsenic has led to nausea, vomiting and diarrhoea. It was assumed that the arsenic particles were transported to the larynx by mucociliary clearance and then reached the gastrointestinal tract as a result of swallowing. Acute encephalopathy (hallucinations, increased excitability, emotional lability, memory loss, difficulties in learning new information) has been reported after occupational exposure, but ingestion of arsenic cannot be excluded as the main route of exposure</p> <p>Features of systemic toxicity may also occur</p>
Ingestion and systemic features	<p>Following acute exposure features usually start within 30 minutes to 2 hours and commonly include abdominal pain, vomiting and diarrhoea. In more severe cases, the severity of gastrointestinal fluid loss may precipitate hypovolemic shock and acute tubular necrosis</p> <p>Trivalent arsenic compounds such as arsenic trioxide are particularly irritant to the GI mucosa and may cause haemorrhagic gastroenteritis</p> <p>The most severely poisoned patients progress within hours to multi-organ involvement. Features include deterioration in hepatic and renal function, coagulopathy, haemolysis, rhabdomyolysis, non-cardiogenic pulmonary oedema (adult respiratory distress syndrome, myelosuppression (classically pancytopenia) and cardiac involvement (myocardial depression, ST segment changes, prolonged QT interval, ventricular tachycardia, torsade de pointes or ventricular fibrillation). Neurological features include CNS depression, hallucinations, paraesthesia, convulsions, encephalopathy and peripheral neuropathy. Pancreatitis has also been reported</p>
Dermal	<p>Arsenic compounds are irritants. Typical responses following skin contact include erythema and swelling, with papules and blisters in more severe cases. Toxic epidermal necrolysis has been reported. Exposure to arsenic in the workplace has also caused contact dermatitis. Features of systemic toxicity would only be expected following prolonged skin exposure or if the skin integrity was already damaged prior to skin contact</p>

Ocular	Highly irritant and corrosive to the eye There are limited data on ocular exposure, but features expected include pain, lacrimation, blepharospasm, conjunctivitis, photophobia, visual disturbance and corneal damage
Reference TOXBASE. Arsenic and arsenic compounds, 01/2019. 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.

Following disrobe, improvised dry decontamination should be considered for an incident involving arsenic compounds 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.

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 should where possible 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

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 particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears

Dermal exposure

- decontaminate (as above) the patient following surface contamination
- treat skin burns conventionally
- treat systemic features of toxicity as for ingestion
- 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
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- maintain a clear airway and adequate ventilation
- treat systemic features of toxicity as for ingestion
- other supportive measures as indicated by the patient's clinical condition

Ingestion

- maintain a clear airway and adequate ventilation
- monitor vital signs, cardiac rhythm and check capillary blood sugar
- perform a 12 lead ECG in all patients that require assessment
- other supportive measures as indicated by the patient's clinical condition

Clinical decontamination and first aid references

TOXBASE	http://www.toxbase.org (accessed 03/2019)
TOXBASE	Arsenic and arsenic compounds, 01/2019
TOXBASE	Arsenic – features and management, 01/2019
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.

First published: June 2016

Full document update: August 2019

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