



# Inorganic Arsenic

## Incident management

### Key Points

#### **Fire**

- Non combustible under normal conditions
- Emits toxic arsenic fumes and gaseous arsine upon decomposition
- In the event of a fire involving arsenic, use fine water spray and liquid-tight chemical protective suits with breathing apparatus

#### **Health**


- Toxic by ingestion, inhalation and skin absorption
- Corrosive
- Secondary contamination may occur
- Inhalation may cause irritation of the upper respiratory tract and cause cough, sore throat, breathlessness, wheeze, pulmonary oedema and respiratory failure
- Ingestion causes abdominal pain, vomiting, diarrhoea, hypovolaemic shock and cardiovascular collapse
- Arsenic is highly irritant and corrosive to the eye causing pain, lacrimation, conjunctivitis, photophobia and corneal damage
- Dermal contact may cause erythema and swelling.


#### **Environment**

- Dangerous for the environment
- Inform Environment Agency of substantial release incidents

## Hazard Identification

### Standard (UK) Dangerous Goods Emergency Action Codes<sup>(a)</sup>

<b>UN</b>		<b>1556</b>	Arsenic compound, liquid, n.o.s., inorganic, including: arsenates, n.o.s., arsenites, n.o.s., arsenic sulphides	
<b>EAC</b>		<b>2X</b>	Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses.	
<b>APP</b>		<b>B</b>	Gas-tight chemical protective suit with breathing apparatus**.	
<b>Hazards</b>	<b>Class</b>	<b>6.1</b>	Toxic substance	
	<b>Sub risks</b>	-		
<b>HIN</b>		<b>66</b>	Highly toxic substance	

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<b>APP</b>		-		
<b>Hazards</b>	<b>Class</b>	<b>6.1</b>	Toxic substance	
	<b>Sub risks</b>	-		
<b>HIN</b>		<b>60</b>	Toxic or slightly toxic substance	


UN – United Nations number; EAC – Emergency Action Code; APP – Additional Personal Protection; HIN - Hazard Identification Number


\* Liquid-tight chemical protective clothing (BS 8428) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).

\*\* Gas-tight chemical protective clothing conforming to BS EN 943 part 2 in combination with self-contained open circuit positive pressure compressed air breathing apparatus to BS EN 137.

<sup>a</sup> Dangerous Goods Emergency Action Code List, HM Fire Service Inspectorate, Publications Section, The Stationery Office, 2009.

*Standard (UK) Dangerous Goods Emergency Action Codes<sup>(a)</sup>*

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<b>EAC</b>		<b>2X</b>	Use fine water spray. Wear liquid-tight chemical protective clothing 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>	<b>6.1</b>	Toxic substance	
	<b>Sub risks</b>	-		
<b>HIN</b>		<b>66/60</b>	Highly toxic/toxic or slightly toxic substance	

<b>UN</b>		<b>1558</b>	Arsenic	
<b>EAC</b>		<b>2Z</b>	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.	
<b>APP</b>		-		
<b>Hazards</b>	<b>Class</b>	<b>6.1</b>	Toxic substance	
	<b>Sub risks</b>	-		
<b>HIN</b>		<b>60</b>	Toxic or slightly toxic substance	



UN – United Nations number; EAC – Emergency Action Code; APP – Additional Personal Protection; HIN - Hazard Identification Number

\* Normal fire fighting clothing i.e. fire kit (BS EN 469), gloves (BS EN 659) and boots (HO specification A29 and A30) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).

<sup>a</sup> Dangerous Goods Emergency Action Code List, HM Fire Service Inspectorate, Publications Section, The Stationery Office, 2009.



*Chemical Hazard Information and Packaging for Supply Classification<sup>(a)</sup>*

*Arsenic*

<b>Classification</b>	<b>T</b>	Toxic	
	<b>N</b>	Dangerous for the environment	
<b>Risk phrases</b>	<b>R23/25</b>	Toxic by inhalation and if swallowed	
	<b>R50/53</b>	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment	
<b>Safety phrases</b>	<b>S1/2</b>	Keep locked up and out of reach of children	
	<b>S20/21</b>	When using do not eat, drink or smoke	
	<b>S28</b>	After contact with skin, wash immediately with plenty of ... (see manufacturers advice)	
	<b>S45</b>	In case of accident or if you feel unwell seek medical advice immediately (show the label where possible)	
	<b>S60</b>	This material and its container must be disposed of as hazardous waste	
	<b>S61</b>	Avoid release into the environment. Refer to special instructions/safety.	

<sup>a</sup> Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.2.  
<http://esis.jrc.ec.europa.eu/index.php?PGM=cla> (accessed 11/2011).

Arsenic compounds<sup>(a)</sup>

<b>Classification</b>	<b>T</b>	Toxic	
	<b>N</b>	Dangerous for the environment	
<b>Risk phrases</b>	<b>R23/25</b>	Toxic by inhalation and if swallowed	
	<b>R50/53</b>	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment	
<b>Safety phrases</b>	<b>S1/2</b>	Keep locked up and out of reach of children	
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## Specific concentration limits

Concentration	Classification
$C \geq 0.2 \%$	T; R23/25
$0.1 \% \leq C < 0.2 \%$	Xn; R20/22

<sup>a</sup> Arsenic compounds with the exception of diarsenic trioxide, arsenic trioxide diarsenic pentaoxide, arsenic pentoxide and arsenic oxide.

*Globally Harmonised System of Classification and Labelling of Chemicals (GHS)<sup>(a)</sup>*




**Arsenic**

<b>Hazard Class and Category</b>	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	
<b>Hazard Statement</b>	<b>H331</b>	Toxic if inhaled	
	<b>H301</b>	Toxic if swallowed	
	<b>H400</b>	Very toxic to aquatic life	
	<b>H410</b>	Very toxic to aquatic life with long lasting effects	
<b>Signal Words</b>	DANGER		

Implemented in the EU on 20 January 2009.

<sup>a</sup> Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.1.  
<http://esis.jrc.ec.europa.eu/index.php?PGM=cla> (accessed 11/2011).

*Arsenic compounds*

<b>Hazard Class and Category</b>	Acute Tox. 3	Acute toxicity (oral, inhalation), category 3	
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	<b>H301</b>	Toxic if swallowed	
	<b>H400</b>	Very toxic to aquatic life	
	<b>H410</b>	Very toxic to aquatic life with long lasting effects	
<b>Signal Words</b>	DANGER		

## Physicochemical Properties

<b>CAS number</b>	7440-38-2
<b>Atomic weight</b>	75
<b>Chemical symbol</b>	As
<b>Common synonyms</b>	Grey arsenic; metallic arsenic
<b>State at room temperature</b>	Solid
<b>Volatility</b>	Non-volatile at 20 °C
<b>Specific gravity</b>	5.7 at 14 °C (water = 1)
<b>Flammability</b>	Non-combustible, substance itself does not burn
<b>Lower explosive limit</b>	Data not available
<b>Upper explosive limit</b>	Data not available
<b>Water solubility</b>	Sparingly and extremely slowly soluble in cold water
<b>Reactivity</b>	Forms volatile, highly toxic arsine gas when reduced in acid solution
<b>Reaction or degradation products</b>	Emits toxic arsenic fumes and gaseous arsine upon decomposition
<b>Odour</b>	Odourless

References<sup>(a,b,c)</sup>

<sup>a</sup> Arsenic (HAZARDTEXT® Hazard Management). In: Klasco RK (Ed): TOMES® System. Thomson Micromedex, Greenwood Village, Colorado (accessed 08/2010).

<sup>b</sup> The Merck Index (14<sup>th</sup> Edition). Entry 794; Arsenic, 2006.

<sup>c</sup> The Dictionary of Substances and their Effects. Ed. S Gangolli. Second Edition, Volume 1, 1999.

**Threshold Toxicity Values**

<b>EXPOSURE VIA INGESTION</b>	
<b>mg kg<sup>-1</sup></b>	<b>SIGNS AND SYMPTOMS</b>
<b>1 - 3</b>	Lethal dose

References<sup>(a)</sup>

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TOXBASE - <http://www.toxbase.org>

<sup>a</sup> TOXBASE: Arsenic and arsenic compounds, 2010.

## 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***		

\* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr 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 hr 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 hr without experiencing or developing life-threatening health effects.

### Interim Acute Exposure Guideline Levels (AEGLs)<sup>(a)</sup>

	mg m <sup>-3</sup>				
	10 min	30 min	60 min	4 hr	8 hr
AEGL-1 <sup>†</sup>	-	-	-	-	-
AEGL-2 <sup>††</sup>	3.7	3.7	3.0	1.9	1.2
AEGL-3 <sup>†††</sup>	11	11	9.1	5.7	3.7

<sup>†</sup> The level of the chemical in air at or above which the general population could experience notable discomfort.

<sup>††</sup> The 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.

<sup>†††</sup> The level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

<sup>a</sup> U.S. Environmental Protection Agency. Acute Exposure Guideline Levels, <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 01/2011)

## Exposure Standards, Guidelines or Regulations

### Occupational standards

<b>WEL<sup>(a)</sup></b>	LTEL (8 hour reference period): 0.1 mg m <sup>-3</sup>
	STEL (15 min reference period): No guideline value specified

### Public health guidelines

<b>DRINKING WATER QUALITY GUIDELINE<sup>(b)</sup></b>	10 µg L <sup>-1</sup>
<b>AIR QUALITY GUIDELINE<sup>(c)</sup></b>	66, 6.6 and 0.66 µg m <sup>-3</sup> for an excess lifetime cancer risk of 1:10000, 1:100000, 1:1000000, respectively.
<b>SOIL GUIDELINE VALUE AND HEALTH CRITERIA VALUES<sup>(d,e)</sup></b>	<b>Residential</b> 32 mg kg <sup>-1</sup> dry weight soil
	<b>Allotment</b> 43 mg kg <sup>-1</sup> dry weight soil
	<b>Commercial</b> 640 mg kg <sup>-1</sup> dry weight soil
	<b>Index dose<sup>oral</sup></b> 0.3 µg kg <sup>-1</sup> bw day <sup>-1</sup>
	<b>Index dose<sup>inhalation</sup></b> 0.002 µg kg <sup>-1</sup> bw day <sup>-1</sup>

WEL – Workplace exposure limit; LTEL - Long-term exposure limit; STEL – Short-term exposure limit

<sup>a</sup> List of approved workplace exposure limits (as consolidated with amendments October 2007). <http://www.hse.gov.uk/cosHH/table1.pdf> (An update to EH40/2005: Workplace Exposure Limits 2005. The Stationery Office, London) (accessed 01/2011).

<sup>b</sup> The Water Supply (Water Quality) Regulations 2000 (England) and the Water Supply (Water Quality) Regulations 2001 (Wales) (accessed 01/2011).

<sup>c</sup> Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications, European Series, No. 91, Second Edition, 2000 (accessed 01/2011).

<sup>d</sup> Environment Agency (EA). Soil Guideline Values for Arsenic in soil. Science Report SC050021/Arsenic SGV.2009. EA. Bristol, UK (accessed 01/2011).

<sup>e</sup> Environment Agency (EA), Contaminants in soil: updated collation of toxicological data and intake values for humans. Arsenic. Science Report SC050021/TOX 1. 2009, EA: Bristol, UK (accessed 01/2011).

## Health Effects

### *Major routes of exposure<sup>(a)</sup>*

- Toxic by ingestion and inhalation.

### *Immediate Signs or Symptoms of Acute Exposure<sup>(b)</sup>*

- Inhalation causes irritation to the upper airways, cough, sore throat, breathlessness, wheeze, pulmonary oedema and respiratory failure. At very high exposures, perforation of the nasal septum has occurred. Features of systemic toxicity may also occur.
- Ingestion causes abdominal pain, vomiting, and diarrhoea leading to hypovolaemic shock, myocardial depression and cardiovascular collapse. Trivalent arsenic is corrosive to the mouth and mucous membranes causing oral burns, dysphagia and haemorrhagic gastroenteritis. Other features include ECG changes, pulmonary oedema, adult respiratory distress syndrome (ARDS) and acute respiratory failure, CNS depression, convulsions, encephalopathy and coma.
- Dermal contact may cause erythema and swelling, with papules and vesicles in more severe cases. Exposure to arsenic dusts in the workplace may cause contact dermatitis. Features of systemic toxicity would only be expected following prolonged skin exposure or if skin integrity was already damaged prior to skin contact.
- Ocular exposure may cause pain, lacrimation, blepharospasm, conjunctivitis, photophobia, visual disturbance and corneal damage. Arsenic is highly irritant and is corrosive to the eye.

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TOXBASE - <http://www.toxbase.org> (accessed 01/2011)

<sup>a</sup> TOXBASE: Arsenic and arsenic compounds, 07/2010

<sup>b</sup> TOXBASE: Arsenic – features and management, 06/2010

## Decontamination and First Aid

### Important Notes<sup>(a)</sup>

- Ambulance staff, paramedics and emergency department staff treating chemically-contaminated casualties should be equipped with Department of Health approved, gas-tight (Respirex) decontamination suits based on EN466:1995, EN12941:1998 and prEN943-1:2001, where appropriate.
- Decontamination should be performed using local protocols in designated areas such as a decontamination cubicle with adequate ventilation.
- Secondary contamination may occur.

### Dermal exposure<sup>(a,b)</sup>

- Remove patient from exposure.
- Double-bag soiled clothing and place in a sealed container clearly labelled as a chemical hazard.
- Wash any affected areas with copious amounts of water.
- Treat skin burns conventionally.
- Treat systemic features of toxicity as ingestion.

### Ocular exposure<sup>(a)</sup>

- Remove patient from exposure.
- Remove contact lenses if necessary and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-15 minutes.
- Patients with corneal damage and those whose symptoms do not resolve rapidly should be referred for urgent ophthalmological assessment.

### Inhalation<sup>(a)</sup>

- Remove patient from exposure.
- Maintain a clear airway and adequate ventilation.
- Give humidified oxygen.
- Nebulised bronchodilators may be of benefit if bronchospasm is present
- Monitor pulse, blood pressure, respiratory rate, oxygen saturation and cardiac rhythm for at least 4 hours
- Commence intravenous fluids in patients with diarrhoea and vomiting.
- Apply other measures as indicated by the patient's clinical condition.

### Ingestion<sup>(a)</sup>

- Ensure a clear airway and adequate ventilation.
- Consider gastric lavage if a significant amount has been ingested within 1 hour and vomiting has not already occurred. Activated charcoal is unlikely to be of benefit.
- Monitor pulse, blood pressure, respiratory rate, oxygen saturation and cardiac rhythm for at least 4 hours.
- Perform a 12 lead ECG in all patients.

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TOXBASE - <http://www.toxbase.org> (accessed 01/2011)

<sup>a</sup> TOXBASE: Arsenic and arsenic compounds, 07/2010.

<sup>b</sup> TOXBASE: Arsenic – features and management, 06/2010.

- Correct hypotension by raising the foot of the bed and by giving appropriate fluid challenge. Treat brady and tachyarrhythmias appropriately.
- Commence intravenous fluids in patients with diarrhoea and vomiting.
- Apply other measures as indicated by the patient's clinical condition.

This document will be reviewed not later than 3 years or sooner if substantive evidence becomes available.