



## Benzene

### Incident Management

#### Key Points

##### General

- liquid at room temperature with low solubility in water
- aromatic petrol-like odour
- highly flammable and highly volatile
- explosive; reacts violently with oxidants, nitric acid, sulphuric acid and halogens generating a fire and explosion hazard

##### Health effects

- major routes of exposure are inhalation, ingestion and skin contact
- inhalation may result in mucous membrane irritation, sore throat, cough, hoarseness of voice and dyspnoea; pulmonary oedema and haemorrhage may follow severe exposure
- ingestion causes burning sensation of the mouth, oesophagus and stomach; nausea, vomiting and abdominal pain may follow
- dermal contact can cause erythema and dermatitis
- benzene vapour may cause eye irritation at high concentrations

##### Casualty decontamination at the scene


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

##### Environment








- avoid release 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

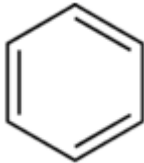
<b>UN</b>		1114	Benzene	
<b>EAC</b>		3WE	Use normal foam. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident†	
<b>APP</b>		A(fl)	Gas-tight chemical protective suit with breathing apparatus‡ Flammable liquid	
<b>Hazards</b>	<b>Class</b>	3	Flammable liquid	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		33	Highly flammable liquid (flashpoint below 23°C)	
<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><b>Reference</b></p> <p>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)\***

<b>Hazard class and category</b>	Flam. Liq. 2	Flammable liquids, category 2	
	Asp. Tox. 1	Aspiration hazard, category 1	
	Skin Irrit. 2	Skin irritation, category 2	
	Eye Irrit. 2	Eye irritation, category 2A	
	Muta. 1B	Germ cell mutagenicity, category 1B	
	Carc. 1A	Carcinogenicity, category 1A	
	STOT RE 1	Specific target organ toxicity following repeated exposure, category 3	
<b>Hazard statement</b>	H225	Highly flammable liquid and vapour	
	H304	May be fatal if swallowed and enters airways	

	H315	Causes skin irritation
	H319	Causes serious eye irritation
	H340	May cause genetic defects
	H350	May cause cancer
	H372	Causes damage to organs through prolonged or repeated exposure
Signal words	DANGER	
* Implemented in the EU on 20th January 2009		
<b>Reference</b>		
European Commission. Harmonised classification – Annex VI of Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <a href="http://echa.europa.eu/information-on-chemicals/cl-inventory-database">http://echa.europa.eu/information-on-chemicals/cl-inventory-database</a> (accessed 03/2019).		

## Physicochemical Properties

<b>CAS number</b>	71-43-2
<b>Molecular weight</b>	78
<b>Formula</b>	C <sub>6</sub> H <sub>6</sub>
<b>Common synonyms</b>	Benzol
<b>State at room temperature</b>	Liquid
<b>Volatility</b>	Highly volatile, vapour pressure: 94.8 mmHg at 25°C
<b>Specific gravity</b> <b>Vapour density</b>	0.88 (water =1) at 20°C 2.7 (air = 1)
<b>Flammability</b>	Highly flammable
<b>Lower explosive limit</b>	1.2%
<b>Upper explosive limit</b>	8.0%
<b>Water solubility</b>	Low solubility in water
<b>Reactivity</b>	Will form explosive mixtures with air. Reacts violently with oxidants, nitric acid, sulphuric acid and halogens generating a fire and explosion hazard. Attacks plastics and rubber
<b>Reaction or degradation products</b>	–
<b>Odour</b>	Aromatic petrol-like odour
<b>Structure</b>	
<b>References</b>	
<p>Hazardous Substances Data Bank. Benzene. HSDB No. 35 (last revision date 09/10/2014). 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> (accessed 03/2019).</p> <p>International Programme on Chemical Safety. International chemical safety card entry for benzene. ICSC 0015, 2016. World Health Organization: Geneva.</p>	

## Reported Effect Levels from Authoritative Sources

### Exposure by inhalation

ppm	mg/m <sup>3</sup>	Duration	Signs and symptoms	Reference
25	80	8 hours	No immediate clinical effects (8 hours)	a
300–3,000	957–9,570	–	CNS effects (drowsiness, dizziness, headache, vertigo, tremor, delirium and loss of consciousness)	b
7,500	24,000	30 minutes	Dangerous to life	a
10,000-20,000	-	5–10 minutes	Can be fatal	b
20,000	>64,000	5–10 minutes	CNS depression, cardiac arrhythmia, respiratory failure and death	a, b

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. Benzene. Environmental Health Criteria 150, 1993.  
 b Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for benzene, 2007.

### Exposure by ingestion

mg/kg bw	Signs and symptoms	Reference
125	Estimated lethal dose (based on an adult weighing 70 kg)	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 US EPA IRIS. Toxicological Review of Benzene (Noncancer Effects). 2002.

## Published Emergency Response Guidelines

### Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m <sup>3</sup> )
<b>ERPG-1*</b>	50 <sup>(1)</sup>	160
<b>ERPG-2†</b>	150	480
<b>ERPG-3‡</b>	1,000	3,200

\* 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

<sup>(1)</sup> Odour should be detectable near ERPG-1

#### Reference

Reference

American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values.

[https://www.aiha.org/get-](https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf)

[involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf](https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf)

(accessed 03/2019).

### Acute exposure guideline levels (AEGs)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
<b>AEG-1*</b>	130	73	52	18	9
<b>AEG-2†</b>	2,000 <sup>(1)</sup>	1,100	800	400	200
<b>AEG-3‡</b>	<sup>(2)</sup>	5,600 <sup>(1)</sup>	4,000 <sup>(1)</sup>	2,000 <sup>(1)</sup>	990

\* 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

Lower explosive limit (LEL) = 14,000 ppm

<sup>(1)</sup> = >10% LEL, <sup>(2)</sup> = >50% LEL

AEG-3: 10 min = <sup>(2)</sup> 9,700 ppm

For values denoted as <sup>(1)</sup> safety considerations against the hazard(s) of explosion(s) must be taken into account

For values denoted as <sup>(2)</sup> extreme safety considerations against the hazard(s) of explosion(s) must be taken into account

#### Reference

US Environmental Protection Agency. Acute Exposure Guideline Levels. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm>

(accessed 03/2019).

## 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>	1	3.25	No guideline specified	
<p>WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit</p> <p><b>Reference</b> Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 3<sup>rd</sup> Edition, 2018.</p>				

### Public health guidelines

<b>Drinking water standard</b>	1 µg/L
<b>Air quality guideline</b>	17, 1.7 and 0.17 µg/m <sup>3</sup> for an excess lifetime cancer risk of 1/10,000, 1/100,000, 1/1,000,000, respectively
<p><b>References</b></p> <p>The Water Supply (Water Quality) Regulations 2018 (Water, England and Wales) 2018. The Private Water Supplies (England) Regulations 2016 and The Private Water Supplies (Wales) Regulations 2017. Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications, European Series, No. 91, Second Edition, 2000. WHO Guidelines for Indoor Air Quality: Selected Pollutants. World Health Organization Regional Office for Europe, Copenhagen. 2010.</p>	



## Health Effects

### Major route of exposure

- Ingestion, inhalation and skin contact

### Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
<b>Inhalation</b>	<p>Mucous membrane irritation, sore throat, cough, hoarseness of voice and dyspnoea. Severe exposure to benzene vapours causes inflammation of the airways with pulmonary oedema and haemorrhages</p> <p>Benzene is well absorbed by inhalation and patients might develop systemic features</p>
<b>Ingestion</b>	<p>Burning sensation of the mouth, oesophagus and stomach, with nausea, vomiting and abdominal pain. Gastrointestinal ulceration, severe gastric inflammation and later pyloric stenosis have also been reported</p> <p>Systemic features can develop after ingestion of benzene</p> <p>Aspiration of benzene causes inflammation (pneumonitis), pulmonary oedema and haemorrhage</p>
<b>Dermal</b>	<p>Benzene is a skin irritant and prolonged or excessive contact may cause erythema and dermatitis</p> <p>Chemical burns are possible. Sub-acute low dose exposures to vapours has caused membrane irritation and skin irritation</p>
<b>Ocular</b>	<p>Benzene vapour may cause eye irritation at high concentrations and droplets may cause a burning sensation</p>
<b>Systemic</b>	<p>Initial euphoria and excitation followed by CNS depression, dizziness, drowsiness, headache, incoordination, staggering gait, cardiac arrhythmia, respiratory failure, delirium, coma and convulsions. Cerebral oedema has been reported</p>
<p><b>Reference</b> TOXBASE. Benzene, 12/2018. <a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 03/2019).</p>	

## 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 benzene 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.

**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
- 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](http://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
- 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 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
- manage 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/inhalation/systemic toxicity

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

### Clinical decontamination and first aid references

TOXBASE	<a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 03/2019)
TOXBASE	Benzene, 12/2018
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.

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