UK Health Security Agency

Bromine

Incident management

Contents

Main points

General

Bromine is a dark red to brown fuming liquid with a suffocating odour.

It is also a strong oxidant and it reacts violently with combustible and reducing materials.

When bromine is heated, it emits highly toxic fumes and will react with water or steam to produce toxic and corrosive fumes

Health

Irritation of eyes and nose with sore throat, cough, chest tightness and wheeze follows inhalation exposure; headache, fever, tachycardia and confusion may also develop.

Ingestion causes pain in mouth, throat and abdomen, vomiting, haematemesis and dyspnoea.

Skin contact with can cause burns which take a long time to heal and can become deeply ulcerated if left untreated; burns may initially cause no pain or visible effects and may develop 1 to 5 days after exposure.

Exposure to low concentrations causes inflammation of the eyelids, lacrimation, conjunctivitis and irritation while high concentrations can cause blepharospasm, palpebral oedema and photophobia.

Casualty decontamination at the scene

Bromine is a highly corrosive substance. Therefore, following disrobe, improvised wet decontamination should be considered.

Environment

Hazardous to the environment.

Inform the Environment Agency where appropriate.

Spillages and decontamination run-off should be prevented from entering drains and watercourses.

Hazard identification

Table 1. Standard (UK) dangerous goods emergency action codes

Notes in the format [n1] refer to notes beneath the table.

UN		1744	Bromine or bromine solution	
EAC		2XE	Use alcohol-resistant foam but, if not available, fine water spray can be used. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [n1]. Danger that the substance can be violently or explosively reactive. Spillages 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 [n2]	
APP		A(!)	Gas-tight chemical protective suit in combination with breathing apparatus [n3] The substance may have a particularly deleterious effect on chemical protective clothing	
Hazards	**Class**	8	Corrosive substances	
	Sub-risks	6.1	Toxic substances	
HIN		886	Highly corrosive substance, toxic	

Notes to Table 1

Abbreviations: UN = United Nations number, EAC = emergency action code, APP = additional personal protection, HIN = hazard identification number.

[n1] 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.

[n2] 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.

[n3] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2. Thermal-resistant gloves should be worn such as those conforming to BS EN 511:2006 or BS EN 407:2004.

Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office 2021

Table 2. The GB classification, labelling and packaging (CLP) regulation

Hazard class and category	Acute Tox. 2	Acute toxicity (inhalation), category 2	
	Skin Corr. 1A	Skin corrosive, category 1A	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
Hazard statement	H330	Fatal if inhaled	
	H314	Causes severe skin burns and eye damage	
	H400	Very toxic to aquatic life	
Signal words	Danger		

Reference

The Health and Safety Executive (HSE) GB CLP Regulation (viewed February 2022)

Physicochemical properties

Table 3. Physicochemical properties of bromine

CAS number	7726-95-6
Molecular weight	159.82
Formula	Br_2
Common synonyms	-
State at room temperature	Dark red-brown fuming liquid
Volatility	Vapour pressure = 175 mm Hg (at 21ºC)
Specific gravity **Vapour density**	3.1 (water =1) 5.51 (air = 1)
Flammability	Non-combustible but enhances combustion of other substances
Lower explosive limit	-
Upper explosive limit	-
Water solubility	3.58 g/100 mL water (at 20ºC)
Reactivity	Strong oxidant. Reacts violently with combustible and reducing materials. Attacks metal and some forms of rubber, plastic and coatings
Reaction or degradation products	When heated will emit highly toxic fumes and will react with water or steam to produce toxic and corrosive fumes
Odour	Suffocating odour
Structure	Br – Br

References

International Programme on Chemical Safety. ‘International chemical safety card entry for Bromine’. ICSC 0107, 2005. World Health Organization (WHO) Geneva

PubChem. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information 2004-. PubChem Compound Summary for CID 24408, Bromine (viewed February 2022)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation

ppm	mg/m^3	Signs and symptoms	Reference
> 1.0	> 6.5	Irritation level	a
40 to 60	260 to 390	Toxic pneumonitis and pulmonary oedema	a
1,000	6,500	Fatal within a few minutes	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

Reference

International Programme on Chemical Safety (IPCS) Poisons Information Monograph (PIM) 080: Bromine, 1999

Published emergency response guidelines

Table 5. Acute exposure guideline levels (AEGLs)

Notes in the format [n1] refer to notes beneath the table.

	ppm				
	10 min	**30 min**	**60 min**	**4 hours**	**8 hours**
AEGL-1 [n1]	0.033	0.033	0.033	0.033	0.033
AEGL-2 [n2]	0.55	0.33	0.24	0.13	0.095
AEGL-3 [n3]	19	12	8.5	4.5	3.3

Notes to Table 5

[n1] Level of the chemical in air at or above which the general population could experience notable discomfort.

[n2] 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.

[n3] 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 (viewed February 2022)

Exposure standards, guidelines or regulations

Table 6. Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	**mg/m^3**	**ppm**	**mg/m^3**
WEL	0.1	0.66	0.2	1.3

Notes to table 6

Abbreviations. WEL = workplace exposure limit, LTEL = long-term exposure limit, STEL = short-term exposure limit.

Reference

HSE. EH40/2005 Workplace Exposure Limits, Fourth edition, 2020

Table 7. Public health standards and guidelines

Drinking water standard **WHO drinking water quality guideline**	Values not given
WHO air quality guideline	

Health effects

Major route of exposure

Extremely irritating or corrosive to mucous membranes. Exposure to any quantity could be dangerous.

Table 8. Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Potent respiratory irritant causing irritation of eyes and nose with sore throat, cough, chest tightness and wheeze. It can also cause headache, fever, tachycardia and confusion. Chemical pneumonitis, tachypnoea, dyspnoea and stridor due to laryngeal oedema can occur. Pneumomediastinum has been reported following prolonged coughing and choking. Pulmonary oedema with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36 hours to develop. Symptoms may take several weeks to resolve completely. Corrosive damage to the mucous membranes of both the upper and lower respiratory tract can occur in serious cases. Severe inhalation injuries may result in persistent hoarseness, pulmonary fibrosis and chronic obstructive airway disease
Ingestion	Ingestion will cause immediate pain with burning in the mouth, throat and stomach, followed by abdominal pain, vomiting, haematemesis and dyspnoea. The lips, tongue and mucous membranes may become stained a brown colour. Pain and oedema may make swallowing difficult. Haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases. Stridor and respiratory complications can develop following aspiration of corrosive materials. In early severe cases, gastric or oesophageal perforation may occur. A potential late complication is stricture formation which usually occurs between 2 weeks and 2 months post exposure.
Dermal	Skin contact with either liquid for fumes may cause burns which can become deeply ulcerated if not decontaminated. Liquid spilt on the skin causes a cooling sensation on first contact followed by a burning sensation.

Route	Signs and symptoms
	Burns may initially cause no pain or visible effects and may develop 1 to 5 days after exposure. Burns initially appear as brown discolouration of the skin. Subsequently blisters, vesicles and pustules develop. Third degree burns, deep ulcers, and scars can develop, depending on the severity of exposure. Skin exposure to lower concentrations of bromine for example, diluted in swimming pools can cause pruritic, blotchy, measles-like rashes in the face, trunk and extremities lasting up to 2 weeks. Patients dermally exposed to lower concentrations of bromine tend to seek medical attention late. However, they can still sustain severe injury if treatment is delayed. Deep, penetrating burns develop over a period of days due to continued damage to contaminated skin.
Ocular	Ocular exposure to the vapour or liquid can cause severe burns to the eye. Lower concentrations cause inflammation of the eyelids, lacrimation, conjunctivitis and irritation. High concentrations can cause blepharospasm, palpebral oedema and photophobia

Reference

TOXBASE. Bromine, December 2018 (viewed February 2022)

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 wet decontamination should be considered for an incident involving bromine (highly corrosive).

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 the UK Health Security Agency (Radiation, Chemicals and Environment Directorate) 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 (for example, 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 and so on) 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 or 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 persons individually.

Detailed information on clinical management can be found on TOXBASE.

Important notes

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

Resuscitation of unconscious patients should be carried out prior to decontamination.

Decontamination should be performed in a well-ventilated area, preferably with its own ventilation system.

Avoid contaminating yourself with this product and wash any exposed area.

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 soap and copious amounts of water under low pressure for at least 10 to 15 minutes, or until the pH of the skin is normal (pH of the skin is 4.5 to 6, although it may be closer to 7 in children, or after irrigation). The earlier irrigation begins, the greater the benefit.

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.

Do not apply neutralising chemicals as heat produced during neutralisation reactions may cause thermal burns and increase injury.

Recheck pH of affected area for a period of 15-20 minutes and repeat irrigation if abnormal.

Burns with strong solutions may require irrigation for several hours or more.

Once the pH is normal and stabilised, treat as per a thermal injury.

Burns totalling more than 15% of body surface area in adults (more than 10% in children) will require standard fluid resuscitation as for thermal burns.

Moderate to severe chemical burns should be reviewed by a burn's specialist.

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 (for example, 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 (for example, via an infusion bag with a giving set) for a minimum of 10 to 15 minutes irrespective of the initial conjunctival pH. A Morgan Lens may be used if anaesthetic has been given.

Aim for a final conjunctival pH of 7.5 to 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 referred urgently to an ophthalmologist.

Other supportive measures as indicated by the patient's clinical condition.

Inhalation

Maintain a clear airway and ensure adequate ventilation.

Give oxygen to achieve oxygenation if required.

Perform a 12-lead ECG in all patients who require assessment and monitor cardiac rhythm.

Children are at increased risk of airway obstruction.

Other measures as indicated by the patient's clinical condition.

Ingestion

Maintain airway and establish haemodynamic stability.

In severely affected patients critical care input is essential. Urgent assessment of the airway is required. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction.

Do not attempt gastric lavage.

Do not give neutralising chemicals as heat produced during neutralisation reactions may increase injury.

The use of water or milk (maximum initial volume = 100 - 200 mL in an adult; 2 mL/kg in a child) as diluents in the management of corrosive ingestion may be of some symptomatic benefit (but caution is necessary following large ingestions where mucosal damage or perforation may have already developed). There is experimental evidence to suggest that early dilution therapy with water or milk reduces acute alkali injury of the oesophagus but administration of large volumes of fluid should be avoided as they may induce vomiting and increase the risk of oedema.

Monitor vital signs and check capillary blood glucose.

Check and record pupil size.

Perform a 12 lead ECG and monitor cardiac rhythm.

Other supportive measures as indicated by the patient's condition.

Clinical decontamination and first aid references

TOXBASE (viewed February 2022)

TOXBASE Bromine (2018)

TOXBASE Bromine: features and management (2018)

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation heath secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

This document from the UKHSA Radiation, Chemicals and Environment Directorate reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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