



# Sulphur Dioxide

## Incident Management

### Key Points

#### Fire

- non-flammable
- reacts violently with sodium hydride, alcohols, caustics, amines and water
- contact with copper, bronze or alkali metals may cause explosions
- produces sulphurous acid when in contact with water
- in the event of a fire involving sulphur dioxide, use fine water spray and liquid-tight chemical protective clothing with breathing apparatus

#### Health



- dissolves in moisture on skin, eyes and mucous membranes to form sulphurous acid
- inhalation causes irritation of the eyes, nose, nasopharynx and glottis; exposure to moderate to high doses can cause gastrointestinal symptoms and damage to the respiratory tract
- dermal exposure causes severe irritation, causing stinging pain, redness and blisters
- ocular exposure causes lacrimation, corneal opacity, erosion and necrosis which may result in blindness

#### Environment




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

## Hazard Identification

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

<b>UN</b>		1079	Sulphur dioxide	
<b>EAC</b>		2RE	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 may be washed to drains with large quantities of water. Due care must however still be exercised to avoid unnecessary pollution to surface and groundwaters. There may be a public safety hazard outside the immediate area of the incident†	
<b>APP</b>		B	Gas-tight chemical protective suit with breathing apparatus‡	
<b>Hazards</b>	<b>Class</b>	2.3	Toxic gases	
	<b>Sub-risks</b>	8	Corrosive substances	
<b>HIN</b>		268	Toxic gas, corrosive	
<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 the 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>‡ Chemical protective clothing should be gas tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137</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, 2015</p>				

**Classification, labelling and packaging (CLP)\***

<b>Hazard class and category</b>	Press. Gas	Compressed gas	
	Skin Corr. 1B	Skin corrosion, category 1B	
	Acute Tox. 3	Acute toxicity (oral, dermal, inhalation), category 3	
<b>Hazard statement</b>	H314	Causes severe skin burns and eye damage	
	H331	Toxic if inhaled	
<b>Signal words</b>	DANGER		
<p>* Implemented in the EU on 20 January 2009</p> <p><b>Reference</b>  European Commission. Harmonised classification – Annexe VI to 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 05/2015).</p>			

## Physicochemical Properties

<b>CAS number</b>	7446-09-5
<b>Molecular weight</b>	64.06
<b>Empirical formula</b>	SO <sub>2</sub>
<b>Common synonyms</b>	Sulphurous anhydride, sulphurous oxide
<b>State at room temperature</b>	Colourless gas
<b>Volatility</b>	Vapour pressure = 3 x 10 <sup>3</sup> mmHg at 25°C
<b>Specific gravity</b>	2.26 (air = 1.0) at 0°C
<b>Flammability</b>	Non-flammable
<b>Lower explosive limit</b>	No data available
<b>Upper explosive limit</b>	No data available
<b>Water solubility</b>	Soluble
<b>Reactivity</b>	Reacts violently with sodium hydride, alcohols, caustics, amines and water. Explosions may occur from contact with ethanol, ether, fluorine, chlorine trifluoride and chlorates. Contact with copper, bronze or alkali metals may cause explosions
<b>Reaction or degradation products</b>	Produces sulphurous acid when in contact with water
<b>Odour</b>	Irritating pungent odour
<b>Structure</b>	O=S=O
<p><b>References</b></p> <p>Hazardous Substances Data Bank [Internet]. Bethesda (MD): National Library of Medicine (US); [Last Revision Date .30/04/2010]. Sulfur dioxide; Hazardous Substances Databank Number: 228. Available from: <a href="http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB">http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB</a> (assessed 05/2015).</p> <p>International Programme for Chemical Safety (IPCS). International Chemical Safety Card entry for sulphur dioxide, ISCS 0074, 2006. World Health Organization: Geneva.</p> <p>Sulfur Dioxide (HAZARDTEXT™ Medical Management). In: Klasco RK (Ed): TOMES® System. Truven Healthcare Analytics Inc., Greenwood Village, Colorado, USA. (electronic version). RightAnswer.com, Inc., Midland, MI, USA, Available at: <a href="http://www.rightanswerknowledge.com">http://www.rightanswerknowledge.com</a> (assessed 05/2015).</p>	

## Reported Effect Levels from Authoritative Sources

### Exposure by inhalation

ppm	mg/m <sup>3</sup>	Signs and symptoms	Reference
<0.1	0.26	Increased airway resistance in asthmatics when exercising	c
0.76	2	Self-reported nose and throat irritation	a
4	11	Tightness in chest	b
5	13	Healthy adults experienced increased airway resistance	c
10	26	Sneezing and coughing	c
20	52	Bronchospasm	c
100	262	Immediately dangerous to life and health	d

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. Environmental Health Criteria 8: Sulfur oxides and suspended particulate matter, 1979. World Health Organization: Geneva.
- b European Commission, Scientific Committee on Occupational Exposure Limits. Recommendation from the Scientific Committee on Occupational Exposure Limits for Sulphur Dioxide, 2009.
- c Agency for Toxic Substances and Disease Registry (ATSDR). Medical Management Guidelines for Sulfur Dioxide, 2014. <http://www.atsdr.cdc.gov/MMG/MMG.asp?id=249&tid=46> (accessed 10/2015)
- d TOXBASE. Sulphur dioxide, 2008. <http://www.toxbase.org> (accessed 10/2015).

### Exposure to skin and eyes

ppm	mg/m <sup>3</sup>	Signs and symptoms	Reference
10–20	26–52	Irritation	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

- a Agency for Toxic Substances and Disease Registry (ATSDR). Medical Management Guidelines for Sulfur Dioxide, 2014. <http://www.atsdr.cdc.gov/MMG/MMG.asp?id=249&tid=46> (accessed 05/2015).

## Published Emergency Response Guidelines

### Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m <sup>3</sup> )
ERPG-1*	0.3 <sup>(1)</sup>	0.79
ERPG-2 <sup>†</sup>	3	7.87
ERPG-3 <sup>‡</sup>	25	65.5

\* 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

<sup>†</sup> 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

<sup>‡</sup> 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

(1) Odour should be detectable near ERPG-1

**Reference**  
American Industrial Hygiene Association (AIHA). 2015 Emergency Response Planning Guideline Values. <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2015%20ERPG%20Levels.pdf> (accessed 09/2015).

### Acute exposure guideline levels (AEGLs)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	0.2	0.2	0.2	0.2	0.2
AEGL-2 <sup>†</sup>	0.75	0.75	0.75	0.75	0.75
AEGL-3 <sup>‡</sup>	30	30	30	19	9.6

\* Level of the chemical in air at or above which the general population could experience notable discomfort

<sup>†</sup> 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

<sup>‡</sup> 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>	No guideline value specified			
WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit				

### Public health guidelines

<b>Drinking water standard</b>	No guideline value specified
<b>Air quality guideline</b>	24-hour average: 20 µg/m <sup>3</sup> 10-minute average: 500 µg/m <sup>3</sup>
<b>Soil guideline values and health criteria values</b>	No guideline value specified

## Health Effects

### Major route of exposure

- inhalation, dermal and ocular exposure

### Immediate signs or symptoms of acute exposure

- dissolves in moisture on skin, eyes and mucous membranes to form sulphurous acid

Route	Signs and symptoms
<b>Inhalation</b>	Up to 90% of inhaled sulphur dioxide may be absorbed. Irritation of the nose, nasopharynx and glottis is common. Moderate to high doses by inhalation can cause gastrointestinal symptoms including nausea, vomiting and abdominal pain, and corrosive damage to the respiratory tract
<b>Dermal</b>	Severe skin irritant causing stinging pain, redness and blisters Skin contact with escaping compressed gas or liquid can cause frostbite. Skin or clothing contaminated with liquid sulphur dioxide can cause secondary contamination by direct contact or exposure through off-gassing vapour
<b>Ocular</b>	Eye contact may result in lacrimation, corneal opacity, erosion and necrosis which may result in blindness
<b>References</b>	
TOXBASE. Sulphur dioxide, 2008. <a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 10/2015).	



## 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.

Sulphur dioxide gas reacts with tissue moisture to form the sulphurous acid, which is corrosive. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details).

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 people individually.

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

### Important note

- 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
- carry out decontamination after resuscitation; resuscitate the patient according to standard guidelines

### 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
- do **not** apply neutralising chemicals as heat produced during neutralisation reactions may cause thermal burns, and increase injury
- 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, or until the pH of the skin is normal (pH of the skin is 4.5–6, 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
- following decontamination recheck the pH of affected areas after 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 for 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/severe chemical burns should be reviewed by a burns 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 (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 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 if required
- perform a 12 lead ECG
- 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 11/2016)
TOXBASE.	Sulphur dioxide, 05/2008
TOXBASE	Corrosives – inhalation, 02/2012
TOXBASE	Skin decontamination – corrosives, 06/2010
TOXBASE	Chemicals splashed or sprayed into the eyes, 02/2014

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