



# Styrene

## Incident Management

### Key Points

#### Fire

- flammable
- can form explosive peroxides; styrene oxide and carbon monoxide may be released when styrene decomposes when burning
- polymerise due to warming, under the influence of light, oxidants, oxygen and peroxides generating a fire and explosion hazard
- in the event of a fire involving styrene, use normal foam and normal fire kit with breathing apparatus

#### Health


- can cause systemic effects by all routes of exposure
- systemic toxicity is characterised by progressive loss of consciousness leading to coma
- inhalation of styrene causes irritation of mucous membranes, coughing and wheezing
- styrene inhalation may also lead to "styrene sickness", which includes headache, nausea, vomiting, weakness, fatigue, dizziness and ataxia
- dermal exposure can cause irritation, itching, dermatitis and erythematous papular dermatitis
- styrene is irritating to the eyes

#### Environment







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

## Hazard Identification

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

<b>UN</b>		2055	Styrene Monomer, Stabilised	
<b>EAC</b>		3Y	Use normal foam, ie protein based that is not alcohol resistant. Wear normal fire kit in combination with breathing apparatus*. There is a danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and surface and groundwaters	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	3	Flammable liquid	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		39	Flammable liquid, which can spontaneously lead to violent reaction	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Normal firefighting clothing is appropriate, ie breathing apparatus conforming to BS EN137 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><b>Reference</b> Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p>				

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

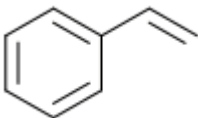
<b>Hazard class and category</b>	Flam. Liq. 3	Flammable liquid, category 3	
	Skin Irrit. 2	Skin irritant, category 2	
	Eye Irrit. 2	Eye irritant, category 2	
	Acute Tox. 4	Acute toxicity (Inhalation), category 4	
	Repr. 2	Reproductive toxicity, category 2	
	STOT RE 1	Specific organ toxicity, repeated exposure, category 1	
	<b>Hazard statement</b>	H226	Flammable liquid and vapour
H315		Causes skin irritation	
H319		Causes serious eye irritation	
H332		Harmful if inhaled	
H361d		Suspected if damaging the unborn child	
H372		Causes damage to the hearing organs through prolonged or repeated exposure	
<b>Signal words</b>	Danger		

\* Implemented in the EU on 20 January 2009

**Reference**

European Commission. Harmonised classification – Annexe VI to 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 05/2017).

## Physicochemical Properties

<b>CAS number</b>	100-42-5
<b>Molecular weight</b>	104
<b>Formula</b>	C <sub>8</sub> H <sub>8</sub>
<b>Common synonyms</b>	Ethenylbenzene; Phenylethylene; Vinylbenzene
<b>State at room temperature</b>	Liquid
<b>Volatility</b>	Vapour pressure 6.4 mm Hg at 25°C
<b>Specific gravity</b>	0.9 at 25°C (water = 1)
<b>Vapour density</b>	3.6 (air = 1)
<b>Flammability</b>	Flammable liquid
<b>Lower explosive limit</b>	0.9%
<b>Upper explosive limit</b>	6.8%
<b>Water solubility</b>	Low solubility in water.
<b>Reactivity</b>	May polymerise due to warming, under the influence of light, oxidants, oxygen and peroxides generating a fire and explosion hazard. Reacts violently with strong acids and strong oxidants. Attacks rubber, copper and copper alloys
<b>Reaction or degradation products</b>	Can form explosive peroxides. Styrene oxide and carbon monoxide may be released when styrene decomposes when burning
<b>Odour</b>	Sweet
<b>Structure</b>	
<p><b>References</b></p> <p>Hazardous Substances Data Bank. Styrene HSDB No. 171 (last revision date 04/09/2014). 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 01/2017)</p> <p>International Programme on Chemical Safety. International Chemical Safety Card entry for Styrene. ICSC 0073, 2006. World Health Organization: Geneva.</p> <p>Styrene (HAZARDTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System, Truven Healthcare Analytics Inc, Greenwood Village CO, US. RightAnswer.com Inc, Midland MI, US. <a href="http://www.rightanswerknowledge.com">http://www.rightanswerknowledge.com</a> (accessed 01/2017).</p>	

## Reported Effect Levels from Authoritative Sources

### Exposure by ingestion

ppm	mg/m <sup>3</sup>	Signs and symptoms	Reference
87	371	Vestibular impairment (1 hour exposure)	a
100	420	Irritation of mucous membranes, eyes and upper respiratory tract	b
200	840	Irritating to eyes and nose, central nervous system effects, drowsiness, nausea, disturbed balance, tendency of impairment of reaction time	b
350	1,490	Marked effects on central nervous system and definite impairment of coordination and motor function	b
600-800	2,520-3,360	Strong immediate irritation of eyes and respiratory tract	b
<p>These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values</p> <p><b>References</b></p> <p>a Agency for Toxic Substances and Disease Registry. Toxicological Profile for Styrene, 2010. Atlanta, US.</p> <p>b International Programme on Chemical Safety, Environmental Health Criteria 26: Styrene, 1983.</p>			

## Published Emergency Response Guidelines

### Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m <sup>3</sup> )
ERPG-1*	50 <sup>1</sup>	213
ERPG-2 <sup>†</sup>	250	1,065
ERPG-3 <sup>‡</sup>	1,000	4,260

\* 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). 2016 Emergency Response Planning Guideline Values. <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf> (accessed 05/2017).

### Acute exposure guideline levels (AEGs) (Interim)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEG-1*	20	20	20	20	20
AEG-2 <sup>†</sup>	230	160	130	130	130
AEG-3 <sup>‡</sup>	1,900 <sup>(1)</sup>	1,900 <sup>(1)</sup>	1,100 <sup>(1)</sup>	340	340

\* 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 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

Note (1): lower explosive limit (LEL) = 9,000 ppm  
(1) = >10% LEL  
(1) safety considerations against the hazard(s) of explosion(s) must be taken into account  
Level of distinct odour awareness = 0.54 ppm

**Reference**  
US Environmental Protection Agency. Acute Exposure Guideline Levels. <http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 05/2017).

## 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>	100	430	250	1,080
WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit <b>Reference</b> Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 2 <sup>nd</sup> Edition, 2011.				

### Public health guidelines

<b>WHO drinking-water guideline value</b>	0.02 mg/L
<b>Air quality guideline</b>	0.26 mg/m <sup>3</sup> (weekly average) 70 µg/m <sup>3</sup> as a 30 minute average (based on odour threshold)
<b>Soil guideline values and health criteria values</b>	Guideline value not given
<b>Reference</b> Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva. 2011. Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications, European Series, No. 91, Second Edition, 2000.	



## Health Effects

### Major route of exposure

- most exposures occur by inhalation of vapour
- both vapour and liquid are irritating to mucous membranes, eyes, skin and respiratory tract; can cause systemic effects by all routes of exposure

### Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
<b>Inhalation</b>	Inhalation may cause irritation of mucous membranes, coughing and wheezing Inhalation by workers has been reported to cause "styrene sickness", the features of which include headache, nausea, vomiting, weakness, fatigue, dizziness and ataxia Inhalation may cause systemic toxicity characterised by progressive loss of consciousness leading to coma. Pulmonary oedema and cardiac arrhythmias may occur
<b>Ingestion</b>	Styrene is absorbed via the GI tract; systemic toxicity including CNS depression is possible
<b>Dermal</b>	Dermal contact may cause irritation, itching, dermatitis and erythematous papular dermatitis. As styrene is absorbed via the skin, systemic toxicity including CNS depression is possible
<b>Ocular</b>	Eye exposure causes irritation. Systemic toxicity is possible
<b>Reference</b> TOXBASE. Styrene, 10/2013. <a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 05/2017).	

## 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.

Following disrobe, improvised dry decontamination should be considered for an incident involving styrene, **unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances.**

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 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

### 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
- do **not** allow smoking nearby. There may be a risk of fire if a solvent is involved

### 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 soap and water under low pressure for at least 10-15 minutes
- the earlier the 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) following surface contamination
- manage as per inhalation
- other supportive measures as indicated by the patient's clinical condition

### Ocular exposure

- remove contact lenses if present and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-15 minutes. Continue until the conjunctival sac pH is normal (7.5 - 8.0). Retest after 20 minutes 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 high flow oxygen to symptomatic patients
- monitor respiratory rate and oxygen saturation
- perform a 12-lead in all patients who require assessment
- other supportive measures as indicated by the patient's clinical condition

## Ingestion

- maintain a clear airway and ensure adequate ventilation
- manage as per inhalation
- other supportive measures as indicated by the patient's clinical condition

## Health effects and decontamination references

TOXBASE <http://www.toxbase.org> (accessed 05/2017)

TOXBASE Styrene, 10/2013

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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