

# **Health monitoring**

Guide for styrene





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# Introduction

This guide is intended to be read by a registered medical practitioner with experience in health monitoring who is engaged by person conducting a business or undertaking (PCBU) to carry out or supervise health monitoring. It provides practical guidance to registered medical practitioners about requirements under the work health and safety (WHS) laws for health monitoring.

This guide applies to all workplaces covered by the WHS Regulations where health monitoring is required.

#### How to use this guide

This guide includes references to the legal requirements under the WHS Act and WHS Regulations. These are included for convenience only and should not be relied on in place of the full text of the WHS Act or WHS Regulations.

The words 'must', 'requires' or 'mandatory' indicate a legal requirement exists that must be complied with. The word 'should' is used in this guide to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

This guide provides information for those registered medical practitioners engaged by a PCBU to carry out or supervise health monitoring for workers. This guidance should be read in conjunction with the following:

- Health monitoring guide for registered medical practitioners
- Health monitoring guides for hazardous chemicals
- Health monitoring guide for workers
- Health monitoring guide for persons conducting business or undertakings (PCBUs).

#### Health monitoring under the WHS Regulations

In certain circumstances, the model WHS Regulations place duties on a PCBU to provide health monitoring to workers. These requirements arise if the worker is carrying out work with hazardous chemicals including lead and asbestos. In addition, the work being carried out must be the kind of work specified in the WHS Regulations. A PCBU has the duty to determine if health monitoring is required.

The WHS Regulations prescribe that health monitoring is carried out by or supervised by a registered medical practitioner with experience in health monitoring.

### Styrene

Styrene (CAS 100-42-5) is a monocyclic aromatic hydrocarbon. It is a colourless, oily liquid that has a sweet smell. The odour threshold for styrene is less than 1 ppm.

*Synonyms:* styrene monomer, phenylethylene, cinnamene, ethenylbenzene, stirolo, styrole, styrolene, styropol, UN 2055 or vinyl benzene.

#### Work activities that may represent a high risk exposure

Styrene is used in the production of polystyrene plastics and resins. Styrene products are used to make pipes, car parts, food containers and carpet backing.

The major uses of styrene include:

- plastics manufacture
- paints
- sealers, and
- other surface coatings.

Examples of work activities involving styrene that require special attention when assessing exposure include:

- fibreglass processes
- manufacturing of reinforced plastics, and
- as an additive in construction materials.

#### Sources of non-occupational exposure

Styrene is released through motor vehicle exhaust, cigarette smoke and photocopiers.

Low levels of styrene are found in fruit and vegetables, nuts and meat.

## 1. Health monitoring for styrene under the Work Health and Safety (WHS) Regulations

Collection of demographic, medical and occupational history

Records of personal exposure

Physical examination

Baseline blood sample for haematological profile

Urinary mandelic acid

#### Health monitoring before starting work in a styrene process

Health monitoring for styrene may be required before the worker starts work so that changes to the worker's health can be detected.

Initial discussions about a health monitoring program should include:

- possible health effects from exposure to styrene
- how to recognise and report symptoms, and
- what is involved in the health monitoring program, for example the frequency of testing and the tests that may be needed.

An initial physical examination should focus on the central nervous and respiratory systems and be performed if indicated by the medical and occupational history or the presence of relevant symptoms.

Due to the effects of styrene on high-frequency hearing, baseline audiometry should be considered.

A baseline haematological profile is required and subsequent testing should be compared to these results.

Styrene is a skin sensitiser and previous work history with the chemical and symptoms of sensitisation should be investigated.

Styrene is a respiratory irritant and it is important to investigate respiratory symptoms. However, spirometry may not be required at this stage.

#### During exposure to a styrene process

#### 2. Monitoring exposure to styrene

Where workers are exposed, suspected of being exposed or are concerned about exposure to styrene, the person conducting the business or undertaking (PCBU) has a duty to arrange a health monitoring appointment with a registered medical practitioner. For example, an appointment should be arranged following spills or loss of containment of styrene resulting in excessive exposure to workers or when workers develop symptoms of styrene exposure.

Inhaled styrene is rapidly absorbed and the uptake is increased with exercise. Mandelic acid and phenylolyoxylic acid are the major metabolites of styrene. About 85 per cent of the absorbed dose is metabolised to mandelic acid and about 10 per cent to phenylglyoxylic acid. Mandelic acid and phenylglyoxylic acid are excreted mainly in the urine. The elimination of mandelic acid is biphasic, with half-lives of three to four hours and 25 to 40 hours. Mandelic acid excretion is maximal at or soon after the end of exposure.

The following tests may be used to test the worker's exposure levels to styrene:

urinary mandelic acid.

Where urinalysis is performed, the following values should be used as a guide for assessing exposure to styrene:

#### Biological exposure standard for styrene<sup>1</sup>

Urinary mandelic acid:

297 mmol/mol creatinine (2.6 mmol/L)

The urine sample should be collected at the end of shift, at the end of the working week.

The biological exposure standard is for exposure measured as mandelic and phenylglyoxylic acids.

Ethyl benzene and many other compounds can be metabolised and excreted in urine as mandelic acid, indicating the urine test for mandelic acid and phenylglyoxylic acids is not specific for styrene.

Mid-shift alcohol consumption may inhibit mandelic acid excretion, giving end-of-shift concentrations up to three times lower than expected. Alcohol consumption should be noted.

<sup>&</sup>lt;sup>1</sup> See <u>Chemical analysis branch handbook, 9th Edition, Workplace and biological monitoring exposure analysis</u>, WorkCover NSW (PDF 3.39MB) for more details

Haematological profiling should be considered and compared with the baseline profile if symptoms of haemopoeitic or lymphatic cancer are observed:

- easy bruising
- excessive bleeding
- painless, swollen lymph nodes
- tiredness, and
- night sweats.

#### Other health monitoring methods

Urinary styrene concentrations have also been used as a measure of styrene exposure. While it is more specific for styrene exposure than urinary mandelic acid levels the method requires careful sample collection timing and analysis.

Liver function tests can inform adverse health effects of chronic exposure to styrene, though the lack of specificity may make interpretation of results difficult.

#### Workplace exposure standard

The workplace exposure standard for styrene is:

- eight hour time weighted average (TWA) of 50 ppm (213 mg/m<sup>3</sup>), and
- short term (15 minute time weighted average) exposure limit (STEL) of 100 ppm (426 mg/m<sup>3</sup>).

A physical examination and urinary testing may be indicated if the results of air monitoring indicate frequent or potentially high exposure (half of the TWA or above).

#### **Removal from work**

Where a medical examination indicates the worker is displaying symptoms of exposure to styrene or where results of biological monitoring indicate exposure that may cause adverse health effects, the registered medical practitioner should consider recommending the worker be removed from styrene-related work.

When removal from styrene-related work is indicated the registered medical practitioner must provide the PCBU with the following recommendations:

- the worker should be removed from work with styrene, and
- the PCBU should review control measures and carry out recommended remedial action.

The worker must be informed of the results of health monitoring.

#### Return to work

Should a worker be removed from styrene-related work, they must not return until the registered medical practitioner has:

- assessed them as medically fit, and
- made a recommendation to the PCBU that the worker can return to remediated styrene-related work.

This assessment should take into consideration the clinical condition of the worker, the worker's biological monitoring results and remediation of the circumstances that led to the symptoms if possible.

#### At termination of work in a styrene process

#### 3. Final medical examination

A final medical examination should be carried out and should include a physical examination with emphasis on the CNS and respiratory systems. As indicated through the monitoring program an examination of optical and auditory systems and haematological profile may be required.

Workers with health conditions or continuing symptoms due to styrene exposure should be advised to seek continuing medical examinations as organised by the registered medical practitioner supervising the health monitoring program.

A health monitoring report from the registered medical practitioner should be provided to the PCBU as soon as practicable after the completion of the monitoring program, and at regular intervals for longer term or ongoing health monitoring processes. The report must include:

- the name and date of birth of the worker
- the name and registration number of the registered medical practitioner
- the name and address of the PCBU who commissioned the health monitoring
- the date of the health monitoring
- any test results that indicate whether or not the worker has been exposed to a hazardous chemical
- any advice that test results indicate that the worker may have contracted an injury, illness or disease as a result of carrying out the work that triggered the requirement for health monitoring
- any recommendation that the PCBU take remedial measures, including whether the worker can continue to carry out the type of work that triggered the requirement for health monitoring, and
- whether medical counselling is required for the worker in relation to the work that triggered the requirement for health monitoring.

#### Potential health effects following exposure to styrene

#### 4. Route of occupational exposure

The primary route of occupational exposure to styrene is via inhalation.

#### 5. Target organ/effect

The target organs and potential effects of styrene exposure include:

Table 1 Target organs and potential effects of styrene exposure

Target organ	Effect			
Central nervous system	Depression			
Skin	<ul><li>Irritation</li><li>Sensitisation</li><li>Dermatitis</li></ul>			
Respiratory System	Upper respiratory tract irritation			
Eyes	Irritation			

#### 6. Acute effects

Acute effects of styrene exposure may include:

- eye, skin and upper respiratory tract irritation
- headaches
- dizziness, and
- nausea.

Cognitive effects including slowed reaction times and inability to concentrate or balance may be observed. Sensory nerve conduction is reduced by up to 10 per cent at 100 ppm (the short term exposure limit).

Styrene inhalation may cause 'styrene sickness' that includes:

- headaches
- nausea
- vomiting
- weakness
- fatigue
- dizziness, and
- ataxia.

#### 7. Chronic effects

Chronic health effects of styrene exposure may include:

- CNS depression, including:
  - o decreased concentration
  - o decreased reaction times, and
  - o impairment of short term memory
- hearing loss
- peripheral neuropathy
- altered liver function, and
- abnormal ECG patterns.

Styrene exposure can also affect colour discrimination (dyschromatopsia) and high-frequency hearing may need to be monitored. Dyschromatopsia effects occur from 50 ppm (the TWA) and are generally transient. However, they may take up to two years to improve once exposure has stopped.

Hepatotoxicity effects are seen due to styrene metabolism in the liver. Levels of exposure at less than 50 ppm (the TWA) have resulted in mild increases in hepatic transaminase concentrations and reduced clearance of conjugated bilirubin. Excessive alcohol intake can exacerbate any effects on the liver caused by styrene.

#### 8. Carcinogenicity

Styrene has not been classified as carcinogenic according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

#### 9. GHS classification

The following GHS health hazard classification for styrene has been taken from Safe Work Australia's Hazardous Chemicals Information System:

#### **Hazard category**

Reproductive toxicity - category 2 (suspected of damaging the unborn child)

Acute toxicity - category 4 (harmful if inhaled)

Specific target organ toxicity (repeated exposure) – category 1 (causes damage to hearing organs through prolonged or repeated exposure)

Skin irritation – category 2

Eye irritation - category 2

#### Source documents

Agency for Toxic Substances and Disease Registry; Toxic Substances Portal – Styrene

American Conference of Governmental Industrial Hygienists (ACGIH) (2011) Documentation of the Biological Exposure Indices, 7th Ed, Cincinnati.

American Conference of Governmental Industrial Hygienists (ACGIH) (2017) *Documentation of the Biological Exposure Indices*, 7th Ed, Cincinnati.

<u>Chemical analysis branch handbook, 9th Edition, Workplace and biological monitoring</u> <u>exposure analysis</u>, WorkCover NSW (PDF 3.39MB).

European Chemicals Agency; Information on Chemicals; Styrene.

Health Protection Agency; General Information - Styrene (PDF 45KB).

Health & Safety Laboratory (2013) Guidance on Laboratory Techniques in Occupational Medicine. Health and Safety Executive.

Lauwerys, R.R. and Hoet, P. (2001) *Industrial Chemical Exposure Guidelines for Biological Monitoring*, 3rd Ed, Lewis Publishers, Boca Raton.

National Industrial Chemicals Notification and Assessment Scheme; Human Health Tier II Assessment for <u>Benzene, ethenyl-.</u>

New Jersey Department of Health; Hazardous Substance Fact Sheet; <u>Styrene Monomer</u> (PDF 230KB).

Safe Work Australia (2013); <u>Workplace Exposure Standards for Airborne Contaminants</u> (PDF 873KB).

Safe Work Australia; Hazardous Chemicals Information System.



# Health monitoring report

Styrene



### Health monitoring report – Styrene

This health monitoring report is a confidential health record and must not be disclosed to another person except in accordance with the Work Health and Safety Regulations or with the consent of the worker.

There are two sections. Complete both sections and all questions as applicable.

**Section 1** A copy of this section should be forwarded to the person conducting the business or undertaking (PCBU) who has engaged your services.

**Section 2** may contain confidential health information. Information that is required to be given to the PCBU should be summarised in Section 1.

#### Section 1 – A copy of this section to be forwarded to the PCBU

#### Person conducting a business or undertaking

Company/organisation name: Click here to enter text.

Site address: Click here to enter text.

Suburb: Click here to enter text.	Postcode: Click here to enter text.
Site Tel: Click here to enter text.	Site Fax: Click here to enter text.

Contact Name: Click here to enter text.

## Other businesses or undertakings engaging the worker (include a separate section for each PCBU)

□ N/A

Company/organisation name: Click here to enter text.

Site address: Click here to enter text. Suburb: Click here to enter text. Site Tel: Click here to enter text. Contact Name: Click here to enter text.

**Postcode:** Click here to enter text. **Site Fax:** Click here to enter text.

#### Worker details (tick all relevant boxes)

Surname: Click here to enter text.	Given names: Click here to enter text.		
Date of birth: Click here to enter a date.	Sex:  Male  Female		
Address: Click here to enter text.			
Suburb: Click here to enter text.	Postcode: Click here to enter text.		
Current job: Click here to enter text.			
Tel (H): Click here to enter text.	Mob: Click here to enter text.		
Date started employment: Click here to enter a date.			

## **Employment in styrene risk work** (tick all relevant boxes) (information provided by the PCBU)

 $\Box$  New to styrene work

□ New worker but not new to styrene work

□ Current worker continuing in styrene work

Worked with styrene since: Click here to enter a date.

**Risk assessment completed:** □ Yes □ No

**Work environment assessment** (tick all relevant boxes) (information provided by the PCBU)

Date of assessment: Click here to enter a date.

#### Styrene industry/use

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□ Plastics manufacture

□ Fibreglass processes

 $\hfill\square$  Paints, sealers and surface coatings

 $\hfill\square$  Manufacture of reinforced plastics

□ Other (specify): Click here to enter text.

#### Other chemicals the worker may be exposed to: Click here to enter text.

Controls		
Eye protection	□ Yes	□ No
Wear gloves	□ Yes	□ No
Respirator use	□ Yes	□ No
Respirator type	Click here	to enter text.
Local exhaust ventilation	□ Yes	□ No
Overalls/work clothing	□ Yes	🗆 No
Laundering by employer	□ Yes	🗆 No
Emergency eye wash and showers (with hot and cold water)	□ Yes	🗆 No
Other please specify		

#### Health monitoring results

#### **Biological monitoring results**

Include/attach test results that indicate whether or not the worker has been exposed

Date	Tests performed	Recommended action or comment
Click here to enter text.	Click here to enter text.	Click here to enter text.
Click here to enter text.	Click here to enter text.	Click here to enter text.
Click here to enter text.	Click here to enter text.	Click here to enter text.
Click here to enter text.	Click here to enter text.	Click here to enter text.

Comments about health monitoring results (for example any early indications or diagnosis of injury, illness or disease): Click here to enter text.

This form contains confidential information and must not be disclosed to another person except in accordance with the Work Health and Safety Regulations or with consent of the worker
Recommendations (by registered medical practitioner) (tick all relevant boxes)
Further/additional health monitoring for worker
$\Box$ This is the final health monitoring report
□ Repeat health assessment in Click here to enter text. month(s) / Click here to enter text. week(s)
Counselling required
□ Medical examination by registered medical practitioner. On Click here to enter a date.
□ Referred to Medical Specialist (respiratory/dermatology/other). On Click here to enter a date.
Recommendations to PCBU
$\Box$ The worker is suitable for work with styrene
Review workplace controls
□ The worker should be removed from work with styrene. On Click here to enter a date.
□ The worker is fit to resume work. On Click here to enter a date.
Biological monitoring results indicate unacceptably high exposure levels
Specialist's name: Click here to enter text.
Additional comments or recommendations: Click here to enter text.

Registered medical practitioner (responsible for supervising health monitoring)

Name: Click here to enter text.

Signature:

Date: Click here to enter a date. Tel: Click here to enter text.

Fax: Click here to enter text.

Registration Number: Click here to enter text.

Medical Practice: Click here to enter text.

Address: Click here to enter text.

Suburb: Click here to enter text.

Postcode: Click here to enter text.

# Section 2 – This section to be retained by the registered medical practitioner

Person conducting a business or underta	Person conducting a business or undertaking				
Company/organisation name: Click here to enter Site address: Click here to enter text. Suburb: Click here to enter text. Site Tel: Click here to enter text. Contact Name: Click here to enter text.	Postcode: Click here to enter text. Site Fax: Click here to enter text.				
Other businesses or undertakings engagi	ng the worker	□ N/A			
Company/organisation name: Click here to enter Site address: Click here to enter text. Suburb: Click here to enter text. Site Tel: Click here to enter text. Contact Name: Click here to enter text.	Postcode: Click here to enter text. Site Fax: Click here to enter text.				
Worker details (tick all relevant boxes)					
Surname: Click here to enter text. Date of birth: Click here to enter a date. Sex: Male Female Pregnant/brea Address: Click here to enter text. Suburb: Click here to enter text.	Given names: Click here to enter test stfeeding Postcode: Click here to enter text.	xt.			
Current job: Click here to enter text. Tel (H): Click here to enter text.	Mob: Click here to enter text.				
Date started employment: Click here to enter a					

#### Past employment and exposure details (tick all relevant boxes)

#### Have you ever worked in any of the following jobs?

If you answered 'yes' to any of the questions, please advise if you experienced any symptoms such as cough or wheeze or asthma when working.

			Comments (all 'yes' answers)
Plastics manufacture	🗆 No	□ Yes	Click here to enter text.
Fibreglass processes	🗆 No	□ Yes	Click here to enter text.
Paints, sealers and surface coatings	🗆 No	□ Yes	Click here to enter text.
Manufacture of reinforced plastics	🗆 No	□ Yes	Click here to enter text.

			Comments (all 'yes' answers)
Other (please specify)	🗆 No	□ Yes	Click here to enter text.

#### General health questionnaire (tick all relevant boxes)

			Comments (all 'yes' answers)
Did you suffer any incapacity lasting two weeks or longer in the last two years	□ No	□ Yes	Click here to enter text.
Have you ever had any operations or accidents or been hospitalised for any reason	□ No	□ Yes	Click here to enter text.
Are you currently being treated by a doctor or other health professional for any illness or injury	□ No	□ Yes	Click here to enter text.
Are you currently receiving any medical treatment or taking any medications. Please detail.	□ No	□ Yes	Click here to enter text.
Do you currently smoke	□ No	□ Yes	Click here to enter text.
Do you practice personal hygiene at work, for example nail biting, frequency of hand washing, eating or smoking, clean shaven, shower and change into clean clothes at end of shift	□ No	□ Yes	

#### Specific health questions (tick all relevant boxes)

Do you have or have you ever had:			Comments (all 'yes' answers)
Blurred vision or other vision problems	□ No	□ Yes	Click here to enter text.
Itchy eyes, runny or congested nose	🗆 No	□ Yes	Click here to enter text.
Loss of hearing or ringing in the ears	🗆 No	□ Yes	Click here to enter text.
Shortness of breath on exertion	🗆 No	□ Yes	Click here to enter text.
Wheezing, bronchitis or asthma now or in the past	🗆 No	□ Yes	Click here to enter text.
Any other lung or respiratory conditions (emphysema, pneumonia or sinusitis)	□ No	□ Yes	Click here to enter text.
Nausea and vomiting	🗆 No	□ Yes	Click here to enter text.
Blackouts, dizziness or fainting	🗆 No	□ Yes	Click here to enter text.
Chronic fatigue or tiredness	🗆 No	□ Yes	Click here to enter text.

This form contains confidential information and must not be disclosed to another person except in accordance with the Work Health and Safety Regulations or with consent of the worker
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Do you have or have you ever ha	d:		Comments (all 'yes' answers)
Any neurological condition affecting nerves in your feet or hands, your coordination or balance	□ No	□ Yes	Click here to enter text.
Any other significant health conditions	□ No	□ Yes	Click here to enter text.

#### General health assessment (if applicable)

Weight: Click here to enter text. kg

**Referred for further testing** 

 $\Box$  No  $\Box$  Yes

BP: Click here to enter text. / Click here to enter text. mmHg

Urinalysis

Blood: 
Normal 
Abnormal

Protein: Click here to enter text.

Sugar: Click here to enter text.

Cardiovascular system			Medical comments (for all yes/abnormal)
Blood pressure	Normal	Abnormal	Click here to enter text.
Heart rate	Normal	□ Abnormal	Click here to enter text.
Heart sounds	Normal	□ Abnormal	Click here to enter text.
Murmurs present	□ No	□ Yes	Click here to enter text.
Evidence of cardiac failure/oedema	□ No	□ Yes	Click here to enter text.
Respiratory system			
Breathing normal and regular character	in 🗆 Ye	es 🗆 No	Click here to enter text.
Auscultation normal	□ Ye	es 🗆 No	Click here to enter text.
Signs of past/present respiratory disease		o □ Yes	Click here to enter text.
Nervous system			
Muscular tone, co-ordination	Normal	□ Abnormal	Click here to enter text.
Tremor	□ No	□ Yes	Click here to enter text.
Skin			
Eczema, dermatitis or allergy	🗆 No	o 🗆 Yes	Click here to enter text.
Skin cancer or other abnorma	llity 🗆 No	o 🗆 Yes	Click here to enter text.
Evidence of nail biting	🗆 No	o □ Yes	Click here to enter text.
Other	🗆 No	o □ Yes	Click here to enter text.

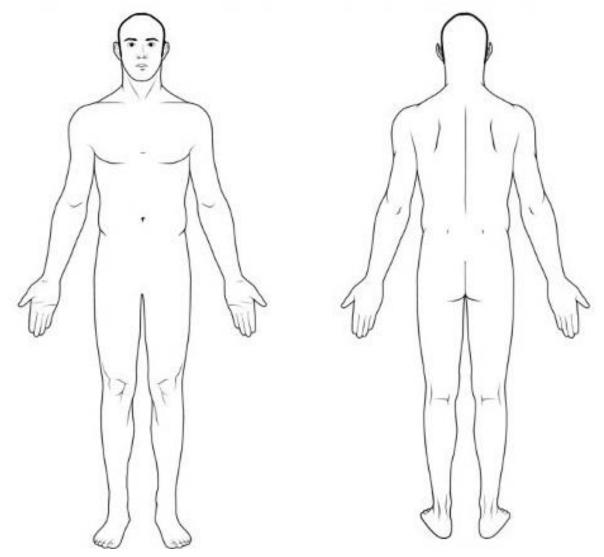


Figure 1 Template of the human body to indicate the location of abnormalities

Еуе			Medical comments (for all abnormal)
Evidence of eye irritation	🗆 No	□ Yes	Click here to enter text.

#### **Biological monitoring results**

#### Include/attach at least the previous two test results (if available)

Date	Tests performed	Recommended action or comment
Click here to enter a date.	Click here to enter text.	Click here to enter text.
Click here to enter a date.	Click here to enter text.	Click here to enter text.
Click here to enter a date.	Click here to enter text.	Click here to enter text.
Click here to enter a date.	Click here to enter text.	Click here to enter text.

## Other medical history, family medical history, current medication, comments, tests or recommendations (use separate sheet if necessary)

Click here to enter text.

#### Registered medical practitioner (responsible for supervising health monitoring)

Name: Click here to enter text.

Signature:

Date: Click here to enter a date.

Tel: Click here to enter text.

Fax: Click here to enter text.

Registration Number: Click here to enter text.

Medical Practice: Click here to enter text.

Address: Click here to enter text.

**Suburb:** Click here to enter text.

Postcode: Click here to enter text.