

Controlling exposures to prevent
occupational lung disease in
MANUFACTURING

Monitoring Exposure to Welding Fume

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• Monitoring

means measuring exposure to hazardous substances, to establish if control is adequate.

• Personal air monitoring

measures the concentration of a chemical in the air in a person's breathing zone.

• Biological monitoring

involves analysis of breath, urine or blood samples collected from an employee.

When is air monitoring needed?

Air monitoring and measurement may be needed where there is a serious risk to health from the inhalation of welding fume and the likely exposure level of the welders to the fume is not known, e.g. during the manual metal arc (MMA) welding of stainless steel. Monitoring may also be needed to help confirm that the control measures in use are working correctly, as a deterioration or failure of engineering controls could result in welders being exposed to high levels of fume.

Under the Control of Substances Hazardous to Health (COSHH) system, an initial exploratory exposure monitoring exercise may be needed to reach an accurate judgement about the risk to health. The results will then influence the assessment of how well control measures for the welding fume are working. The investigation will also need to look at other factors that can influence exposure on the day, such as the production rate setting the amount of welding work needed. These things will influence the personal results of the survey for exposure to welding fume.

It is wise to conduct air monitoring when:

- welding coated material, eg galvanised steel
- using metals which have low exposure limits, such as nickel and chromium
- fume is seen in the air coming away from the welding process
- fume is seen which isn't being captured by the existing extraction
- there are concerns about the performance of the existing control measures
- you want to gather information which will help specify further control measures.

Why do I need air monitoring?

The monitoring information can be used to:

- help to produce the COSHH assessment for the task as it gives an illustration of the exposure risk
- help to select the right fume control solutions
- check that exposure limits are not exceeded
- check that controls work well enough, or if improvements are needed
- check that new controls work well enough
- help choose the right level of respiratory protection
- influence the health surveillance programme.

Legal requirements

The COSHH Regulations require employers to:

- assess the risks to health from hazardous substances such as welding fume (regulation 6)
- adequately control the risk to health (regulation 7)
- maintain, examine and check controls (regulation 9)
- provide health surveillance where appropriate (regulation 11).

Regulation 12 of COSHH also requires employers to inform, instruct and train workers who are exposed to welding fume on:

- the health risks
- how to report any ill health symptoms
- how to use controls to prevent ill health occurring.

The Control of Lead at Work (CLAW) Regulations 2002 require employers to:

- assess the risk from welding and allied processes which result in exposure to lead dust and fumes, eg from lead-based paint on metal (regulation 5)
- prevent or control exposure to lead (regulation 6)
- maintain, examine and check controls (regulation 8)
- carry out air monitoring where there is likely to be significant exposure to lead (regulation 9)
- provide medical surveillance (regulation 10).

Getting started

Air monitoring is a specialist activity. A [qualified occupational hygienist](#) can ensure it is carried out in a way that provides meaningful and helpful results.

When an employer appoints a person to carry out exposure monitoring, they should ensure the person is competent to do so. Those monitoring exposure should demonstrate:

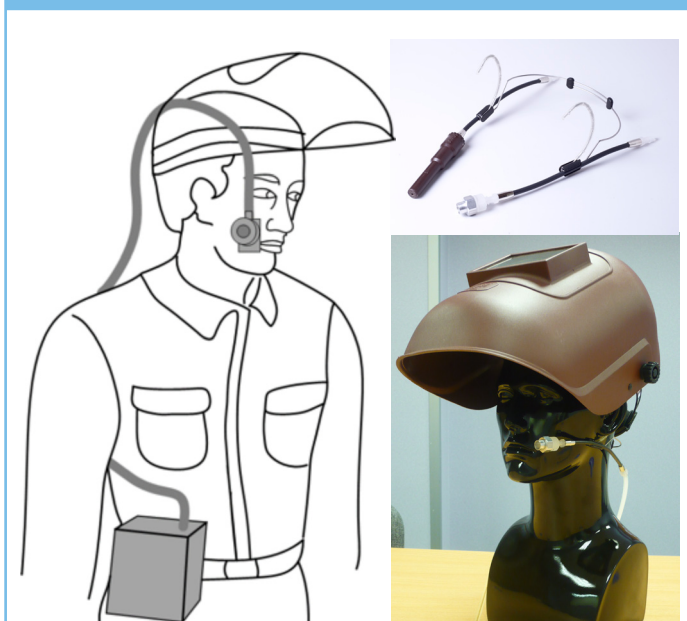
- appropriate training and experience in monitoring exposure
- familiarity with relevant monitoring standards and methods published by HSE, for example; [Monitoring Strategies for Toxic Substances](#) (HSG 173) and British Standards EN ISO 10882-1: [Health & Safety in Welding and Allied Processes](#)
- adequate knowledge of occupational exposure limits and monitoring strategies for welding fume and allied processes
- adequate continuing professional development
- a commitment to providing sensible and proportionate advice.

BOHS, as the Chartered Society for Worker Health Protection, provides a list of qualified consultants in its [Directory of Occupational Hygiene Services](#).

Practicalities of an air monitoring survey

Exposure measurement can involve personal air monitoring, ie measuring the amount of a substance in a worker's breathing zone, in order to estimate the individual's exposures to the particulate component of the fume and give an indication of control effectiveness. This involves getting operators to wear sampling devices whilst they work (See Figure 1 below).

Figure 1: illustrates the ideal position of the air sampling head inside the welder's visor



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What do the results mean and how to interpret them?

Personal air monitoring results can be compared with the relevant set workplace exposure limits (WELs) which are published in the HSE book EH40/2005: [Workplace Exposure Limits](#) [2]. In-house limits can also be set and used to compare with results for task-specific exposures. There is no single WEL for welding fume. Therefore, exposure measurements should be compared to the appropriate limits for the different constituents in the welding fume, such as: iron oxide, hexavalent chromium, nickel and manganese. Hexavalent chromium and nickel in welding fume are both defined occupational carcinogens. This means that there is a requirement to reduce exposure to these constituents to a concentration which is as low as is reasonably practicable (ALARP). For other substances which have a WEL but are not carcinogens or can cause asthma, adequate control of exposure will involve controlling exposure to below the WEL.

The current WEL for manganese is under review as there is a proposal to reduce the existing limit. For further information, please refer to the [Recommendation from the Scientific Committee for Occupational Exposure Limits for Manganese and Inorganic Manganese Compounds \(SCOEL/ SUM/127\)](#) [3].

Any revised WEL, which might be implemented, will require improved fume control measures for many welding processes.

Table 1: shows the UK WELs and SCOEL OELs for some common welding fume metal oxide compounds and gases

Hazardous substance found in welding fume	8 hr long-term exposure limit, time weighted average (TWA)	15 minute short-term limit (STEL)	Reference
Iron oxide	5 mg/m ³	10 mg/m ³	EH40
Manganese (respirable dust)	0.05mg/m ³		EH40
Chromium VI	0.025 mg/m ³		EH40
Chromium III	0.5 mg/m ³		
Nickel	0.05 mg/m ³		
Ozone		0.4mg/m ³ or 0.2ppm	EH40
Nitrogen dioxide (NO ₂)	0.955 mg/m ³ or 0.5ppm	1.91mg/m ³ or 1ppm	SCOEL
Nitrogen monoxide	2.5mg/m ³ or 2ppm		SCOEL

Fixed-site air samplers

An air monitoring survey can also use suitable fixed-site air samplers (also known as static samplers) to provide an overall assessment of airborne concentrations of a substance. Fixed-site air samplers do not directly represent employee or personal exposure. However, these results can help identify:

- loss of good fume control
- sources of fume contributing to exposure
- the extent of spread from the point of welding.

What exposure monitoring isn't

Air monitoring and biological monitoring are not a substitute for putting good fume control solutions in place to protect the health of workers. You can also use other methods to demonstrate that exposure to welding fume is adequately controlled.

Why biological monitoring for welding fume exposure measurement is needed

Biological monitoring can assess exposure to welding by all exposure routes; inhalation, ingestion and skin absorption. The results can be used to check of the effectiveness of respiratory and personal protection equipment (RPE/PPE) being used to protect the health of the welder. A simple urine sample can provide information about an individual worker's exposure to the metals commonly found in welding fumes. An elevated urine result would suggest the worker has some welding fume exposure and that maybe the RPE/PPE/engineering controls need to be improved.



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When would you carry out biological monitoring?

Biological monitoring can also be used for investigating the extent of exposure following a report of ill health.

Biological monitoring for stainless steel welders should include the measurement of nickel and chromium in a urine sample and this should be undertaken on an annual basis where control has been shown to be good. Samples should be collected at the end of a typical working week.

Biological monitoring can also be used for exposure measurement for other metal fumes, including, for example; cadmium or lead, which should be measured if the metal has been cadmium plated or if lead paint (lead oxide primer) is present. To determine recent exposure to cadmium or lead, a blood sample will be required. The table below sets out the recommended biological monitoring analytical method for various metal types.

Table 2: Types of welding, principal metals involved and recommended biological monitoring

Metal Type	Biological Monitoring is recommended
Mild steel and low alloy steels	Chromium Nickel Manganese (can be present in metal >1%)
Stainless Steel	Chromium Nickel
Nickel alloys	Nickel
Aluminium	Aluminium
Copper	Copper

Please note that other elements will be present depending on the weld and metal types. It would be advisable to check for other possible hazardous fume components that welders may be exposed to.

Practicalities in setting up a biological monitoring programme

Employees cannot be compelled to provide biological monitoring samples without consent. Biological monitoring is a specialist activity. Urine samples are usually collected by either an occupational hygienist (www.bohs.org), or occupational health professional (doctor or nurse) (www.som.org.uk). The samples are then sent to a specialist laboratory (www.hsl.gov.uk) for analysis by post.



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References

- HSE's COSHH Essentials for Welding, Hot Work and Allied Processes (WL series) [\[1\]](#)
- Approved Code of Practice and Guidance: Control of Substances Hazardous to Health (L5) [\[2\]](#)
- Monitoring Strategies for Toxic Substances (HSG173) [\[3\]](#)
- Health & Safety in Welding and Allied Processes – Sampling of airborne particles and gases in the operators breathing zone. Part 1: Sampling of airborne particles, BS EN ISO 10882-1. London: British Standards Institution [\[4\]](#)
- Biological Monitoring in the Workplace (HSG167) [\[5\]](#)
- Control of Lead at Work Regulations (L132) [\[6\]](#)
- EH40/2005: Workplace Exposure Limits (WELs) [\[7\]](#)
- Recommendation from the Scientific Committee for Occupational Exposure Limits for Manganese and Inorganic Manganese Compounds: SCOEL/ SUM/127 [\[8\]](#)