

# Exposure to cadmium in silver soldering or brazing

## HSE information sheet

## Engineering Information Sheet No 31 (Revision 1)

This guidance is aimed at employers, managers and workers who use or plan to use cadmium-containing products or materials. It is also relevant to those who may be working on materials that may include cadmium-containing solders.

### European ban

Cadmium has been banned in a range of materials, including as fillers in soldering or brazing, due to serious health effects. There are some exceptions, relating to defence, aerospace or safety-related use and anyone wishing to make use of these should consult the European legislation direct. Companies supplying consumables are aware of the ban and manufacturers have produced cadmium-free alternatives.

### Introduction

Silver (hard) soldering or brazing is a very versatile means of making joints by using a fusible alloy as a filler material between similar or dissimilar materials. High temperatures (over 450 °C for brazing) are applied, usually by handheld flame torch or another heating device, eg induction or electrical heater/furnace, to melt the filler material into a capillary gap between the materials and create a suitable bond.

These joints are normally leakproof, will withstand vibration, tensile and torsional loading, and maintain integrity at both sub-zero and elevated temperatures. When well selected and applied they can also resist attack to a wide range of corrosive environments.

Silver solder alloys are used in practically every branch of the metal fabrication industry.

### Background

A wide range of alloys were developed to provide suitable jointing properties for a variety of parent materials and applications. Although silver is the predominantly component, other materials in the filler

can include copper, zinc, tin, nickel, phosphorus, manganese, silicon and cadmium.

Cadmium reduces the working temperature required and provides good flow properties for making the joint. Typically, 16-25% cadmium may be present in a cadmium-containing silver solder.

### Health effects of cadmium in silver solders

Cadmium is a silver white ductile metal which melts at 320 °C and, when heated above this temperature in air, produces cadmium oxide fumes. Serious health effects on the lungs and kidneys are the principal concerns.

#### Acute (immediate) effects

Initial symptoms from inhalation of cadmium oxide fume include:

- irritation of the eyes, nose and throat; followed by
- cough, headache, dizziness, weakness, chills, fever, chest pains and breathlessness.

Lung damage may occur in the absence of such symptoms and may be delayed for several hours or days. Very high exposures can cause death with symptoms of acute pneumonitis.

If cadmium is swallowed, symptoms may also include nausea, vomiting, diarrhoea, muscular cramps and salivation.

#### Chronic (long-term) effects

Repeated and cumulative exposure to cadmium oxide fume can cause irreversible kidney damage, characterised by increased excretion of low molecular weight proteins in urine. The half-life of cadmium in the kidneys is estimated at 10-40 years so even after exposure has ceased a high body burden will remain.

Adverse effects on the lungs include loss of lung function and abnormalities characteristic of

emphysema. The severity of these effects increases with both cumulative cadmium exposure and cadmium concentration. Cadmium oxide, cadmium chloride, calcium sulphate, cadmium sulphide, cadmium fluoride and cadmium itself have also been classified as Category 2 carcinogens which may cause cancer in humans.

## How exposure occurs

- Breathing in fumes or dust containing cadmium and cadmium oxide
- Ingestion of dust

## Who is at risk?

Those primarily at risk are:

- operators carrying out brazing or silver soldering work with cadmium-containing alloys;
- others in the vicinity exposed to the fume which is generated.

The fume can settle on work surfaces to form a fine dust film which may then contaminate hands, food, drink etc and be ingested. This dust may also be disturbed and inhaled. Those carrying out maintenance and cleaning work can be particularly affected.

People who work on articles which have previously been soldered using cadmium-containing silver solder may also be at risk. For example, jig makers and repairers, though not using cadmium-containing silver solders themselves, may work on jigs which were made or repaired using cadmium solders. This can lead to significant exposure to cadmium and cadmium oxide fume when the existing cadmium-containing solder is heated during the repair.

## Occupational exposure limits for cadmium and cadmium oxide

There are a number of metallic elements present in silver solder fume but the alloys that contain cadmium are likely to present the most significant risk. Occupational exposure limits are expressed in Workplace Exposure Limits (WELs), for an 8-hour Time Weighted Average (TWA) and a short-term 15-minute period.

- For cadmium the 8-hour TWA is 0.025 mg/m<sup>3</sup>.
- For cadmium there is no short term-limit.
- For cadmium oxide the 8 hour TWA is 0.025 mg/m<sup>3</sup>.

- For cadmium oxide the 15-minute short-term limit is 0.05 mg/m<sup>3</sup>.

A short-term WEL for cadmium oxide fume has specifically been set to cover acute high exposures which can occur through intermittent silver soldering.

WELs have a legal status explained in the Control of Substances Hazardous to Health Regulations (COSHH) Approved Code of Practice<sup>1</sup> and EH40: *Occupational exposure limits*.<sup>2</sup>

For a substance which has been assigned a WEL exposure must be reduced below it. For Category 2 carcinogens, such as cadmium oxide, exposure must also be reduced below the WEL as far as is reasonably practicable by following the measures outlined in COSHH regulation 7, Appendix 1, and Schedule 2A.

## What should users of cadmium-containing silver solders do?

Under COSHH, employers and the self-employed must:

- prevent exposure to cadmium or its compounds or, where this cannot reasonably be done, adequately control the exposure;
- carry out a proper assessment of the health risks arising from silver soldering or brazing with cadmium-containing alloys and the precautions necessary to prevent or adequately control them. This may require air sampling and biological monitoring. Include all people who may be exposed.

## Substitution

Prevention of exposure should always be considered first.

A full range of practical and safer 'cadmium-free' silver solders are now available. Users of cadmium containing alloys must consider changing to the new range.

While the cost of some 'cadmium-free' alternatives may be greater, and further costs can result from extended heating cycles and lower output rates, these can soon be recovered by savings made in the protective measures required.

Only where full justification can be given for the use of a cadmium-containing silver solder based on proper risk assessment and the technical requirements of the job should it continue in use.

Where cadmium-free solders are used, a thorough risk assessment should be made of the substance being substituted to ensure that no new uncontrolled risks have been introduced. General advice on substitution can be found at [www.hse.gov.uk/coshh/basics/substitution.htm](http://www.hse.gov.uk/coshh/basics/substitution.htm) and you should contact your supplier for information.

## **Control of exposure**

In the limited cases where use of 'cadmium-free' silver solders is not reasonably practicable, exposure must be adequately controlled by a suitable combination of engineering and process control measures.

As cadmium oxide is a Category 2 carcinogen all the requirements of regulation 7(5) of COSHH must be followed. These include:

- total enclosure of the process and handling systems as far as is reasonably practicable;
- local and general extract ventilation and the use of other plant, processes and systems of work which minimise, suppress and contain fume and dust;
- minimising the number of people exposed and periods of exposure;
- prohibiting smoking, eating and drinking in contaminated areas;
- regularly cleaning work surfaces to minimise contamination (care should be taken to ensure that cleaning activities do not result in exposure, eg dust should be vacuumed rather than swept up);
- the provision of suitable washing and changing facilities close at hand;
- demarcating potentially contaminated areas and displaying suitable warning signs;
- safe storage, handling and disposal of cadmium containing silver solders;
- use of closed and clearly labelled containers.

The COSHH Approved Code of Practice (ACOP)<sup>1</sup> gives further advice on the measures to be taken.

Key factors which should be considered in providing adequate control are:

- composition of the filler material, ie amount of cadmium;
- brazing temperature;
- brazing time;
- rate of consumption;
- size of the workroom;
- room ventilation.

Because of the directional nature of brazing torch flames and strong convection currents induced, appreciably higher ventilation capture velocities may be required than for most other fume control

situations. Flame torches can scatter a plume of fume from the joint, causing it to contaminate adjacent areas. As a consequence, containment in an open-fronted booth fitted with extract ventilation may prove far more effective than captor hoods. Care should be taken to ensure that such control measures are effective. Specialist advice may be needed on the design of control measures.

Where it is not possible to ensure that adequate control of exposure is achieved by engineering and process control measures alone then suitable and adequate respiratory protective equipment (RPE) should be worn.

## **Environmental risks**

Environmental protection legislation, including regulations for waste disposal, must also be complied with. Acid pickling or burning off articles with cadmium containing silver solder joints may present special problems. Pickling can result in significant quantities of cadmium entering effluent systems and limits being breached.

## **Maintenance of control measures**

All control measures should be maintained in efficient working order and good repair at all times. In particular, under COSHH, extract ventilation systems must be examined and tested by a competent person at least once in every 14 months and appropriate records kept.

All control measures in use should be visually checked, where possible, at appropriate intervals and without undue risk to maintenance staff. In the case of local exhaust ventilation (LEV) and work enclosures such checks should be carried out at least once a week.

Preventative maintenance procedures should indicate which engineering control measures require servicing, the nature of the work to be carried out, by whom, and how any defects which are found will be put right.

RPE should also be properly maintained and regularly examined, tested, cleaned and suitably stored when not in use.

Filters will need replacing where appropriate, in accordance with the conditions of use and suppliers' instructions.

## Monitoring exposure

Where significant exposure to cadmium or its compounds can occur, monitoring may be required to ensure the effectiveness of control measures and compliance with occupational exposure limits.

Air sampling will not provide a complete picture of the risks where the ingestion of cadmium occurs.

Biological monitoring may also be appropriate to establish the full extent of exposure and the risks, eg as an adjunct to atmospheric monitoring or where ingestion is suspected as occurring.

Further guidance is given in the COSHH ACOP,<sup>1</sup> *Monitoring strategies for toxic substances*<sup>3</sup> and *Biological monitoring in the workplace*.<sup>4</sup>

The recommended method for measurement of cadmium is contained in MDHS10/2 *Cadmium and inorganic compounds of cadmium in air*.<sup>5</sup>

## Health surveillance

The need for health surveillance and its extent should be determined as part of the COSHH assessment. Where health surveillance is necessary it should be carried out under the direction of a suitably qualified health professional, eg an occupational health doctor or nurse.

Further information is given at [www.hse.gov.uk/coshh/basics/surveillance.htm](http://www.hse.gov.uk/coshh/basics/surveillance.htm)

The surveillance may include initial and periodic health assessment, lung function tests and biological monitoring involving the measurement of cadmium or biological markers of its effects in the blood and urine.

Suitable health records for exposure to cadmium oxide as a carcinogen will need to be kept. See the Appendix to the COSHH ACOP.<sup>1</sup>

## Information, instruction and training

Employers must provide their employees and any others at risk with enough information, instruction and training for them to know:

- the risks to health arising from exposure to cadmium and cadmium oxide fume;
- the precautions which must be taken.

This includes, in particular, details of how control measures are to be used, reporting defects and the proper use and maintenance of RPE.

Results of any monitoring of exposure in the workplace and information on the collective results and conclusions of any health surveillance carried out should also be provided.

## References

- 1 *Control of substances hazardous to health (COSHH). The Control of Substances Hazardous to Health Regulations 2002 (as amended). Approved Code of Practice and guidance L5 (Sixth edition)* HSE Books 2013 ISBN 978 0 7176 6582 2 [www.hse.gov.uk/pubns/books/l5.htm](http://www.hse.gov.uk/pubns/books/l5.htm)
- 2 *EH40/2005 Workplace exposure limits: Containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations (as amended)* Environmental Hygiene Guidance Note EH40 (Second edition) HSE Books 2011 ISBN 978 0 7176 6446 7 [www.hse.gov.uk/pubns/books/eh40.htm](http://www.hse.gov.uk/pubns/books/eh40.htm)
- 3 *Monitoring strategies for toxic substances* HSG173 (Second edition) HSE Books 2006 [www.hse.gov.uk/pubns/books/hsg173.htm](http://www.hse.gov.uk/pubns/books/hsg173.htm)
- 4 *Biological monitoring in the workplace: A guide to its practical application to chemical exposure* HSG167 (Second edition) HSE Books 1997 ISBN 978 0 7176 1279 6 [www.hse.gov.uk/pubns/books/HSG167.htm](http://www.hse.gov.uk/pubns/books/HSG167.htm)
- 5 *Cadmium and inorganic compounds of cadmium in air: Laboratory method using flame atomic absorption spectrometry or electrothermal atomic absorption spectrometry* MDHS10/2 HSE [www.hse.gov.uk/pubns/mdhs](http://www.hse.gov.uk/pubns/mdhs)

## Further reading

*Cadmium and you: Working with cadmium – are you at risk?* Leaflet INDG391(rev1) HSE Books 2010 [www.hse.gov.uk/pubns/indg391.htm](http://www.hse.gov.uk/pubns/indg391.htm)

*Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV)* HSG258 (Second edition) HSE Books 2011 ISBN 978 0 7176 6415 3 [www.hse.gov.uk/pubns/books/HSG258.htm](http://www.hse.gov.uk/pubns/books/HSG258.htm)

*Respiratory protective equipment at work: A practical guide* HSG53 (Fourth edition) HSE Books 2013 ISBN 978 0 7176 6454 2 [www.hse.gov.uk/pubns/books/HSG53.htm](http://www.hse.gov.uk/pubns/books/HSG53.htm)

HSE website: [www.hse.gov.uk](http://www.hse.gov.uk)

## **Further information**

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit [www.hse.gov.uk/](http://www.hse.gov.uk/). You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

This leaflet is available at:  
[www.hse.gov.uk/pubns/eis31.htm](http://www.hse.gov.uk/pubns/eis31.htm).

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