

Oxygen use in the workplace

Fire and explosion hazards



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Who is this leaflet for?

This guidance is for anyone who uses oxygen gas in cylinders, in the workplace. For example, it is used:

- in welding, flame cutting and similar processes;
- for helping people with breathing difficulties;
- in hyperbaric chambers as a medical treatment;
- for food preservation and packaging;
- in steelworks and chemical plants.

This leaflet describes the hazards from using oxygen and the precautions needed when using oxygen equipment. If you are an employer, it provides information which will assist you in your risk assessment.

What are the legal duties of an employer?

Employers are legally required to assess the risks in the workplace, and take all reasonably practicable precautions to ensure the safety of workers and members of the public.

Include a careful examination of the risks from using oxygen in your risk assessment. You can find more information about risk assessments on HSE's website.¹

What are the hazards from using oxygen?

Oxygen behaves differently to air, compressed air, nitrogen and other inert gases.

The air we breathe contains about 21% oxygen. Even a small increase in the oxygen level in the air – to just 24% – can create a dangerous situation where:

- it becomes easier to start a fire, which will then burn hotter and more fiercely than in normal air;
- it may be almost impossible to put the fire out.

It is also very reactive. Pure oxygen, at high pressure – such as from a cylinder – can react violently with common materials, such as oil and grease. Other materials may catch fire spontaneously. Nearly all materials, including textiles, rubber and even metals, will burn vigorously in oxygen.

A leaking valve or hose in a poorly ventilated room or confined space can quickly increase the oxygen concentration to a dangerous level.

What are the causes of oxygen fires and explosions?

The main causes of fires and explosions when using oxygen are:

- oxygen enrichment from leaking equipment;
- use of materials not compatible with oxygen;
- use of oxygen in equipment not designed for oxygen service;
- incorrect or careless operation of oxygen equipment.

What is oxygen enrichment?

Oxygen enrichment is the term often used to describe situations where the oxygen level is greater than in air. Oxygen is colourless, odourless and tasteless. The human senses cannot easily detect the presence of an oxygen-enriched atmosphere.

Oxygen enrichment results from:

- leaks from damaged or poorly maintained hoses, pipes and valves;
- leaks from poor connections;
- opening valves deliberately or accidentally;
- not closing valves properly after use;
- using an excess of oxygen in welding, flame cutting or similar processes;
- poor ventilation where oxygen is being used.

What are the main ways to prevent oxygen enrichment?

You should:

- keep oxygen equipment in good condition;
- take care when using it;
- ensure good ventilation.

Oxygen enrichment can also result from the misuse of oxygen. Never use oxygen for:

- cooling or refreshing the air in confined spaces;
- dusting benches, machinery or clothing.

The main danger to people from an oxygen-enriched atmosphere is that clothing or hair can easily catch fire, causing serious or even fatal burns. For example, people can easily set their clothing and bedding on fire by smoking while receiving oxygen treatment for breathing difficulties.

Always forbid smoking where oxygen is being used.

What should I do if I suspect oxygen enrichment from an oxygen leak?

You should:

- turn off the oxygen supply;
- extinguish cigarettes and open flames;
- make sure the room is well ventilated;
- identify and repair the source of the leak.

It is possible that oxygen may contaminate any clothing in the area. If you suspect contamination, remove the clothing and take it outside for airing and ventilating.

If there is ignition and fire, evacuation may be necessary.

What should I do when working in confined spaces?

Some of the most serious oxygen-related incidents have involved damaged oxygen hoses leaking into confined spaces, where welding and burning operations were taking place. The workers' oxygen-enriched clothing caught fire, causing serious or fatal injuries.

You should not take gas cylinders into confined spaces. Instead, you should use hoses to feed the gas in; remove the hoses from the confined space when work is finished or suspended, such as at the end of each day. Where it is not practical to remove the hoses, disconnect them from the gas supply at the cylinder or manifold.

Where the risk from oxygen enrichment is high, such as in a confined space or a poorly ventilated room, the use of oxygen monitoring equipment is advisable.

You will find more information in the leaflet *Confined spaces: A brief guide to working safely*.²

Which materials are not compatible with oxygen?

Some materials, such as oil and grease, can react explosively if they come into contact with pure oxygen at high pressure. Many other materials, including plastics and metals, may catch fire spontaneously. Such materials are incompatible with oxygen.

Equipment designed for oxygen service is made from materials and components that have been tested and proved compatible and safe for the purpose.

The reasons for a particular design and choice of material are not always obvious. Using substitute materials or components, which appear to be similar but are not proven to be oxygen-compatible, is extremely dangerous and has caused many accidents.

You need to take care when replacing the following:

O-rings and gaskets

There are hundreds of different types of rubber and elastomer and most are not compatible with oxygen. If in doubt, it is advisable to check with the manufacturer whether the material is oxygen-compatible.

Metal components

Many metals and alloys are not suitable for use with oxygen.

Pressure regulators

You must make sure that the pressure rating of the regulator is not less than the full cylinder supply pressure. Pressure regulators for gas welding equipment should comply with BS EN ISO 2503³ and for medical gases with BS EN ISO 10524.⁴

Many existing regulators were made to standards that have now been withdrawn, such as BS 5741, BS 7650 and BS EN 585. These regulators may not be suitable for pressures above 200 bar. If in doubt, check with the supplier or manufacturer.

Oxygen hoses

The flexible oxygen hose used for welding etc should comply with BS EN ISO 3821⁵ or BS EN ISO 5359.⁶

Lubricants

As a rule, lubricants should be avoided. Only lubricants that are made for oxygen service, and are specified by the equipment supplier, should be used.

Tape

Tape should be avoided. Only tape that is marked as suitable for oxygen service, and is specified by the equipment supplier, should be used.

Other components

In some cases, the materials may appear to be compatible but the shape and configuration of components may be important in minimising the fire risk. Only components approved by the manufacturer should be used when maintaining oxygen equipment.

You should always ensure that high-pressure oxygen systems are designed, constructed, installed and commissioned by competent people who have specialised knowledge of the subject.

All oxygen apparatus and equipment must be properly identified with the gas name and safe working pressure.

What happens if I use equipment not designed for oxygen?

Many serious accidents have been caused by using oxygen instead of other gases such as air, compressed air or nitrogen. Oxygen can react explosively with oils and greases. People have been injured or even killed when pumps, engines, tyres and pressure equipment have been blown apart by the explosion.

Oxygen can also cause other materials to ignite spontaneously. The resulting fire can cause damage to equipment and injury to people.

You should never use oxygen for:

- driving pneumatic tools;
- inflating vehicle tyres;
- pressurising and purging systems;
- replacing air or inert gas;
- starting diesel engines.

Oxygen must not be introduced into any equipment unless competent people with specialist knowledge have designed it for oxygen service. If in doubt, it is advisable to check with the equipment supplier.

What should I do to prevent or reduce the risks when using oxygen equipment?

If oxygen cylinders and equipment are used carelessly or incorrectly, then a fire may result. All users of oxygen should know and understand the dangers, and should receive training in the use of oxygen equipment.

Oxygen cylinders

You should:

- handle oxygen cylinders carefully. It is sensible to use a purpose-built trolley to move them;
- keep cylinders chained or clamped to prevent them from falling over;
- store oxygen cylinders when not in use in a well-ventilated storage area or compound, away from combustible materials and separated from cylinders of flammable gas, eg propane and butane;
- only store as many cylinders as you need to;
- return empty cylinders to the supplier;
- treat empty cylinders with the same caution as you would a full one.

Oxygen equipment

You should:

- open the valve slowly. Rapid opening, particularly of cylinder valves, can result in brief, high oxygen speeds, causing frictional heat, particularly if any dirt or dust is present. Alternatively, if the system has a dead end, such as where a pressure regulator is connected to an oxygen cylinder, heat can be generated through oxygen. Both cases can result in a fire;
- make sure that the regulator outlet valve is closed before opening the oxygen cylinder valve, particularly when opening the cylinder valve for the first time after changing cylinders;
- make sure that cylinder valves are closed and piped supplies isolated whenever work is stopped. Do not try to cut off the supply of oxygen by nipping or kinking flexible hose when changing equipment, eg blowpipes;
- maintain hoses and other equipment in good condition. Leak tests can be carried out easily using a spray or liquid solution that is certified for use on oxygen systems. Soap or liquids that may contain grease should not be used.

Cleanliness

You should always:

- keep oxygen equipment clean. Contamination by dust, sand, oils, greases or general atmospheric debris is a potential fire hazard. Portable equipment is particularly susceptible to contamination, and precautions should be taken to keep it clean;
- use clean hands or gloves when assembling oxygen equipment, eg attaching the pressure regulator, making connections;
- wear suitable clean clothing, free from oil and easily combustible contaminants.

General precautions

You should always:

- make sure that ventilation is adequate;
- check that fire extinguishers are in good condition and ready for use;
- check that escape routes are clear.

Dos and don'ts checklist

Do

- Be aware of the dangers of oxygen. If in doubt, ask.
- Prevent oxygen enrichment by ensuring that equipment is leak-tight and in good working order.
- Check that ventilation is adequate.
- Always use oxygen cylinders and equipment carefully and correctly.
- Always open oxygen cylinder valves slowly.

Don't

- Don't smoke where oxygen is being used.
- Don't use replacement parts that have not been specifically approved for oxygen service.
- Don't use oxygen equipment above the pressures certified by the manufacturer.
- Don't use oil or grease to lubricate oxygen equipment.
- Don't use oxygen in equipment that is not designed for oxygen service.

References

- 1 HSE's risk management website: www.hse.gov.uk/risk
- 2 *Confined spaces: A brief guide to working safely* Leaflet INDG258(rev1)
HSE Books 2012 www.hse.gov.uk/pubns/INDG258.htm
- 3 BS EN ISO 2503:2009 *Gas welding equipment. Pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (300 MPa)*
British Standards Institution
- 4 BS EN ISO 10524: Parts 1–4:2006 *Pressure regulators for use with medical gases* British Standards Institution
- 5 BS EN ISO 3821:2010 *Gas welding equipment. Rubber hoses for welding, cutting and allied processes* British Standards Institution
- 6 BS EN ISO 5359:2008 *Low-pressure hose assemblies for use with medical gases* British Standards Institution

Further reading

The safe use of compressed gases in welding, flame cutting and allied processes
HSG139 HSE Books 1997 ISBN 978 0 7176 0680 1
www.hse.gov.uk/pubns/books/HSG139.htm

Industrial gas cylinder manifolds and distribution pipework/pipelines (excluding acetylene) CP4(rev3) Code of Practice British Compressed Gases Association 2005

The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply) CP7(rev5) Code of Practice British Compressed Gases Association 2008

Guidance for the storage of gas cylinders in the workplace Guidance Note
GN2(rev4) British Compressed Gases Association 2011

British Standards can be obtained in PDF or hard copy formats from
BSI: <http://shop.bsigroup.com> or by contacting BSI Customer Services for hard
copies only Tel: 020 8996 9001 email: cservices@bsigroup.com.

British Compressed Gases Association: bcga.co.uk

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit 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.

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