

# Recommendations

for the storage,  
use and  
handling of  
common  
industrial gases  
in cylinders  
including LPG

RC8

## LOSS PREVENTION RECOMMENDATIONS

These Recommendations are part of a series of insurer documents developed under the Insurers' Fire Research Strategy Funding Scheme (InFiReS) and published by the FPA. InFiReS membership comprises a group of UK insurers that actively support a number of expert working groups developing and promulgating best practice for the protection of property and business from loss due to fire and other risks. The technical expertise for the Recommendations is provided by the Technical Directorate of the FPA and experts from the insurance industry who together form the InFiReS Risk Control Steering Group.

The aim of the FPA Series of Recommendations is to provide loss prevention guidance for industrial and commercial processes and systems. The series continues a long tradition of providing authoritative guidance on loss prevention issues started by the Fire Offices' Committee (FOC) of the British insurance industry over a hundred years ago and builds upon earlier publications from the LPC and the ABI.

Lists of other publications on loss control including other documents in the RC series are available at [www.thefpa.co.uk](http://www.thefpa.co.uk) and from the FPA at London Road, Moreton in Marsh, Gloucestershire GL56 0RH. Copies of publications can be purchased from the FPA at that address or by calling 01608 812500 or e-mailing [sales@thefpa.co.uk](mailto:sales@thefpa.co.uk).

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## SCOPE

These Recommendations address the fire and explosion hazards of common industrial gases in cylinders and of liquefied petroleum gas (LPG) bottles and are applicable to their storage, use and handling.

The gases falling within the scope of these Recommendations include LPG, oxygen, acetylene, hydrogen, nitrogen, argon and argon mixtures. It should be stressed, however, that this is not the complete list of gases to which this document refers and that the Recommendations are applicable to a wide range of gases commonly used in industry.

The Recommendations do not apply to special gases such as xylene/phosgene, which by their nature may require additional fire safety precautions, or to medical gases.

It should be recognised also that the fire risks associated with non-flammable compressed gases will differ from those associated with flammable compressed gases.

LPG is a generic term used to describe commercial propane, commercial butane or mixtures of the two.

## INTRODUCTION

Gases in cylinders, often referred to as bottled gases, in which the gas is contained under pressure, are commonly used in industry. They are also frequently employed in schools, laboratories and other occupancies. LPG is under sufficient pressure to liquefy the gas whereas non-LPG gases are often kept under higher pressures of around 15 atmospheres.

A small leak of gas from a cylinder under pressure can result in a large volume of gas at room temperature and atmospheric pressure. Some of the gases under consideration here, as well as being highly flammable, readily form ignitable mixtures with air over an exceptionally wide range of concentrations and are, therefore, potentially extremely hazardous. They are liable to explode when in contact with an ignition source such as a lighted match or electrical spark.

Acetylene is a prime example. When a cylinder containing a compressed gas is involved in a fire, whether the gas is flammable or not, it is likely to explode with devastating consequences. This is a particular hazard with acetylene, since explosions of acetylene vapour develop higher pressures and are therefore more damaging than explosions of most other gases. Current UK fire service procedures recommend that, even with cooling water applied, acetylene cylinders which have been exposed to heat should be left in situ for at least 24 hours with a 200m exclusion zone around the cylinders. (This may have implications for adjacent premises and organisations in terms of business interruption.)

Oxygen has particularly dangerous characteristics in relation to fire hazard by supporting and accelerating combustion. Materials not normally considered combustible may easily ignite in an oxygen-enriched atmosphere. Grease should therefore not be used on oxygen cylinder valves etc.

Further information on the specific hazards and characteristics of common industrial gases are given in the FPA's book *Fire and Hazardous Substances* (ref. 1). Detailed information is also available from the gas suppliers and the British Compressed Gases Association (ref. 2).

The contents of gas cylinders containing common industrial gases are easily identifiable from the colour of the cylinder shoulder and the label on the cylinder shoulder.

BS EN 1089-3 (ref. 3) describes the colour coding system. Common gases have specified colours while others are coloured according to their hazards.

Examples of colour codes for gas hazards

Toxic and corrosive	Yellow
Flammable	Red
Oxidising	Light blue
Inert	Bright green

Thus hydrogen will be red.

Examples of specific gas colour codes

Oxygen	White
Acetylene	Maroon
Nitrogen	Black
Argon	Dark green
Carbon dioxide	Grey
Nitrous oxide	Blue
Helium	Brown

Compressed gas cylinders (not LPG) should be stampmarked and labelled according to the hazard they present and in compliance with BS EN 1089-1 (ref. 4) and BS EN 1089-2 (ref. 5).

There may still be some old cylinders on sites with the obsolete BS 349: 1973 colouring codes and care should be taken to ensure contents are identified accurately. The old colours for common gases are: oxygen – black; nitrogen – black and grey; and argon – blue. Acetylene has retained maroon as its colour from the old system.

## DEFINITIONS

### *Cylinder*

A gas container (usually made of metal) designed to be transportable and having an internal volume of at least 0.5 litres and not greater than 3000 litres. In practice it is expected that the maximum capacity will be in the region of 50 litres.

### *Nominal empty cylinders*

A cylinder from which most, if not all, of the contents have been discharged but which may still contain residual vapour.

*Fuel gas*

Any gas that releases energy in a controlled reaction by combustion.

**RECOMMENDATIONS**

**1 General**

- 1.1 Users should know and understand the properties of the gas they are using and the correct operating procedures for the equipment being used with the gas. Safety data and operating instructions/publications should be obtained from the suppliers of cylinders and equipment. Adequate training, including action in the event of an emergency, is essential for all users before equipment is employed.
- 1.2 Cylinders should be treated with care. They should be prevented from falling during use, in store and when being transported. They should never be rolled along the floor or ground.
- 1.3 Only cylinders that are properly labelled and colour-coded should be accepted from the supplier. The label should be checked against requirements. Prior to use the label and the colour code should again be checked to ensure that the correct cylinder has been selected.
- 1.4 Any damage or contamination of the cylinders should be immediately reported to the suppliers and repainting of cylinders involved in a fire or other damaging incident should never be undertaken. No attempt to repair cylinders or their valves should be made.
- 1.5 Smoking should be prohibited in all areas where cylinders are used or stored and suitable notices displayed.

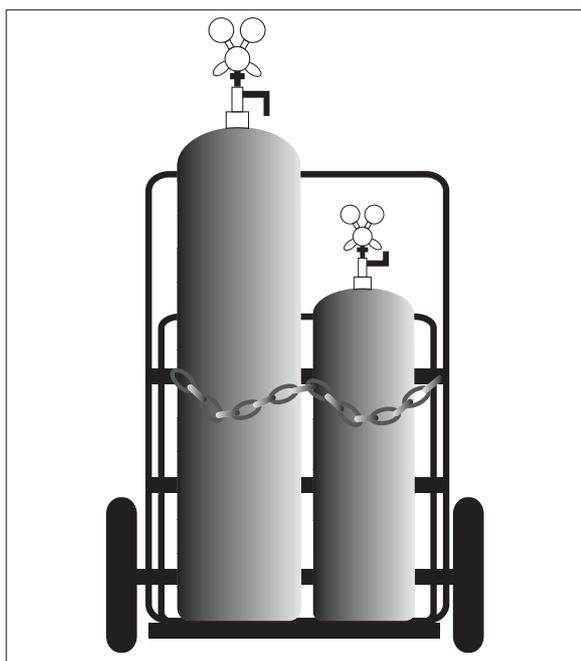


Fig. 1. Typical welding gas trolley

- 1.6 All gases should be assessed for safety hazards and in relation to the Control of Substances Hazardous to Health Regulations 2002 (COSHH) (ref. 6) for hazards to health. An explosion risk assessment should be carried out to comply with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (ref. 7).
- 1.7 Operatives using or handling cylinders should wear appropriate low-flammability clothing, safety shoes and suitable eye protection.
- 1.8 Loading/unloading. Employers should be aware of their responsibilities under The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004 (ref. 8).

**2 Storage**

*2.1 General*

- 2.1.1 Good natural ventilation is essential, particularly where storage is within a building (see section 2.3). Ventilation should be provided at high and low levels. It is preferable for cylinders to be stored in the open (see section 2.2) but with some protection from the weather.
- 2.1.2 Storage should not be below ground level. In large areas where cylinders of different classes of gas are stored consideration should be given to the provision of radiation barriers. Such barriers should have a fire resistance of at least 30min and have a height not less than that of the tallest cylinder.
- 2.1.3 Storage areas should be readily accessible but secure to prevent access by unauthorised persons.
- 2.1.4 Permanent warning notices should be prominently displayed at the storage areas, identifying the gases stored and prohibiting smoking and the use of naked lights or motor vehicles (except for loading and unloading of cylinders).
- 2.1.5 Designated storage areas should be used solely for the storage of gas cylinders. They should not contain other products, particularly not oil, paint or corrosive liquid.
- 2.1.6 Cylinders should be stored with their valves uppermost. Protective valve covers should be used when the cylinders are not in service.
- 2.1.7 Full cylinders should be stored separately from nominally empty cylinders and cylinders of different gases should be segregated from each other.
- 2.1.8 Storage arrangements should ensure adequate turnaround of stock. Nominally empty cylinders should not be stored longer than absolutely necessary and a check should be made to ensure their valves are closed

- 2.1.9 Gas cylinders should at all times be securely supported either on trolleys, within racks or fixed to structural features using welded steel chain.
- 2.1.10 Within the storage area, oxygen cylinders should not be stored within 3m of any fuel gas cylinder.
- 2.1.11 Compressed gas cylinders and acetylene cylinders should not be stored within 3m of any LPG cylinder in excess of 50kg capacity.
- 2.2 *Storage in the open*
- 2.2.1 Cylinders stored in the open should be enclosed within a compound, which should be sited as far from buildings as possible and, where practical, at least 4m from boundary fences. The compound should not be close to roadways or motor vehicle movements (other than for loading and unloading cylinders).
- 2.2.2 Storage should be on a compacted, level, load-bearing surface, preferably concrete or paved. There should be no drains, manholes or openings to basement areas in or near storage areas.
- 2.2.3 The compound should be securely fenced with, for example, 1.8m high wire mesh on metal or concrete posts. Gates to the compound should be secured by a good quality chain and padlock.
- 2.2.4 To shade cylinders from direct sunlight, a light, open-sided weather covering of non-combustible construction should be used. Storage should not be under tarpaulins.
- 2.2.5 The compound and adjacent areas should be kept clear of combustible materials and vegetation. If weed killers are employed only those of the non-chlorate type should be used.
- 2.3 *Storage within a building*
- 2.3.1 Where possible the store should be a detached building constructed of non-combustible materials and located as far as practicable from other buildings.
- 2.3.2 Good natural ventilation is essential. Ventilation should be provided at high and low levels.
- 2.3.3 If cylinders are stored within part of a building used for some other purpose then the following three conditions should be satisfied:
- 2.3.4 The store should be on the ground floor of the building in a room having at least one wall constituting or being contiguous with an external wall with a door or doors leading directly to the open.
- 2.3.5 The store should be separated from the rest of the building by walls and floors built to fire break standards as specified in the *LPC Design Guide for the Fire Protection of Buildings 2000* (ref. 9).

- 2.3.6 The store should be of non-combustible construction.
- 2.3.7 Cylinders should be stored in a cool area. They should not be stored adjacent to steam or hot water pipes or radiators.
- 2.3.8 Where possible, electrical equipment and wiring should be located outside areas where flammable gases are stored.
- 2.3.9 Areas where flammable gases are stored should be subject to a risk assessment to comply with DSEAR (ref. 7). Such areas would normally be classed as zone 2 for these purposes and appropriate explosion proof or flame proof equipment used in accordance with BS EN 60079-14: 2003 (ref. 10).
- 2.3.10 Explosion venting in the form of non-combustible lightweight roofing or walling should be provided. It should be noted that explosion venting in walls is only acceptable when there is no risk of injury to people outside.
- 2.3.11 If it is essential that gas cylinders are stored in a building used for processes other than cylinder storage, then the numbers should be kept to an absolute minimum.

### 3 Use

#### 3.1 Cylinders

- 3.1.1 Cylinder valves should only be opened with a proper key. If the valve is thought to be damaged no attempt should be made to open it. Cylinder valves should always be carefully closed whenever equipment is not in use.

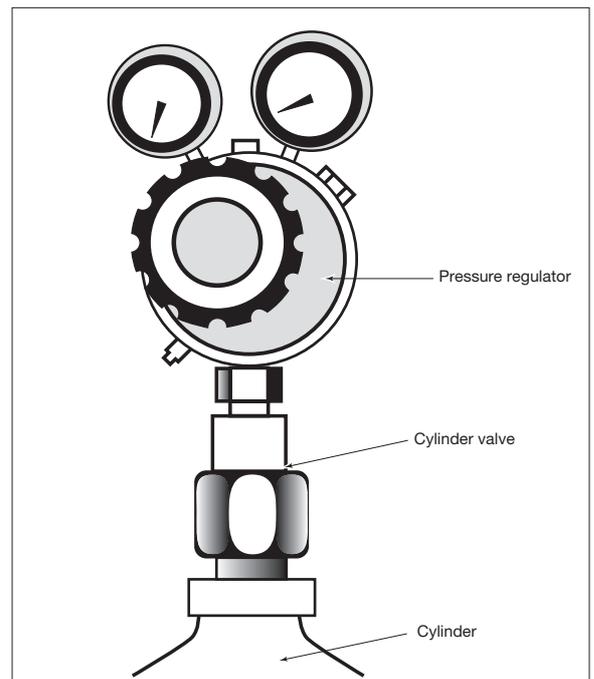


Fig. 2. Typical valve and regulator assembly.

- 3.1.2 There should never be a transfer of gas to another cylinder for mixing of gases or for any other reason.
- 3.1.3 An individual cylinder should never be removed from a manifolded cylinder pallet.
- 3.1.4 Cylinders in use should be kept well clear of all heat sources, especially oxy-fuel gas torches and electrical welding tools.
- 3.1.5 Grease or oil should never be allowed to come into contact with cylinders, their valves or equipment. **This is particularly important with cylinders containing oxygen as this gas will react dangerously with grease or oil.**  
White or red lead, jointing compounds or jointing tape should never be applied to any cylinders, valves or equipment.
- 3.1.6 Before assembling regulators and fittings, care should be taken that there are no particles of dirt in the cylinder outlet. Particles of dirt and residual moisture can be removed by 'cracking' open and immediately closing the valve. This is known as 'snifiting' and, when carried out, eye protection must be worn and extreme care exercised that there is no possible source of ignition in the vicinity. The operator should stand clear of the gas stream and on no account attempt to deflect it with the hand or face. In the case of high purity gases such as argon, the outlet of the cylinder valve should be dried beforehand with a clean dry cloth. **Hydrogen must never be 'snifted' since the gas flow can generate sufficient electrostatic charge to cause ignition.**
- 3.1.7 Where a cylinder is connected to a laboratory or manufacturing process in which the process pressure can exceed the cylinder supply pressure, adequate precautions should be taken to prevent back flow of contaminated gases or liquids. As a minimum precaution a non-return valve or check valve should be fitted. A preferable arrangement is an automatic shut-off/isolation valve activated when the supply gas cylinder pressure drops below a predetermined level. Usually this is the level of pressure at which the cylinder should be replaced. Operation of the cut off should be indicated by an alarm. It should be noted that such systems require frequent maintenance. An empty cylinder should never be left connected to a process.
- 3.1.8 Where many cylinders are in use simultaneously, a pipeline supply from a manifolded system of cylinders located safely outside a building should be considered. Cylinders inside a building can cause severe firefighting difficulties. The design and installation of pipeline systems should be entrusted to specialists working to appropriate British Compressed Gases Association Codes of Practice (ref. 2).
- 3.1.9 Acetylene and LPG cylinders should be used (and stored) in the upright position apart from LPG cylinders specially designed for use on fork lift trucks where the internal tubing is arranged for horizontal use.
- 3.1.10 When not in use oxy/acetylene sets should be returned to an appropriate, well ventilated storage location within the workroom well away from any combustible materials or wherever possible a separate and suitable store.
- 3.2 *Equipment*
- 3.2.1 Equipment (regulators, hoses, blowpipes) should be disconnected prior to storage or transportation of cylinders. Where cylinders are fitted to a purpose-made cylinder trolley for moving to a place of work, then the equipment may be left connected but the valves must be closed before moving.
- 3.2.2 Before connecting any cylinders to a system ensure it is suitable for the pressure involved.
- 3.2.3 Constant and thorough ventilation should be provided wherever cylinder gases are used. This is particularly important in confined spaces.
- 3.2.4 Only the regulator designed for the gas should be used. In particular, propane and butane need different regulators.
- 3.2.5 For welding and similar applications, flashback arresters should be fitted downstream of pressure regulators to all fuel gas supply hoses/lines and oxygen supply hoses/lines where used in conjunction with fuel gases, to prevent flames travelling back into cylinders.
- 3.2.6 Only purpose-made hoses in good condition should be used which comply with BS EN 559: 2003 (ref. 11).
- 3.2.7 For LPG cylinders, however, only purpose-made hoses in good condition which comply with BS 3212: 1991 (ref. 12) should be used.
- 3.2.8 Hoses should be secured by clips that are approved by the equipment manufacturer. Worm-drive clips are not suitable for this purpose.
- 3.2.9 The condition of hose connections should be regularly checked.
- 3.2.10 **Joint fittings (or piping) made of copper should on no account be used in conjunction with acetylene.**
- 3.2.11 Hoses should not be coiled around cylinders or their regulators.
- 3.2.12 The use of hoses which are either too long or too short for their purpose should be avoided. The latter could lead to operations being carried out

too close to cylinders. Hoses should be sited well clear of sparks and where they will not be subjected to damage by being walked on or by contact with sharp metal. Fires in coiled hoses are especially difficult to deal with.

- 3.2.13 With oxy-fuel equipment, use hose check valves to prevent backfeeding, to prevent the mixing of oxygen and fuel gas in a hose and subsequently a fire within the hose.
- 3.2.14 Cylinder valves (including those in store) and assembled equipment should be checked for leaks as a matter of routine and not only when a leak is heard or smelt. Particular attention should be given to all joints, pressure regulators and equipment valves. Naked flames should never be used when looking for a leak. Only a leak-testing fluid approved by the gas cylinder supplier should be used for testing. Particular caution should be observed when testing for oxygen leaks since any residue could result in reaction with the gas leading to spontaneous ignition.
- 3.2.15 Permanent welding and other hot work areas should be considered as high fire hazard areas. The risks from fire will be mitigated by ensuring that combustible items and other hazards are segregated from the hot work by non-combustible/fire-resisting partitions or screens and that no combustible building components are likely to be ignited by the operations. Where maintenance of buildings or machinery is involved and mobile equipment used, it is essential that the FPA recommendations RC7 (ref. 13) are fully complied with.

### 3.3 Maintenance

- 3.3.1 All cylinders and equipment should be maintained in a clean condition. Special care is required in the storage of oxygen regulators. The nozzles of blowpipes should be regularly examined and, if clogged, cleaned in accordance with the manufacturer's instructions.
- 3.3.2 All equipment for use with cylinders should be returned to the supplier for routine examination and/or servicing at intervals recommended by the supplier. Repairs when required should always be arranged with the equipment supplier. Faulty or leaking regulator gauges should always be dealt with by returning the complete regulator assembly.
- 3.3.3 Cylinders owned by the gas supplier are automatically submitted for maintenance and testing when returned to the gas supplier for filling. This is not the case when the cylinders are owned by the user, who must then be aware of the statutory obligations with regard to these functions.

## 4 Fire protection

- 4.1 No attempt should be made to extinguish an outbreak of fire involving burning fuel gases until the gas supply has been shut off. Untrained personnel should not attempt to tackle a fire involving fuel gases and the area should be evacuated and the fire brigade should be called immediately.
- 4.2 Provision should be made for an adequate supply of water for fire brigade use to provide hose streams for cooling cylinders that might become exposed to heat from a fire. Suitable access to the storage area should also be provided for firefighting.
- 4.3 Fire extinguishers, approved and certificated by an independent, third-party certification body, of a type suitable for extinguishing fires in nearby materials should be provided in the vicinity of all areas in which gases are used or stored. These should be provided in easily accessible positions and maintained in accordance with BS 5306: Parts 3 and 8 (refs 14 and 15).
- 4.4 Consideration should be given to water spray or automatic sprinkler protection in situations where significant numbers of cylinders of fuel gases are stored.

## REFERENCES

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CP5, *The design and construction of manifolds using acetylene gas from 1.5 bar to a maximum working pressure of 25 bar (362 lbf/in<sup>2</sup>)*, Revision 1: 1998, BCGA.  
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15. BS 5306: *Fire extinguishing installations and equipment on premises: Part 8: 2000, Selection and installation of portable fire extinguishers. Code of practice*, British Standards Institution.

## FURTHER GUIDANCE

### British Standards Institution

BS EN 13463: Part 1: 2001, *Non-electrical equipment for potentially explosive atmospheres. Basic method and requirements*, BSI.

### Health and Safety Executive

L136. *Control and mitigation measures. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance*, HSE Books, 2003.

L138. *Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance*, HSE Books, 2003.

### LP Gas Association

CoP 7. *Storage of full and empty LPG cylinders and cartridges*, March 2004, LPGA.

CoP 24. *Use of LPG cylinders: Part 6: The use of propane in cylinders at commercial and industrial premises*, May 2000, LPGA.

## USEFUL ADDRESSES

British Compressed Gases Association, 6 St Mary's Street, Wallingford, OX10 0EL, United Kingdom.

British Standards Institution, 389 Chiswick High Road, London W4 4AL, United Kingdom.

HSE Books, PO Box 1999, Sudbury, CO10 2WA, United Kingdom.

The LP Gas Association, Pavilion 16, Headlands Business Park, Salisbury Road, Ringwood, BH24 3PB, United Kingdom.

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