

# RC8: Recommendations for the storage, use and handling of common industrial gases in cylinders



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# Summary of Key Points

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<b>Comply with the law</b>	<ul style="list-style-type: none"><li>Undertake an assessment in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (as amended in 2015) as well as a fire risk assessment in compliance with the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland).</li></ul>
<b>Ensure the continued well being of your business</b>	<ul style="list-style-type: none"><li>Where it is intended that a process involving a gas cylinder is to be left operating without staff in attendance then undertake a specific risk assessment for the process and implement appropriate control measures in accordance with the guidance set out in RC42: <i>Recommendations for fire safety of unattended processes</i>.</li></ul>
<b>Reduce the risk</b>	<ul style="list-style-type: none"><li>Manage the use of gas cylinders to keep the number to the minimum compatible with operational needs.</li></ul>
<b>Apply the acronym VICES</b>	<ul style="list-style-type: none"><li>Use the acronym VICES to help apply five basic principles to ensure that any gas cylinder that is necessary in the workplace is used and stored with appropriate care.</li></ul>
<b>Ventilation</b>	<ul style="list-style-type: none"><li>Provide adequate ventilation, as determined by a DSEAR assessment, at high and low levels by natural or mechanical means to prevent the concentration of a release of vapour from accumulating to within the explosive limits of the most hazardous gas likely to be present.</li></ul>
<b>Ignition</b>	<ul style="list-style-type: none"><li>Remove all possible sources of ignition from areas where cylinders of flammable gases are stored.</li></ul>
<b>Containment</b>	<ul style="list-style-type: none"><li>Store gas cylinders vertically and chain them in position in storage areas. When being transported, chain or strap them to a suitable trolley.</li></ul>
<b>Exchange</b>	<ul style="list-style-type: none"><li>Eliminate the use of gas cylinders from the workplace wherever practicable. Replace hazardous materials with less hazardous substances.</li></ul>
<b>Separation</b>	<ul style="list-style-type: none"><li>Store full cylinders separately from nominally empty cylinders. Cylinders of different gases should be segregated from each other.</li></ul>
<b>Security</b>	<ul style="list-style-type: none"><li>Identify areas where cylinders of nitrous oxide and Entonox are stored in the fire risk assessment and ensure that the security of these areas is subject to a specific security review.</li></ul>

## Symbols used in this guide



Good practice



Bad practice



Discussion topic



Frequently asked question

# 1 Introduction

Cylinders of compressed gas, in which the gas is contained under pressure, are commonly encountered in a wide range of industrial and commercial operations and may be found in schools, laboratories and on building sites as well as providing fuel or reactants for many industrial processes.

Although gas cylinders may all look very similar, there are important differences between those designed to be used with different gases to accommodate the appropriate control valves and safety features. LPG cylinders are of a different design to most others, being shorter and of a larger diameter. As LPG liquefies at low pressure, this design accommodates the handling of this gas in a convenient form. Other gases are not so readily liquefied and much more robust metal cylinders are required to handle the higher pressures involved.

Because of the high pressures involved, a small leak of gas from a cylinder can result in a large volume of gas at normal temperature and atmospheric pressure. Where the leak involves a flammable gas, an extremely large volume of hazardous gas and air mixture can form in a short period of time, which may explode in contact with an ignition source as small as the spark from an electric switch. The release of a toxic gas or one that replaces oxygen in the air leading to suffocation are extremely hazardous for other reasons.

Oxygen has particularly dangerous characteristics in relation to fire by supporting and accelerating combustion. Materials not normally considered combustible may easily ignite in an oxygen-enriched atmosphere. For this reason grease should never be used on oxygen cylinder valves.

Further information on the specific hazards and characteristics of common industrial gases are given in the FPA's publication *Fire and hazardous substances* (ref 2). Detailed information is also available from gas suppliers and the British Compressed Gases Association (ref 3).

The contents of gas cylinders containing common industrial gases are readily identifiable from the colour of the cylinder shoulder and the label. BS EN 1089-3 (ref 4) describes the colour coding system; common gases have specified colours while others are coloured according to their hazards.

Compressed gas cylinders containing LPG should be stamp-marked and labelled according to the hazard they present and in compliance with BS EN ISO 13769 (ref 5) and BS EN ISO 7225 (ref 6).

Examples of colour codes for gas hazards are set out in Table 1. Tables 2 and 3 illustrate the colour coding of inert gases for medical and industrial applications, while Table 3 provides examples of some industrial gases and gas mixtures.

There may still be some old cylinders on industrial sites with the obsolete BS 349 (ref 7) colour codes but as this standard has been withdrawn, care should be taken to ensure contents are identified accurately. The colouring of the cylinders should now conform to BS EN 1089-3 (ref 4) but reliance should not be placed solely on the colour of the cylinder for identifying the contents; a careful check should also be made of the labels.



- What measures can be taken to minimise the number of gas cylinders in the workplace?

## 2 Scope

These recommendations address best practice for the storage, use and handling of commonly encountered industrial gases supplied to industry and commerce in cylinders. The gases considered include both flammable and non-flammable substances, all of which can introduce fire and explosion hazards into the workplace.

The cylinders falling within the scope of these Recommendations include (but are not restricted to) LPG, oxygen, nitrogen, acetylene, hydrogen, helium, argon, compressed air and those containing other flammable and non-flammable gases.

In the case of cylinders which form parts of automatic fire suppression systems, the instructions provided by the installing engineers should be observed.

Miniature disposable gas cylinders associated with the dairy produce and beverage industries are outside the scope of these recommendations, together with the use of LPG in passenger vehicles.

Acetylene is a particularly hazardous gas; where it is in use, the additional measures for the safe management of acetylene cylinders set out in RC49: *Recommendations for the storage, handling and use of acetylene cylinders* (ref 1) must be observed.

Although reference is made in these recommendations to toxic gases, health and safety issues associated with these materials are not considered further in this publication.

## 3 Synopsis

These recommendations outline good practice when storing, handling and using gas cylinders. Additional material concerning acetylene cylinders is set out in RC49: *Recommendations for the storage, handling and use of acetylene cylinders*, which should be observed in conjunction with the guidance in this document wherever acetylene cylinders are stored or used.

It is emphasised that for both life safety and property protection purposes the numbers of gas cylinders kept in the workplace should be minimised. This applies to both full and nominally empty cylinders.

Gas cylinders of all types should be used and handled with care and caution, and staff who work with them should be familiar with the potential hazards that they introduce into the workplace.

## 4 Definitions

### Cylinder

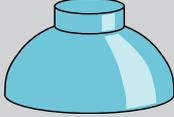
A gas container designed to store and transport gases above atmospheric pressure. (For the purposes of these recommendations, the cylinders will have an internal volume of at least 0.5 litres and not greater than 3000 litres. In practice, the volume of compressed gas in the cylinders will be about 50 litres.)

### LPG

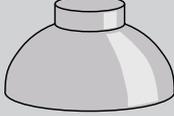
LPG (liquefied petroleum gas) is a generic term used here to describe commercial propane, commercial butane or mixtures of the two.

### Nominally empty cylinders

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

Gas type	Colours	
Inert		Bright green RAL 6018
Oxidising		Light blue RAL 5012
Flammable		Red RAL 3000
Toxic and/or corrosive		Yellow RAL 1018

**Table 1: Colour classification by hazard property**

Gas type	Colours	
Argon		Dark green RAL 6001
Nitrogen		Black RAL 9005
Carbon dioxide		Grey RAL 7037
Helium		Brown RAL 8008

**Table 2: Inert gases for medical and industrial applications**

Gas type		Colours	
Air or synthetic air	$O_2 < \text{or } - 23.5\%$		Bright green RAL 6018
Ammonia	$NH_3$		Yellow RAL 1018
Chlorine	$Cl_2$		Yellow RAL 1018
Hydrogen	$H_2$		Red RAL 3000
Krypton	Kr		Bright green RAL 6018
Methane	$CH_4$		Red RAL 3000
Argon/carbon dioxide	Ar/ $CO_2$		Bright green RAL 6018
Nitrogen/carbon dioxide	$N_2/CO_2$		Bright green RAL 6018

Table 3: Examples of some industrial gases and gas mixtures

## 5 Recommendations

### 5.1 Compliance with fire safety legislation

- 5.1.1 A suitable and sufficient fire risk assessment should be undertaken for all premises to which the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland) applies (refs 8-12).
- 5.1.2 As well as staff handling and using gas cylinders, the assessment should consider staff and others remote from the process area who may be affected by smoke and heat in the event of a fire. Where a significant number of cylinders are stored, handled or in use, the implications for other people in the neighbourhood should also be addressed. In business-critical areas, the implications for property protection and business continuity, as well as life safety, should also feature prominently in the assessment.
- 5.1.3 An assessment should be undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (as amended in 2015) (ref 13). In common with the fire risk assessment, this should be undertaken by a competent person and should identify any hazard zones in the workplace.

- 5.1.4 Risk assessments should be subject to periodic review, including at the time when any changes to the numbers of gas cylinders (whether full or nominally empty), the types of gases present or the design or location of the storage areas are being considered.

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## 5.2 Business continuity

- 5.2.1 Even a small fire can have a disproportionate effect on a business if it occurs in a critical area. The storage, use and handling of gas cylinders are hazardous operations and must be carefully managed to avoid unnecessary disruption to the efficient functioning of the business.
- 5.2.2 In commercial premises where processes routinely involve the use of cylinders, the fire hazards and thus the threat to the business are increased if the processes are allowed to continue unattended. If it is intended that equipment is to be left operating without staff in attendance then a specific risk assessment for the process should be undertaken and appropriate control measures introduced. Further information regarding unattended processes is set out in RC42: *Recommendations for fire safety of unattended processes* (ref 14).
- 5.2.3 All businesses should take steps to maintain the continuity of their operations by making a suitable emergency plan. Guidance for this is set out in *Business resilience: A guide to protecting your business and its people* (ref 15). The emergency plan should address the implications of a fire, flood or other perceived disaster on all facets of the business model. It should indicate the lines of communication that should be followed and the contact details for specialist assistance, providers of alternative accommodation and suppliers of replacement equipment.
- 5.2.4 Table top exercises should be held periodically to test the effectiveness and suitability of the emergency plans.
- 5.2.5 Consideration may be given to applying commercially available computer programs, such as the ROBUST software (Resilient Business Software Toolkit) that is available free of charge (ref 16), or similar product, to develop and check the adequacy of the plan.

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## 5.3 Fire safety management

- 5.3.1 The numbers of gas cylinders kept on site should be carefully managed and kept to the minimum compatible with operational needs. In particular, nominally empty cylinders should not be allowed to accumulate but should be returned to the supplier at the earliest opportunity.
- 5.3.2 The response by fire and rescue services to 999/112 calls and signals routed via fire alarm monitoring organisations varies widely throughout the UK, and differs from day to night-time. Fire safety managers should refer to the relevant fire and rescue service to make themselves aware of the levels of response in the areas in which their premises are located and consider this information when undertaking and reviewing their fire risk assessments.
- 5.3.3 Site plans should be available for the emergency services. These should show the locations of the storage areas, the type, quantity and location of gas cylinders in each area and the location of installations using the cylinders.
- 5.3.4 Users should be able to recognise the gas cylinders that they routinely use and understand the properties of the gases they contain. They should be familiar with the correct operating procedures for the equipment being used with the gases. 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 processes are commenced.



- Fire safety managers should refer to the relevant fire and rescue service to make themselves aware of the levels of response in the areas in which their premises are located and consider this information when undertaking and reviewing their fire risk assessments. (5.3.2)



- Cylinders should be treated with care. They should be prevented from falling during use, in store and when being transported. (5.3.5)

- 5.3.5 Cylinders should be treated with care. They should be prevented from falling during use, in storage and when being transported. This is usually done by chaining the cylinders in place in their designated storage area or securing them on trolleys while being moved. They should never be rolled along the floor or ground.
- 5.3.6 Only cylinders that are properly labelled and colour-coded should be accepted from the supplier. The label should be checked against requirements on delivery. Prior to use, the label and the colour code should again be checked to ensure that the correct cylinder has been selected. A cylinder without a label should not be used; it should be returned to the supplier.
- 5.3.7 Any damage or contamination of a cylinder should be reported immediately to the supplier. Cylinders involved in a fire or other damaging incident should not be repainted and no attempt should be made to repair cylinders or their valves.
- 5.3.8 No attempt should be made to modify a gas cylinder for any other use.
- 5.3.9 Designated smoking areas outside the premises should be at least 10m away from gas cylinder stores.
- 5.3.10 Employers responsible for loading or unloading vehicles should be aware of their responsibilities under the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended) (ref 17).
- 5.3.11 Appropriate security precautions should be in place to protect against arson and vandalism where gas cylinders are stored in the open air. At the time of the fire risk assessment, precautionary measures should be considered depending on the character of the neighbourhood and the quantity and nature of the cylinders stored. See RC48: *Arson prevention. The protection of premises against deliberate fire raising* (ref 18).

## FAQ

- What training is necessary for staff who routinely handle and use gas cylinders? (5.3.4 and 5.4.2)



Figure 1: Example of a proprietary gas cylinder storage cabinet

## 5.4 VICES

- 5.4.1 The HSE guidance regarding flammable liquids in booklet HS(G)51 (ref 19) suggests the use of the acronym VICES to help apply five basic principles which ensure that any flammable or highly flammable liquid that is necessary in the workplace is used and stored with appropriate care. These principles can also be applied to the use and storage of gas cylinders.
- 5.4.2 Suitable staff training should be in place to ensure all personnel are aware of the hazards associated with the use of gas cylinders in the workplace and apply VICES to ensure a safer working environment for all.
- 5.4.3 The acronym may be explained as follows:

### V Ventilation (see section 5.5)

Is there sufficient ventilation to keep the concentration of any escaping vapour below its lower explosive and/or harmful limits?

### I Ignition (see section 5.6)

Have all possible ignition sources been removed from areas where cylinders of flammable gases are stored?

Is the electrical equipment used in the area suited to the risk category?

### C Containment (see section 5.7)

Are cylinders held vertically and chained in position in storage areas?

When transported are cylinders chained or strapped to a suitable trolley?

Are nominally empty cylinders properly managed?

### E Exchange (see section 5.8)

Can the use of gas cylinders be eliminated from the workplace?

Can hazardous materials be replaced by less hazardous substances?

## **S Separation** (see section 5.9)

Is the gas cylinder store suitably separated from other stored materials?

Are empty cylinders conspicuously marked and kept separate from full containers?

Are physical barriers (such as walls, doors, appropriate cabinets and bins) present as required?

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## **5.5 Ventilation**

- 5.5.1 It is preferable for cylinders to be stored in the open with protection from the weather and direct sunlight. Where cylinder storage has to be within a building, good natural ventilation is essential and should be provided.
- 5.5.2 Adequate ventilation, as determined by a DSEAR assessment, should be provided at high and low levels by natural or mechanical means to prevent the concentration of a release of vapour from accumulating to within the explosive limits of the most hazardous gas likely to be present. The degree of ventilation required will depend on the properties of the gas concerned and will normally be determined by reference to the COSHH assessment (see ref 20).
- 5.5.3 The low and high level ventilation openings should be provided direct from the storage area to the outside. Care should be taken to prevent cylinders from obstructing the openings. Natural ventilation may be achieved by the use of air-bricks.
- 5.5.4 Mechanical ventilation may be used, providing at least six air changes per hour with vents positioned so as to provide cross-flow. Duct openings should not allow fire spread. Fan motors should not be positioned within ductwork, and should be suitable for the hazard zone (as identified by the DSEAR assessment). All mechanical ventilation installations shall comply with BS 5925 (ref 21).
- 5.5.5 Where mechanical ventilation is installed, the location of the exhaust outlet should be subject to a risk assessment in compliance with DSEAR. In most cases it should be adequate if the ventilation ductwork is terminated at least 3m above ground level and the same distance from building openings (including the eaves of buildings), boundaries, natural hazards such as drains and sources of ignition.
- 5.5.6 Ducting should:
- be of non-combustible construction,
  - take as short a route as possible,
  - have as few directional changes as possible,
  - be arranged so that vapours cannot condense and collect at low points in the ductwork, and
  - be routed to a safe place in the open air.
- 5.5.7 No fire dampers should be fitted in extract ducts for flammable vapours.
- 5.5.8 Explosion venting in the form of non-combustible lightweight roofing or walling should be provided according to the findings of a risk assessment. In such a case, a lightweight roof or relief panels in the walls would serve to vent an explosion, provided that they release the pressure to a safe place so as not to cause injury or damage to property.
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## 5.6 Ignition

- 5.6.1 Where possible, electrical equipment and wiring should be located outside areas where gas cylinders are stored.
  - 5.6.2 Assessment of the lightning risk should be undertaken in accordance with BS EN 62305 (ref 22) and the requirements of RC35: *Protection of buildings against lightning strike* (ref 23). Particular consideration is warranted for gas cylinder compounds located in open areas.
  - 5.6.3 Heating must be suitable for the hazard zone in which the cylinders are being stored or used. Where a heating system providing ducted warm air or supplying hot water or steam to pipes and radiators is in use, the system should incorporate a heat exchanger so as to prevent any release of flammable gas from coming into contact with an ignition source. The temperature of the external surface of heaters should not exceed 120°C.
  - 5.6.4 Cylinders should not be positioned within 1m of heaters or steam pipes.
  - 5.6.5 Heating installations and equipment should be maintained according to the manufacturer's instructions.
  - 5.6.6 Vigilance should be maintained against deliberate fire setting at all times as a fire involving a gas cylinder is an extremely hazardous event.
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## 5.7 Containment

- 5.7.1 The discharge of a dangerous substance into the atmosphere may have safety and environmental impacts. Gases should not be deliberately released from gas cylinders, even from those that are nominally empty.
  - 5.7.2 The requirements regarding separation and storage set out in sections 5.9 and 5.10 below are also applicable to containment.
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## 5.8 Exchange

- 5.8.1 Wherever practicable, the use of gas cylinders should be minimised in the workplace. Hazardous materials should be replaced with less hazardous substances and large cylinders replaced with those of smaller capacity. Guidance on suitable alternative gases for various activities commonly utilising acetylene is provided in RC49: *Recommendations for the storage, handling and use of acetylene cylinders* (ref 1).
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## 5.9 Separation

- 5.9.1 The separation of gas cylinders from everyday work processes and routines should follow the recommendation outlined in section 5.10 below.
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## 5.10 Storage

### General

- 5.10.1 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.
- 5.10.2 Full cylinders should be stored separately from nominally empty cylinders, and cylinders of different gases should be segregated from each other.
- 5.10.3 Cylinders should be stored with their valves uppermost.
- 5.10.4 Protective valve covers should be used when the cylinders are not in service.

- 5.10.5 Gas cylinders should at all times be securely supported either on trolleys, within racks or fixed to structural features using welded steel chain.
- 5.10.6 Storage areas should be readily accessible but secure to prevent access by unauthorised persons.
- 5.10.7 The doors or gates to cylinder storage areas should be provided with ramped access and be sufficiently wide to allow the passage of trolleys.
- 5.10.8 Permanent warning notices should be prominently displayed at 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).
- 5.10.9 Storage arrangements should ensure adequate turnaround of stock and allow for strict stock rotation of full cylinders to enable those with the shortest expiry time to be used first. Nominally empty cylinders should not be stored longer than absolutely necessary and a check should be made to ensure their valves are closed.
- 5.10.10 Oxygen cylinders should not be stored within the same enclosed storage area as cylinders of LPG or other flammable gases. In external storage areas, oxygen cylinders should not be stored in the same cage or within 3m of cylinders of any fuel gas.
- 5.10.11 Compressed gas cylinders should not be stored within 3m of any LPG cylinder in excess of 50kg capacity.

### FAQ

- Where should an external cylinder store be located? (Sections 5.10.12 to 5.10.19)



- Cylinders stored in the open should be enclosed within a compound, which should be sited as far from buildings as possible. (5.10.15)
- External gas cylinder storage compounds should be securely fenced; gates should be secured by a good quality chain and padlock. (5.10.16)
- Cylinders stored in the open air should be shaded from direct sunlight. (5.10.17)



Figure 2: Cylinder valve

### External cylinder stores

- 5.10.12 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.
- 5.10.13 Gas cylinders should not be stored or handled in areas that are liable to flooding.
- 5.10.14 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.
- 5.10.15 Cylinders stored in the open should be enclosed within a compound located at least 4m from boundary fences, buildings and structures. The compound should not be close to roadways or motor vehicle movements (other than for loading and unloading cylinders).
- 5.10.16 The compound should be securely fenced with, for example, 1.8m high welded wire mesh on metal or concrete posts. Gates to the compound should be secured by a good quality chain and padlock.
- 5.10.17 To shade cylinders from direct sunlight, an open-sided weather covering of non-combustible construction should be used. Storage should not be under tarpaulins.
- 5.10.18 The compound and adjacent areas should be kept clear of combustible materials, such as idle pallets and vegetation. If weed killers are employed, only those of a non-chlorate type should be used.
- 5.10.19 Gas cylinder compounds and any pipelines should be prominently signed and protected from impact by vehicles, for example by the erection of kerbs or bollards.

### Internal cylinder stores

- 5.10.20 Internal cylinder stores should not be located below ground level.
- 5.10.21 Where possible, the store should be a detached building constructed of non-combustible materials and located as far as practicable from other buildings. Consideration should be given to providing explosion venting as described in section 5.5.8 above.
- 5.10.22 If cylinders are stored within part of a building used for some other purpose, the following conditions should be satisfied:
  - 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.



- When stored inside a building, cylinders should not be stored adjacent to steam or hot water pipes or radiators. (5.10.23)



- The use of a proprietary storage cabinet to house gas cylinders, together with associated manifolds and gas handling equipment should be considered where gas cylinders are stored within premises. (5.10.24)

- The store should be separated from the rest of the building by walls and floors built to fire break standards as specified in *Approved Document B: Fire Safety (Volume 2) – Buildings other than dwellinghouses Incorporating Insurers' Requirements for Property Protection* (ref 24).

5.10.23 Cylinders should be stored in a cool area. They should not be stored adjacent to steam or hot water pipes or radiators.

5.10.24 If it is essential that gas cylinders are stored in a building used for processes other than cylinder storage:

- the numbers should be kept to an absolute minimum; and
- the use of proprietary storage cabinets complying with BS EN 14470-2 (ref 25) should be used to house gas cylinders, together with associated manifolds and gas handling equipment where practicable.

5.10.25 The provision of a leak detection system with remote monitoring should be considered, particularly where large numbers of gas cylinders are stored.

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## 5.11 Security

5.11.1 Cylinders of nitrous oxide ('laughing gas') and Entonox have become a target for theft due to the value of the contents when used for recreational activities. Areas where cylinders of these gases are stored should be subject to a specific security review.

5.11.2 Where nitrous oxide or Entonox are stored, the structure should be of brick or block construction rather than welded mesh, and comply with the guidance set out in paragraphs 5.10.20 to 5.10.25 above.

5.11.3 Entrance doors should provide an appropriate degree of security protection and be fitted with locks/electronic access control systems and intruder alarms in consultation with the insurers of the property.

5.11.4 Keys to the cylinder store should be signed in and out with dates and times. The doors should be kept locked at all times when the store is not in use.

5.11.5 The delivery and collection of gas cylinders from the store by the supplier should be monitored.

5.11.6 The store should be located where it can be readily observed; serious consideration should be given to providing monitoring by CCTV.

5.11.7 The ordering and monitoring of stocks of nitrous oxide and Entonox cylinders should be carefully managed so it can be readily identified if cylinders are missing.

5.11.8 The police, the insurer and the supplier of the gas cylinders should be notified immediately if any theft has been established.

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## 5.12 Use

### Cylinders

5.12.1 When preparing cylinders for use:

- open cylinder valves slowly using the correct spindle key or the handwheel fitted on some cylinders;
- cylinder valves should not be subjected to excessive torque;
- an opened valve should never be left against the backstop but should be turned back half a turn to avoid seizure in an open position;
- to shut the valve, turn it clockwise just enough to stop the gas completely - never use force; and
- if the gas supply is not being used for more than a few moments, the cylinder valve should be closed.



- Grease or oil should never be allowed to come into contact with cylinders, their valves or equipment. This can be extremely hazardous. (5.12.7)



- In laboratories what measures should be taken to prevent back flow of contaminated gases or liquids? (5.12.10)



- Where many cylinders are in use simultaneously, a pipeline supply from a manifolded system of cylinders located safely outside a building should be considered (5.12.11)

- 5.12.2 Gas cylinders of LPG-fuelled trucks should not be changed in areas where highly flammable or flammable liquids are stored or used.
- 5.12.3 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.
- 5.12.4 There should never be a transfer of gas to another cylinder for mixing of gases or for any other reason.
- 5.12.5 No attempt should be made to remove an individual cylinder from a manifold cylinder pallet as these cylinders are not suitable for stand-alone use.
- 5.12.6 Cylinders in use should be kept well clear of all heat sources, especially oxy-fuel gas torches and electrical welding tools.
- 5.12.7 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.
- 5.12.8 White or red lead jointing compounds or jointing tape should never be applied to any cylinders, valves or equipment.
- 5.12.9 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 opening and immediately closing the valve. When carried out, eye protection should 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. This operation must never be carried out on hydrogen cylinders as the gas flow can generate sufficient electrostatic charge to cause ignition of the gas.
- 5.12.10 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. A nominally empty cylinder should never be left connected to a process.
- 5.12.11 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 26).
- 5.12.12 All gas 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 use in a horizontal position.

### **Equipment**

- 5.12.13 Regulators and pressure gauges 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.
- 5.12.14 Before connecting any cylinders to a system it should be ensured that the equipment is suitable for the pressure involved.
- 5.12.15 Constant and thorough ventilation should be provided wherever cylinder gases are used. This is particularly important in confined spaces.
- 5.12.16 Only the regulator designed for the gas should be used. In particular, propane and butane need different regulators.
- 5.12.17 For welding and similar applications, flashback arresters should be fitted downstream

of pressure regulators to all fuel gas supply hoses/lines - oxygen supply hoses/lines where used in conjunction with fuel gases - to prevent flames travelling back into cylinders.

- 5.12.18 Only purpose-made hoses in good condition should be used which comply with BS EN ISO 3821: *Gas welding equipment. Rubber hoses for welding, cutting and allied processes* (ref 27). For LPG cylinders, only purpose-made hoses in good condition which comply with BS 3212: *Specification for flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations* (ref 28) should be used.
- 5.12.19 Hoses should be secured by clips that are approved by the equipment manufacturer. Worm-drive clips are not suitable for this purpose.
- 5.12.20 The condition of hose connections should be checked before each use of the equipment.
- 5.12.21 Hoses should not be coiled around cylinders or their regulators.
- 5.12.22 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.
- 5.12.23 With oxy-LPG equipment, check valves should be used to prevent backfeeding, the mixing of oxygen and fuel gas in a hose, and subsequently a fire within the hose.
- 5.12.24 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 smelled. 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.
- 5.12.25 Relevant staff should be made aware as part of their training (see 5.3.4) that cylinder valves for flammable gases have left handed threads. Left-hand-threaded pressure regulators should not be interchanged between gases as to do so could be hazardous.
- 5.12.26 Permanent welding and other hot work areas should be considered as high fire hazard areas. The risk 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 requirements of RC7: *Hot work* (ref 29), including the management of the work under a permit-to-work scheme, are fully complied with.

## FAQ

- How long should hoses used with gas cylinders be? (5.12.22)

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### 5.13 Maintenance

- 5.13.1 All cylinders and equipment should be maintained in a clean condition. Special care is required in the storage of oxygen regulators (see 5.10.7). The nozzles of blowpipes should be regularly examined and, if clogged, cleaned in accordance with the manufacturer's instructions.
- 5.13.2 All equipment for use with cylinders should be returned to the supplier for routine examination and/or servicing at intervals recommended by the supplier. Cylinder regulators should be changed every five years or as otherwise indicated by their date-stamp. Repairs when required should always be arranged with the equipment supplier. Faulty or leaking regulator gauges should be replaced immediately and the complete regulator assembly returned to the supplier.

- 5.13.3 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. Inspection periods vary according to the gases contained in the cylinders. For example:
- cylinders containing argon, nitrogen, helium and air should be inspected every ten years;
  - carbon dioxide and self-contained breathing air cylinders require inspecting every five years;
  - cylinders that contain some mixtures of gases should be inspected every three years.
- 5.13.4 Users of gas cylinders should therefore be aware of the requirements for their cylinders and maintain appropriate records. Further information is set out in the International Carriage of Dangerous Goods by Rail (RID) and the International Carriage of Dangerous Goods by Road (ADR) Regulations (refs 30 and 31).



- No attempt should be made to extinguish an outbreak of fire involving burning fuel gases until the gas supply has been shut off. (5.14.1)

## 5.14 Fire protection

- 5.14.1 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; the area should be evacuated and the fire brigade should be called immediately.
- 5.14.2 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.
- 5.14.3 An appropriate number of fire extinguishers, 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. All such extinguishers should be approved and certificated by an independent, third-party accredited certification body. The extinguishers should be provided in easily accessible positions as set out in BS 5306-8: *Fire extinguishing installations and equipment on premises. Selection and installation of portable fire extinguishers. Code of Practice* (ref 32) and maintained in accordance with BS 5306-3: *Fire extinguishing installations and equipment on premises. Commissioning and maintenance of portable fire extinguishers. Code of Practice* (ref 33).
- 5.14.4 Consideration should be given to water spray or automatic sprinkler protection in situations where significant numbers of cylinders of fuel gases are stored. Sprinkler systems should be installed and maintained in accordance with the requirements of the *LPC Rules for automatic sprinkler installations incorporating BS EN 12845: Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance* (ref 34).

## 6.0 Checklist

6.1 Compliance with fire safety legislation (Section 5.1)		Yes	No	N/A	Action required	Due date	Sign on completion
6.1.1	Has a suitable and sufficient fire risk assessment been undertaken for all premises to which the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland) applies? (5.1.1)						
6.1.2	As well as the staff handling and using gas cylinders, does the assessment consider staff and others remote from the process area who may be affected by smoke and heat in the event of a fire? (5.1.2)						
6.1.3	Has an assessment been undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (as amended in 2015)? (5.1.3)						
6.1.4	Are the risk assessments subject to periodic review? (5.1.4)						
6.2 Business continuity (Section 5.2)							
6.2.1	Are staff aware that even a small fire can have a disproportionate effect on a business if it occurs in a critical area? (5.2.1)						
6.2.2	If it is intended that equipment is to be left operating without staff in attendance, has a specific risk assessment for the process been undertaken and appropriate control measures introduced? (5.2.2)						
6.2.3	Does the emergency plan address the implications of a fire, flood or other perceived disaster on all facets of the business model? (5.2.3)						
6.2.4	Are table top exercises held periodically to test the effectiveness and suitability of the emergency plans? (5.2.4)						
6.2.5	Has consideration been given to applying commercially available computer programs, such as the ROBUST software (Resilient Business Software Toolkit) that is available free of charge (ref 16), or similar product, to develop and check the adequacy of the plan? (5.2.5)						
6.3 Fire safety management (Section 5.3)							
6.3.1	Are the numbers of gas cylinders kept on site carefully managed and kept to the minimum compatible with operational needs? (5.3.1)						
6.3.2	Has reference been made to the fire and rescue service so as to be aware of the levels of response in the areas in which the premises are located and is this information considered when undertaking and reviewing their fire risk assessments? (5.3.2)						
6.3.3	Are site plans available for the emergency services? (5.3.3)						
6.3.4	Are users able to recognise the gas cylinders that they routinely use and understand the properties of the gases they contain? (5.3.4)						
6.3.5	Are cylinders always treated with care? (5.3.5)						
6.3.6	Are only cylinders that are properly labelled and colour-coded accepted from the supplier? (5.3.6)						
6.3.7	Is any damage or contamination of a cylinder reported immediately to the supplier? (5.3.7)						
6.3.8	Are staff aware that no attempt should be made to modify a gas cylinder for any other use? (6.3.8)						
6.3.9	Are designated smoking areas outside the premises at least 10m away from gas cylinder stores? (5.3.9)						

	Yes	No	N/A	Action required	Due date	Sign on completion
6.3.10						
Are employers responsible for loading or unloading vehicles aware of their responsibilities under the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009? (5.3.10)						
6.3.11						
Are appropriate security precautions in place to protect against arson and vandalism where gas cylinders are stored in the open air? (5.3.11)						
<b>6.4</b>	<b>VICES (Section 5.4)</b>					
6.4.1						
Are the VICES principles applied to the use and storage of gas cylinders? (5.4.1)						
6.4.2						
Is suitable staff training in place to ensure all personnel are aware of the hazards associated with the use of gas cylinders in the workplace and can apply VICES to ensure a safer working environment for all? (5.4.2)						
<b>6.5</b>	<b>Ventilation (Section 5.5)</b>					
6.5.1						
Where cylinder storage has to be within a building, is good natural ventilation provided? (5.5.1)						
6.5.2						
Is adequate ventilation, as determined by a DSEAR assessment, provided at high and low levels by natural or mechanical means to prevent the concentration of a release of vapour from accumulating to within the explosive limits of the most hazardous gas likely to be present? (5.5.2)						
6.5.3						
Are the ventilation openings provided direct from the storage area to the outside? (5.5.3)						
6.5.4						
Where mechanical ventilation is used, does it provide at least six air changes per hour with vents positioned so as to provide cross-flow? (5.5.4)						
6.5.5						
Where mechanical ventilation is installed, is the location of the exhaust outlet subject to a risk assessment in compliance with DSEAR? (5.5.5)						
6.5.6						
Has the ducting been designed in accordance with best practice? (5.5.6)						
6.5.7						
Is the extract ductwork for flammable vapours free of fire dampers? (5.5.7)						
6.5.8						
Is explosion venting in the form of non-combustible lightweight roofing or walling provided according to the findings of a risk assessment? (5.5.8)						
<b>6.6</b>	<b>Sources of ignition (Section 5.6)</b>					
6.6.1						
Where possible, is electrical equipment and wiring located outside areas where gas cylinders are stored? (5.6.1)						
6.6.2						
Has an assessment of the lightning risk been undertaken in accordance with BS EN 62305 and the requirements of RC35? (5.6.2)						
6.6.3						
Is heating suitable for the hazard zone in which the cylinders are being stored or used? (5.6.3)						
6.6.4						
Are cylinders positioned at least 1m away from heaters or steam pipes? (5.6.4)						
6.6.5						
Are heating installations and equipment maintained according to the manufacturer's instructions? (5.6.5)						
6.6.6						
Is vigilance maintained against deliberate fire setting at all times? (5.6.6)						
<b>6.7</b>	<b>Containment (Section 5.7)</b>					
6.7.1						
Are staff aware that gases should not be deliberately released from gas cylinders, even from those that are nominally empty? (5.7.1)						

<b>6.8 Exchange (Section 5.8)</b>		Yes	No	N/A	Action required	Due date	Sign on completion
6.8.1	Wherever practicable, is the use of gas cylinders minimised in the workplace, are hazardous materials replaced with less hazardous substances and are large cylinders replaced with those of smaller capacity when possible? (5.8.1)						
<b>6.9 Separation (Section 5.9)</b>							
6.9.1	Does the separation of gas cylinders from everyday work processes and routines follow the recommendation outlined in section 5.10? (5.9.1)						
<b>6.10 Storage (Section 5.10)</b>							
6.10.1	Are designated storage areas used solely for the storage of gas cylinders? (5.10.1)						
6.10.2	Are full cylinders stored separately from nominally empty cylinders and are cylinders of different gases segregated from each other? (5.10.2)						
6.10.3	Are cylinders stored with their valves uppermost? (5.10.3)						
6.10.4	Are protective valve covers used when the cylinders are not in service? (5.10.4)						
6.10.5	Are gas cylinders securely supported on trolleys, within racks or fixed to structural features using welded steel chain? (5.10.5)						
6.10.6	Are storage areas readily accessible but secure to prevent access by unauthorised persons? (5.10.6)						
6.10.7	Are doors or gates to cylinder storage areas provided with ramped access and sufficiently wide to allow the passage of trolleys? (5.10.7)						
6.10.8	Are permanent warning notices prominently displayed at storage areas? (5.10.8)						
6.10.9	Do storage arrangements ensure adequate turnaround of stock and allow for strict stock rotation of full cylinders? (5.10.9)						
6.10.10	Are oxygen cylinders stored in a different enclosed storage area from cylinders of LPG or other flammable gases? (And in external storage areas, are oxygen cylinders stored in a different cage or more than 3m away from cylinders of any fuel gas? (5.10.10)						
6.10.11	Are compressed gas cylinders stored more than 3m from any LPG cylinder in excess of 50kg capacity? (5.10.11)						
6.10.12	Is storage on a compacted, level, load-bearing surface, preferably concrete or paved? (5.10.12)						
6.10.13	Are gas cylinders stored or handled in areas that are not liable to flooding? (5.10.13)						
6.10.14	In large areas where cylinders of different classes of gas are stored, is consideration given to the provision of radiation barriers? (5.10.14)						
6.10.15	Are cylinders stored in the open enclosed within a compound located at least 4m from boundary fences, buildings and structures? (5.10.15)						
6.10.16	Is the gas cylinder compound securely fenced? (5.10.16)						
6.10.17	To shade cylinders from direct sunlight, is an open-sided weather covering of non-combustible construction used? (5.10.17)						
6.10.18	Are the compound and adjacent areas kept clear of combustible materials, such as idle pallets and vegetation? (5.10.18)						
6.10.19	Are gas cylinder compounds and any pipelines prominently signed and protected from impact by vehicles? (5.10.19)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.10.20	Are internal cylinder stores located above ground level? (5.10.20)						
6.10.21	Where possible, is gas cylinder storage in a detached building constructed of non-combustible materials and located as far as practicable from other buildings and has explosion venting been considered? (5.10.21)						
6.10.22	If cylinders are stored within part of a building used for some other purpose, are the conditions set out in section 5.10.22 observed? (5.10.22)						
6.10.23	Are cylinders stored in a cool area? (5.10.23)						
6.10.24	Are proprietary storage cabinets complying with BS EN 14470-2 used to house gas cylinders? (5.10.24)						
6.10.25	Has the provision of a leak detection system with remote monitoring been considered? (5.10.25)						
<b>6.11 Security (Section 5.11)</b>							
6.11.1	Are areas where cylinders of nitrous oxide and Entonox are stored subject to a specific security review? (5.11.1)						
6.11.2	Where nitrous oxide or Entonox are stored, is the structure of brick or block construction rather than welded mesh and does it comply with the guidance set out in paragraphs 5.10.20 to 5.10.25? (5.11.2)						
6.11.3	Do entrance doors provide an appropriate degree of security protection and are they fitted with locks/electronic access control systems and intruder alarms in consultation with the insurers of the property? (5.11.3)						
6.11.4	Are keys to the cylinder store signed in and out with dates and times with the doors being kept locked at all times when the store is not in use? (5.11.4)						
6.11.5	Is the delivery and collection of gas cylinders from the store by the supplier monitored? (5.11.5)						
6.11.6	Is the store located where it can be readily observed and has serious consideration been given to providing monitoring by CCTV? (5.11.6)						
6.11.7	Is there suitable stock management of nitrous oxide and Entonox cylinders to ensure any missing stock can be readily identified? (5.11.7)						
6.11.8	Will the police, the insurer and the supplier of the gas cylinders be notified immediately if any theft has been established? (5.11.8)						
<b>6.12 Use (Section 5.12)</b>							
6.12.1	When preparing cylinders for use, is the best practice set out in section 5.12.1 followed? (5.12.1)						
6.12.2	Are the gas cylinders of LPG-fuelled trucks changed in areas away from those where highly flammable or flammable liquids are stored or used? (5.12.2)						
6.12.3	Are cylinder valves only opened with a proper key? (5.12.3)						
6.12.4	Are staff aware that there should never be a transfer of gas to another cylinder for mixing of gases or for any other reason? (5.12.4)						
6.12.5	Are staff aware that no attempt should be made to remove an individual cylinder from a manifold cylinder pallet? (5.12.5)						
6.12.6	Are cylinders in use kept well clear of all heat sources, especially oxy-fuel gas torches and electrical welding tools? (5.12.6)						
6.12.7	Is grease or oil never allowed to come into contact with cylinders, their valves or equipment? (5.12.7)						

	Yes	No	N/A	Action required	Due date	Sign on completion
6.12.8						
6.12.9						
6.12.10						
6.12.11						
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6.12.23						
6.12.24						
6.12.25						
6.12.26						
<b>6.13 Maintenance (Section 5.13)</b>						
6.13.1						
6.13.2						
6.13.3						
6.13.4						

6.14 Fire protection (Section 5.14)		Yes	No	N/A	Action required	Due date	Sign on completion
6.14.1	Have staff been made aware that no attempt should be made to extinguish an outbreak of fire involving burning fuel gases until the gas supply has been shut off? (5.14.1)						
6.14.2	Has provision been 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? (5.14.2)						
6.14.3	Is suitable access to the storage area provided for firefighting? (5.14.2)						
6.14.4	Is there an appropriate number of fire extinguishers, of a type suitable for extinguishing fires in nearby materials, provided in the vicinity of all areas in which gases are used or stored? (5.14.3)						
6.14.5	Has consideration been given to water spray or automatic sprinkler protection in situations where significant numbers of cylinders of fuel gases are stored? (5.14.4)						

1. RC49: *Recommendations for the storage, handling and use of acetylene cylinders*, 2016, Fire Protection Association.
2. *Fire and hazardous substances*, electronic download available from the members' section of the FPA website: [www.thefpa.co.uk](http://www.thefpa.co.uk).
3. Information available from the British Compressed Gases Association website: [www.bcga.co.uk](http://www.bcga.co.uk).
4. BS EN 1089-3: 2011, *Transportable gas cylinders. Gas cylinder identification (excluding LPG). Colour coding*, British Standards Institution.
5. BS EN ISO 13769: 2009: *Gas cylinders. Stamp marking*. British Standards Institution.
6. BS EN ISO 7225: 2007 + A1: 2012: *Gas cylinders. Precautionary labels*. British Standards Institution.
7. BS 349: 1973: *Specification for identification of the contents of industrial gas containers* (superseded), British Standards Institution.
8. Regulatory Reform (Fire Safety) Order 2005, SI 2005 No 1541, The Stationery Office.
9. The Fire (Scotland) Act 2005, asp 5, The Stationery Office.
10. Fire Safety (Scotland) Regulations 2006, Scottish SI 2006 No 456, The Stationery Office.
11. Fire and Rescue Services (Northern Ireland) Order 2006, SI 2006 No 1254 (NI9), The Stationery Office.
12. Fire Safety Regulations (Northern Ireland) 2010, SI 2010 No 325 (NI), The Stationery Office.
13. Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), 2002, SI 2002 No 2776 (as amended in 2015), The Stationery Office.
14. RC42: *Recommendations for fire safety of unattended processes*, 2011, Fire Protection Association.
15. *Business resilience: A guide to protecting your business and its people*, 2005, Fire Protection Association.
16. The ROBUST software (Resilient Business Software Toolkit) may be found at <https://robust.riscauthority.co.uk>
17. Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, SI 2009 No 1348, The Stationery Office.
18. RC48: *Arson prevention. The protection of premises from deliberate fire raising*, 2010, Fire Protection Association.
19. HSG 51: *Storage of flammable liquids in containers*, 2015, Health and Safety Executive.
20. The Control of Substances Hazardous to Health Regulations 2002, SI 2002/2677 (as amended), The Stationery Office.
21. BS 5925: 1991, *Code of practice for ventilation principles and designing for natural ventilation*, British Standards Institution.
22. BS EN 62305: *Protection against lightning* (several parts), British Standards Institution.
23. RC35: *Protection of buildings against lightning strike*, 2013, Fire Protection Association.
24. *Approved Document B: Fire Safety (Volume 2) – Buildings other than dwellinghouses Incorporating Insurers' Requirements for Property Protection*, 2015, RIBA.
25. BS EN 14470-2: *Fire safety storage cabinets. Safety cabinets for pressurised gas cylinders*, 2007, British Standards Institution.
26. CP4: *Industrial gas cylinder manifolds and distribution pipework (excluding acetylene)*, Rev 4:2012, British Compressed Gas Association.
27. BS EN ISO 3821: 2010: *Gas welding equipment. Rubber hoses for welding, cutting and allied processes*, British Standards Institution.
28. BS 3212: 1991: *Specification for flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations*, British Standards Institution.
29. RC7: *Hot work*, 2012, Fire Protection Association.

30. International Carriage of Dangerous Goods by Rail (RID), 2011, United Nations Economic Commission for Europe.
31. International Carriage of Dangerous Goods by Road (ADR) Regulations, 2011, United Nations Economic Commission for Europe.
32. BS 5306-8: 2012: *Fire extinguishing installations and equipment on premises. Selection and positioning of portable fire extinguishers. Code of practice*, British Standards Institution.
33. BS 5306-3: 2009: *Fire extinguishing installations and equipment on premises. Commissioning and maintenance of portable fire extinguishers. Code of practice*, British Standards Institution.
34. *LPC Rules for automatic sprinkler installations incorporating BS EN 12845: Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance*, British Standards Institution, 2009, Fire Protection Association.

#### **Further reading**

##### **British Standards Institution**

BS EN 13463-1: 2009: *Non-electrical equipment for potentially explosive atmospheres. Basic method and requirements*, British Standards Institution.

##### **Health and Safety Executive**

L138. *Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved code of practice and guidance*, 2nd edition, HSE Books, 2013.

##### **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.

**Note:** The LP Gas Association (LPGA) documents listed above can be obtained from UKPLG. (UKPLG was formed by the merger of the LP Gas Association (LPGA) and the Association for Liquid Gas Equipment and Distributors (ALGED) in January 2008).

##### **Other**

*Health Technical Memorandum HTM02-01: Medical gas pipeline systems: Part A: Design, installation, validation and verification*, Department of Health.

*Health Technical Memorandum HTM02-01: Medical gas pipeline systems: Part B: Operational management*, Department of Health.



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