Department
SHEW

Compressed Gases Safety

Guidance for Users of Compressed Gases (Code of Practice)

Document Information

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Code of Practice (CoP) on Safe Use of Compressed Gases

1 Introduction

Compressed gases, cylinders and associated systems are used widely at the University of Bath. This will include use in laboratories, workshops, plant rooms and infrastructure equipment, catering outlets or during maintenance or construction activities. Compressed gas systems are also provided for firefighting in university buildings.

Compressed gases and associated systems are valuable tools for research, teaching, and other activities. However, the storage, handling and use of compressed gases can pose a range of risks (asphyxiation, toxicity, flammability, burns) and therefore they must be safely handled and managed to prevent harm and injury.

The principal legislation that applies to the use of hazardous gases is the Control of Substances Hazardous to Health (COSHH) Regulations. For flammable gases, there is the additional consideration of the Dangerous Substances and Explosives Atmospheres Regulations (DSEAR). Gas cylinders that are connected to manifolds; a gas distribution system that connects multiple gas lines and junctions into a single channel, are classed as pressure systems and therefore the relevant legislation (the Pressure Systems Safety Regulations 2000) should also be followed.

This Code of Practice (CoP) sets out the University of Bath's requirements for users of compressed gas cylinders to assess and manage the risks, so far as reasonably practicable, arising from the storage, handling, and use of compressed gas cylinders and associated equipment. Users should also refer to specific guidance depending on the type of compressed gas(es) and systems they may be using:

- Controlling fire and explosion risk safety standard
- Safe use of cryogenic materials safety standard
- Safe use of pressure systems

This CoP takes into consideration relevant legislation and standards from recognised UK bodies such as the British Compressed Gases Association (BCGA).

2 Scope

This CoP covers the use of compressed gas cylinders used on university premises, that could be stand-alone cylinders connected directly to equipment or cylinders connected to delivery systems such as manifolds. A gas cylinder is a transportable pressure receptacle of a water capacity not exceeding 150 litres.

This guidance note covers all types of compressed gas cylinders used and stored on university property containing a variety of gases for many different purposes such as:

- Welding using gases such as acetylene.
- Laboratory instrumentation using asphyxiant, toxic and flammable gases for operation, testing and calibration.
- Gloveboxes where a specific atmosphere is required for stability of processes or protection of materials.

- Events such as barbeques where LPG is used.
- Social areas which provide drinks that may require gases such as carbon dioxide.

3 Planning and Risk Assessment

The requirement for hazardous gas supplies needs to be considered at the planning stage of introducing new equipment/instrumentation and refurbishing, and/or installing a new work area such as a laboratory. This should include an initial assessment of significant risk considering the hierarchy of control to eliminate and control the hazards from using compressed gases.

3.1 Hazards

Hazards involved in using cylinders of compressed gas are:

1. Sudden release of stored energy
2. Properties of gas stored under pressure including flammability, explosive, toxicity, oxidising, asphyxiation, corrosiveness, or combinations of these properties.
3. Moving heavy objects – physical injury due to manual handling and impact

3.1.1 Inventory and Plan

Departments must hold an inventory (which could be incorporated within the annual hazard survey) that is updated regularly. The location of all gas cylinders should be identified on a fire plan, distinguishing between flammable and inert gases. A copy of the inventory and plan must be readily available in an emergency. These should be posted adjacent to main fire panels and a copy also provided to security.

A Safety Data Sheet (SDS) for all the types of gas in storage and in use should be readily available, within departments i.e. as electronic copy or paper copy held in areas where gases are used.

3.2 Control Measures

The hierarchy of control should always be applied when determining the control measures to prevent or reduce the hazards identified with using gas cylinders for a work area such as a laboratory or workshop.

Elimination – locating gas cylinders external to the building and outside within a purpose-built or designed storage area removes the hazard from persons present in the building. Also, dilution and dispersion of the gas in the event of a leak or release in an outside storage area prevents the hazard from being realised.

However, locating cylinders externally and piping gases into a building is not risk free. The hazards associated with the piped in gas delivery system will need to be risk assessed and control measures implemented to reduce these risks as low as reasonably practicable.

BCGA CP44 The Storage of Gas Cylinders applies to gas cylinders in use and connected to a gas supply delivery system.

CP44 also provides a definition of “outdoors” to ensure adequate ventilation:

A store is considered to be “outdoors” if either of the following conditions are met:

- a minimum of 30 % of the perimeter is open (naturally ventilated), with no roof installed;

- a minimum of 50 % of the perimeter is open (naturally ventilated), with a roof installed.

Where these conditions are not achieved the store is **not** outdoors.

Substitution – this includes use of least hazardous gas available for the purpose, minimum number of gas cylinders present (particularly if indoors) and smallest sizes where practicable, considering usage and number of cylinder changes.

There is a requirement under fire safety legislation to reduce the fire loading where it is practical to do so, and a particular duty to eliminate risks from "dangerous substances", which includes all flammable substances and all types of gas cylinders (including any non-flammable gases / asphyxiants), where it is reasonably practicable to do so. Where this is not practicable (for example where a less hazardous substance cannot be used instead) then other controls, such as restricting amounts held in a laboratory at any one time, must be implemented. These control measures must be documented in risk assessments.

Justification for gas cylinders not being located external to the building and outside must be documented in the risk assessment.

Ventilation – ventilation is an engineered control measure. Adequate ventilation should be provided in all workspaces. Where ventilation is being used as a control measure to mitigate gas release risks, then the type of ventilation provided will need to take account of the nature and hazardous properties of the gas being used and the size and location of the workspace.

The preferred option for gas cylinders should be by natural ventilation out in the open as this is the most effective way to achieve dilution and dispersal in the event of any release.

Where gas cylinders are to be located indoors:

1. For asphyxiant gases calculations should be made taking into consideration size of room and a reasonably foreseeable incident of a slow release from a single cylinder, to determine if unsafe oxygen levels can be realised. If oxygen depletion is identified as a risk, then ventilation will require improvement and/or oxygen monitors should be installed. Existing ventilation provided, e.g. air changes in a laboratory, may also be taken into consideration to qualify the assessment (e.g. if oxygen levels are close to unacceptable). An Excel calculator is provided in Appendix 2 and more detailed information can be found in BCGA CP52 Section 9.
2. Where gases are hazardous to health, such as toxic gases, then the risk assessment should identify if the relevant Workplace Exposure level (WEL) could be exceeded. If a WEL could be exceeded, then Local Exhaust Ventilation (LEV) will be required. The risk assessment should identify whether gas monitoring, in addition to LEV, is required.
3. For flammable gases, a DSEAR assessment must be completed to identify if there are any control measures required to manage fire and explosion risk. The level of controls required will depend on the foreseeability of gas being released and the likelihood that this will ignite. If a release of flammable gas is foreseeable, and the hazard cannot be eliminated or substituted, then adequate ventilation must be provided to dilute the concentration of the flammable gas to a safe level (below that which could form an explosive atmosphere). Additional control measures, such as ATEX rated electrical equipment or use of anti-static clothing may also be needed to reduce ignition risks.

If the use of gas cylinders within a building is robustly justified, then the following measures must also be in place and documented as control measures within the risk assessment.

- Display appropriate warning signs and emergency procedures on entry doors to the workspace.
- Secure individually and vertically to a stable structure such as wall or fixed bench.
- Do not store beside doors or on escape routes.
- Keep below 50 °C as there is an increased risk of over-pressurisation and gas discharge or rupture in the event of them being subject to elevated temperatures.
- Use of low oxygen and/or other gas monitoring systems where risk of asphyxiation or exposure to other health hazards from a release of gas is identified in the risk assessment.
- Keep away from sources of heat or ignition.
- Not placed where objects may strike or fall on them, possibly damaging the cylinders or their components.
- They are not obstructed or in difficult areas to reach to enable access for changing regulators, cylinders, etc.
- Cylinders not in use should be returned to an external store as soon as possible. Regulators must be removed before transporting the cylinder.
- Do not drag, roll, or slide cylinders. Cylinders should be secured in appropriate trolleys when being transported.

3.3 Documentation and Training

All users of gas cylinders must receive training appropriate to their use and handling of gas cylinders. For example, a person responsible for the setup/assembly of a gas delivery system will require a higher level of training than a user of equipment connected to gas cylinders. The completion of this training must be recorded.

Documentation such as a Safe Operating Procedure should be in place along with the risk assessment for use of the gas cylinder and associated equipment. This documentation should be used as the basis for specific user training and should detail:

- Pressure and safety device settings
- User checks
- What to do if fault identified
- Emergency procedures, e.g. in event of a leak, fire or alarm sounding – these should be tested to ensure understanding and that they work

4 Guidance for Safe Use

The following is a summary of general guidance taken from referenced sources, that should be noted in training and documentation for users of gas cylinders.

- Only use cylinders filled by a reputable gas supplier who fills and regularly tests cylinders in accordance with current regulations.
- Cylinders must be clearly marked/labelled with the content of the gas/es inside. If label is not clear or missing, do not use and return to supplier.

- Persons using cylinders, e.g., connecting to equipment, should receive appropriate training and wear required PPE (as identified in the risk assessment).
- Do not connect gas cylinders to any equipment other than the primary regulator.
- Before connecting a pressure regulator or any other fitting to the cylinder valve, check the valve is closed, then ensure that the cylinder valve outlet is clean, dry, and free from damage, dirt, and contamination. If cylinders or any components appear damaged or dirty, then the cylinder must not be used, and the provider informed so that they can rectify.
- Safety devices and valves shall not be tampered with, nor repairs attempted including use of oil/ lubricants.
- Cylinders must have means of closing valve (i.e., hand-wheel or suitable spanner). Any cylinder with a valve that cannot be opened by hand or using a suitable tool must not be used.
- Gases must never be mixed inside cylinders.
- Cylinder valves to be closed when not in active use.
- Cylinders, cylinder valves, couplings, regulators, hoses, and apparatus should be free of oily or greasy substances. This is especially important for oxygen cylinders. Not observing this requirement may result in an explosion.
- Always keep the cylinder valve free of obstructions such as tools, rags, and hoses etc. to permit easy and immediate gas cut off.
- Notify the supplier if you suspect that a contaminant has entered the cylinder.
- Gas cylinders used within buildings should be moved to external stores when not in use and when empty. These should be stored separate form full cylinders where practicable.

4.1 Gas delivery system

A simple gas delivery pressure system will consist only of a pressure regulator, safety devices, such as a non-return valve, and a hose assembly which will supply the output from the pressure regulator to the process equipment.

All equipment which is in contact with a gas must be compatible with that gas.

Always refer to the manufacturers' / suppliers' instructions for the correct and safe use of all equipment and materials used. This includes any maintenance, testing and replacement requirements.

Tape should not be used to secure connections. Damaged or leaking equipment should be taken out of service and replaced.

4.1.1 Pressure Regulators

A pressure regulator is a mechanical device fitted to the outlet of the gas cylinder valve. The pressure regulator reduces the pressure of the gas from the cylinder pressure to the lower pressure required for the operation of the process equipment.

- A pressure regulator shall not be used with any gas other than that for which it is designed and labelled. It shall be suitable for the maximum cylinder pressure being used. Once a

pressure regulator has been in service with a particular gas it shall remain in that gas service for the remainder of its life.

- Where appropriate, regulators should conform to a recognised standard such as BS EN ISO 2503
- Regulators should be labelled with the following information:
    - Gas being used for; for multi-use regulators it must be labelled with the gas first used.
    - Name of manufacturer.
    - Maximum inlet and outlet pressure.
    - Expiry/replacement date.
- Pressure regulators should be kept free of dust, debris, oil, grease, solvents or any other contaminants. Regulators are sensitive piece of equipment and must be handled carefully and appropriately stored when not in use.
- Regulators to be regularly checked that they are in date and for any damage or contamination.
- A regulator replacement programme should be implemented based upon BCGA CP47 Guidelines; replacement every 5 years.
- Store out of use regulators carefully so that they are not jarred or knocked, in clean dry conditions and with protective covers over gas ports.

4.1.2 Safety Devices

This includes flashback or flame arrestors and non-return valves. A flashback arrestor (also known as a flame arrestor) is a device which arrests a flame front (caused by flashback or decomposition), and which is suitable for the most severe type of flame, which may occur, i.e. detonation. It is effective in stopping a flame coming from either one or both directions depending upon the application and design.

- Inert gases, or mixtures of inert gases, do not require flashback arrestors and non-return valves fitted in the system.
- Safety Devices shall comply with a recognised standard such as BS EN ISO 5175-1 for flame arrestors and BS EN ISO 5175-2 for non-return valves.
- Fit a flashback arrestor when using cylinders containing flammable (e.g., propane, acetylene, hydrogen) or oxidising gases (e.g., oxygen) to prevent flames travelling back into cylinders.
- For acetylene a minimum of a 3-function flame arrestor shall be placed within one metre of the pressure regulator. (The Acetylene Safety (England and Wales and Scotland) Regulations).
- A safety device replacement programme should be implemented based upon BCGA CP47 Guidelines; replacement every 5 years for flashback arrestors (or manufacturers recommendation).

- Non-return valves shall be capable of preventing backflow of gases at low and high pressures.
- Where more than one gas is used simultaneously the use of non-return valves should be considered.

4.1.3 Hose Assembly

Hose assemblies are the means by which the gases are conveyed from the pressure regulator to the process equipment. Hose assemblies can be used to convey the gas from the cylinder to the process equipment at pressures up to the maximum regulator outlet pressure. The hose provides a flexible connection between the pressure regulator, safety device(s) and the process equipment. A hose assembly consists of a hose tail inserted into the end of a flexible hose and secured by a suitable hose clamp.

- Use hoses that comply with a recognised standard such as BS EN ISO 3821, and connections that comply with BS EN 560.
- Always use hoses compatible with the gas being used and the pressure required.
- Hoses should clearly identify the gas being used, either by gas name or adopt standard colour coding: See Table 1 in CP47.
- Use correct hose connections, properly fitted, and secured using suitable clips; cable ties are not suitable connectors.
- Use proper connectors to couple hoses together if required such as metal or plastic hose clips, never use tape to connect or extend hoses. The need to extend hoses should be avoided where possible by positioning the gas cylinder close to equipment to minimise hose length.
- Protect hoses from heat, mechanical damage, sparks, oil, grease and other contaminants by positioning away from working area. Do not put hoses above ceiling tiles. Do not trail on the floor. Do not coil around the cylinder.
- Hoses with excessive contamination, damage or wear should be taken out of service and replaced.
- Plastic tubing, of the sort normally encountered in laboratories that is not designed or rated for use with gases, is not recommended for use. Manufacturers requirements must be followed and typically this tubing should only be used for inert gases. For additional information on plastic tubing refer to BCGA CP4 (Appendix A3.2).

4.1.4 Auto Change Unit

This is a device used to ensure continuity of supply between dual system gas supplies, normally situated in the manifold header and set to automatically change from the service bank to the reserve bank at a predetermined pressure. This device commonly has integral pressure regulators. If it does, then it should be treated in the same way as a pressure regulator including replacement every 5 years. Where pressure regulators are not an integral part of the unit a main pressure regulator is still required, and manufacturer's instructions should be followed for maintenance requirements including replacement frequency.

4.2 Maintenance and Inspection

For gas cylinders, the owner, who is normally the gas supplier, has responsibility for inspection and maintenance. Departments should ensure that they know who the owner is and who has responsibility for the maintenance and inspection to ensure it is being completed.

For the gas delivery system (unless integral to the cylinder) the responsibility is with the user. The following user checks should be carried out and recorded:

4.2.1 Assembly Check

- The equipment is to be assembled in accordance with the manufacturer's instructions and checked during and after assembly by trained persons.
- All appropriate equipment to be installed in the correct order, with visual check that completed correctly.
- Check equipment is suitable and safe for use: compatibility with the gas, pressure rating, direction of flow, presence of damage, oil, grease or other contamination.
- Check for leaks especially at connections when equipment is assembled. Only proprietary leak testing kits should be used for this purpose.

4.2.2 Pre-Use Checks

- Check the gas is the correct one required for the work.
- Check regulator and hoses are correct ones for gas being used and are fixed correctly.
- Check regulator is in date.
- Check for any dirt, oil, grease and other contamination particularly at connections.
- Check for any damage or faults
- Ensure any required safety devices are fitted and are in date where required
- Inspect hoses for damage e.g., kinking, twisting, cracking, abrasion.
- Leak testing of all joints at working pressure for regulators and flame arrestors should be carried out in accordance with BCGA requirements, a table is reproduced in Appendix 1.

4.2.3 During or After Use

Any defects or faults that occur during or observed after use should be reported and rectified. The equipment may need to be taken out of service and the equipment should be clearly labelled to ensure it is not used.

If any damage or potential leak is suspected, then leak testing should be carried out to check integrity of joints.

4.2.4 Annual Checks

Annual Checks are required for pressure regulators, safety devices and hose assemblies. As well as visual inspection for damage, life, etc leak testing such as a creep test to ensure regulator integrity is also required for pressure regulators and flame arrestors.

To creep test, isolate the downstream side of the gas regulator by closing the regulator outlet valve, instrument valve or process isolation valve. Close the regulator by turning the adjustment knob counterclockwise until it reaches stop or rotates freely. Slowly turn on the gas supply. When the regulator inlet gauge registers full cylinder delivery pressure, shut off the gas supply. Turn the regulator adjusting knob clockwise until delivery pressure gauge reads approximately half of scale (i.e. 50 psi on a 100 psi gauge). Close the gas regulator by turning the adjustment knob counterclockwise until it rotates freely or reaches the stop. Note the reading on delivery pressure gauge. Wait 15 minutes and recheck the setting on delivery pressure gauge. If any rise in delivery pressure is detected during this time, the regulator is defective. Remove and replace.

A detailed summary of all required checks and testing is provided in Appendix 1 taken from BGCA CP47.

4.2.5 Closing Down Procedure

The gas cylinder and process equipment should be closed down (i.e., cylinder valve turned off) according to the manufacturer's instructions if the equipment is not to be used for 5 or more days.

To close down the gas delivery equipment:

- Close the cylinder valve.
- Vent away the small amount of residual gas via the process equipment.
- Turn the regulator pressure adjusting screw to the zero delivery position (by turning anticlockwise).
- Close the flow-meter valve if fitted.

4.2.6 Inspection

Checking gas cylinders and storage areas should be included on routine departmental inspections.

Individual gas cylinders should be checked that they meet the requirements of this guidance and references and should include:

- Gas cylinder is in use and not being stored inappropriately, e.g. inside a building particularly if empty
- Pressure Regulator in date and is correct type for gas usage
- Safety devices such as flame arrestors are present and in date, where required
- Hoses are correct type for gas use, in good condition and connections made with appropriate clips

Storage areas particularly those outside should also be periodically checked to ensure they are in clean and good condition, not being used for other storage (particularly combustibles where there are flammable gases) and kept secure. This applies to storage areas when not in use. Stores such as cages which are damaged, rusting, etc. should be taken out of use and removed if not needed.

4.3 Handling and Transport

The following should be observed when handling/transporting cylinders:

- Persons handling cylinders should receive appropriate training.
- Wear correct Personal Protective Equipment (PPE) as identified in the risk assessment.

- Use a purpose designed cylinder trolley for long distances, with cylinders secured with a chain or strap.
- 'Churning' may be used for short distances (<5m) on level floor by trained persons.
- Valve must be closed, and protective valve cover in place.
- Remove regulator and hoses before transport and when empty.
- Don't use the protective valve caps for moving or lifting cylinders.
- Don't drop a cylinder or permit them to strike each other violently or be handled roughly. Do not attempt to catch a falling cylinder.
- Ensure transport route has been checked and is free from obstructions, uneven surfaces, etc.
- Do not transport cylinders in a car or other closed vehicle.

4.4 External and Outside Storage

A purpose-built external and outside store as detailed by the British Compressed Gas Association (BCGA) CP44 should always be used where reasonably practicable.

Gas cylinders are designed so that they can be stored outdoors and, as such, they will not be adversely affected by inclement weather conditions in the UK.

- Store should be in a secure location and have adequate security, e.g., locked with access limited to only necessary persons.
- Store must be cool, dry, and well ventilated, away from ignition sources and combustible material.
- The storage location shall take account of separation distances. Reference BCGA GN 41 [49], Separation distances in the gases industry.
- There shall be adequate, through and thorough ventilation. Ventilation is required to ensure that any small leakage of gas is adequately dispersed. Adequate ventilation will prevent or minimise the likelihood of a hazardous atmosphere being created.
- Unless thoroughly risk assessed, storage locations shall always be sited at ground level. If not possible then access for deliveries, cylinder changing etc. should be assessed.
- Cylinders must be stored in compatible groups i.e. flammables must be separated away from oxidizers. Fire walls from other buildings etc. may also be needed for flammables.
- Cylinders must be stored upright and secured from falling by chains and straps.
- Cylinders should be individually secured; using a single restraint strap around a number of cylinders is not acceptable.
- Valves of 'empty' cylinders must be closed to avoid contaminants (e.g., water) from entering cylinder. Remember 'empty' cylinders contain gas at least at atmospheric pressure.
- Keep valve protective caps in place when cylinders are not in use.
- Empty cylinders must be clearly marked and stored separately from cylinders which are full, or which contain gas.

- Provide adequate signage to provide safety information and warnings on the hazardous products being stored. These signs must comply with The Health and Safety (Safety Signs and Signals) Regulations.

4.5 References

BCGA CP43 The safe filling of gas cylinders. 2018

BCGA CP44 The storage of gas cylinders. Revision 1: 2022

BCGA CP47 The safe use of individual portable or mobile cylinder gas supply equipment. Revision 1: 2018

BCGA CP7 The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply)

BCGA CP4 Gas supply and distribution systems (excluding Acetylene)

BCGA GN 41 [49], Separation distances in the gases industry

BCGA GN 3 Safe cylinder handling and the application of the manual handling operations regulations to gas cylinders

BCGA GN 23 Gas safety. Information instruction and training.

BCGA TIS 22 Connecting gas cylinders.

Note BCGA guidance documents can be downloaded here. You will be required to provide contact details if you wish to download these documents.

BS EN ISO 11114 Transportable gas cylinders. Compatibility of cylinder & valve materials with gas contents. Part 1, Metallic materials. Part 2, Non-metallic materials.

Dangerous Substances and Explosive Atmospheres Regulations 2002 Approved Code of Practice and Guidance L138 (Second edition) Published 2013

SHEW document Controlling fire and explosion risk

Appendix 1: Recommended BCGA Inspection and Testing Regime

The Information below is taken from the BCGA Code of Practice 47 The Safe Use of Individual Portable or Mobile Cylinder Gas Supply Equipment. This document includes guidance on inspection, testing and maintenance for pressure regulators, flame arrestors, and hose assemblies.

BCGA check frequency	**BCGA check to be made**
Inspection and Testing Regime: Pressure Regulators	
At assembly:	Check compatible with the gas. Ensure within life for use. Check the regulator inlet pressure is compatible with the maximum cylinder pressure. Ensure the Pressure Adjustment control is firmly fixed to the body and operates freely. Check the inlet and outlet connections sit square to the regulator's body. Check condition of threads and sealing surfaces. Ensure no signs of PTFE tape. Check both gauges on regulator naturally face the front and are undamaged. Ensure both gauge needles reset to zero. No oil, grease, or other contamination. Leak test all joints at working pressure
Before use:	Check body for any signs of soot, oil, grease, or other contamination. Check compatible with the gas. Ensure the Pressure Adjustment control is firmly fixed to the body and operate freely. Ensure the regulator gauges start at zero prior to use. Ensure the pressure rises on the high-pressure gauge when opening the cylinder outlet valve. Check the low-pressure gauge rises smoothly when setting the gas pressure. Leak test all joints at working pressure.
After use:	Check for any damage, contamination, defects, or faults. Check that gauges return to zero during the venting process.
Annually:	Full visual inspection. Check life dates. Functional tests to ensure correct operation. Typically, this will include a creep test to ensure regulator integrity.
Replacement / refurbishment interval:	5 years from date of manufacture or manufacturer's recommendations. Replace with a new, or refurbished unit

BCGA check frequency	BCGA check to be made
Inspection and Testing Regime: Flame Arrestors	
At assembly:	Check correct type fitted. Check manufacturing standard. Ensure within life for use. Check condition of threads and sealing surfaces. Check the Direction of Flow is correct. No oil, grease, or other contamination. Leak test all joints at working pressure. Check the Pressure sensitive cut-off valve button is not restricted / damaged / tied down.
Before use:	Ensure flame arrestors are fitted. Leak test all joints at working pressure.
After use:	Check for any damage, contamination, defects, or faults.
Annually:	Check unit for leaks, flow restrictions and reverse flow to ensure correct operation of non-return valves. Where pressure sensitive cut off valves are fitted, they shall operate at a pressure of no greater than 1.2 bar. If of a pressure sensitive type, check shut-off in the tripped condition in the direction of flow. Check life dates.
Replacement / refurbishment intervals:	5 years from date of manufacture or manufacturer's recommendations. Replace with a new, or refurbished unit.
Inspection and Testing Regime: Hose Assemblies	
At assembly:	Check the manufacturing standard. Check suitability of hose colour, internal bore size and length Check threads and sealing surfaces. Check hoses condition for damage (e.g. kinking twisting or cracking). Ensure HCV and Nut & Tails are fitted using correct ferrules and are located in the correct place. Leak test of all joints at working pressure.
Before use:	Ensure all the gas hose is unwound from gas cylinder trolley prior to use. Check hoses condition for damage (e.g. kinking twisting or cracking). Leak test of all joints at working pressure.
After use:	Check for any damage, contamination, defects, or faults.
Annually:	Reverse hose to ensure the correct operation of non-return valve where fitted. Bend hose in a tight radius to ensure reinforcement is not visible and there is no sign of collapse or distortion.
Replacement / refurbishment:	Determined by local operating conditions. Replace as required.

Appendix 2: Oxygen Depletion Calculator

The calculation of percentage of oxygen in the air after release of cylinder gas		
Room volume		
Length (metres)	0.0	The room dimensions
Width (metres)	0.0	
Height (metres)	0.0	
Room Volume (l*w*h)	0.0	
Volume of gas released		
Volume of gas [Litres]	0.00	cylinder contents at NTP
Volume of gas produced (Metre^3) (Vol_{gas}/1000)	0.000	volume converted to cubic metres
Percentage oxygen in room		
Vol_0 0.2095([Room Vol]-[Vol gas produced]	0.00	Volume of oxygen = [fraction of oxygen in air] times ([the volume of the room] - [volume of nitrogen liberated])
$\%O_2$ (100*[Vol_O]/[Room vol]	**#DIV/0!**	Volume of oxygen divided by the room volume times 100
Fill in the white boxes and read the percentage of oxygen from the red box. Assumptions - even mixing of gas in the room and no allowances for fittings and persons in the room.		
		ref: based on a calculator by BOC

Note: double click on spreadsheet, select worksheet object and then edit to use the calculator.

Oxygen Deficiency Symptoms

Oxygen Content (vol %)	Effects and Symptoms
18-21	No discernible symptoms can be detected
11-18	Diminution of physical and intellectual performance without person's knowledge
8-11	Possibility of fainting after a short period without prior warning
6-8	Fainting within a few minutes, resuscitation possible if carried out immediately
0-6	Fainting almost immediate, death ensues, brain damage if rescued

Note: Information taken from reputable gas association sources such as BOC

Appendix 3: Example of External Store and Trolley for Gas Cylinders