Compressed Gas Safety Policy

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1. Introduction

It is the policy of London Metropolitan University to ensure the health, safety and welfare of all its employees, of students while they are engaged in activities under the supervision of the University, contractors and of members of the public who have access to University property.

It is recognised that some areas across the University use compressed gas cylinders and gas installations as a critical part of their function, supporting teaching and research. It is therefore incumbent on those Schools and Professional Service Departments to manage the use, maintenance and inspection of these systems to ensure the safety of all those working or conducting research in the department.

2. Scope

This policy applies to all London Metropolitan University staff, students, contractors and other persons who use, handle, store, transport, maintain or work with compressed gas cylinders and associated gas installations as part of University activities.

It applies to the use of compressed gas cylinders and associated systems in teaching, research, Estates and other University activities, including the installation, operation, inspection, maintenance, storage and transportation of these systems.

Detailed practical requirements and advice for the safe use of compressed gas cylinders are provided in the University's Compressed Gas Safety Guidance, which should be read in conjunction with this policy.

This guidance does not cover natural gas installations which is a scope of a separate policy.

3. Definitions

The legal term that covers gas cylinders is 'transportable pressure receptacle'. This is a generic term covering a number of types of pressure receptacle: tube, pressure drum, cryogenic receptacle, bundle of cylinders as well as cylinders themselves, plus the valve(s) fitted directly to the receptacle. However, for the purpose of this policy and supporting guidance, the term "compressed gas cylinder" shall be taken to mean all these various types of pressure receptacle.

Handlers - Staff, students, researchers who transport compressed gas cylinders.

Users - Staff, students and researchers who use compressed gas cylinders.

4. Roles and Responsibilities

4.1 Deans of Schools/Directors

Deans and Directors are responsible for the day to day management of health and safety within their departments.

In the context of this document, Deans and Directors are responsible for ensuring staff and students comply with risk assessments, adhere to good practice when transporting, using and installing pressurised gas equipment and for their safety training. They must also ensure that gas cylinders and components are supplied by a reputable supplier (e.g. BOC, Air Products etc.).

Deans and Directors **must** seek approval from Estates if any work on existing piped gas systems or installation of a new gas manifold is planned.

4.2 Local Managers

It is the responsibility of a Manager / Supervisor to ensure that:

1. Appropriate risk assessment/s for work with compressed gas systems and cylinders are made and recorded and kept up to date by periodic review. See section 3 and 4 below and the Risk Assessment Policy for more details on risk assessment process.
2. Users/handlers of compressed gas systems and cylinders receive appropriate training (initial and refresher).
3. Any health monitoring and surveillance measures for users of compressed gas systems are identified in the risk assessment and implemented. Refer to Health Surveillance Policy.
4. Compressed gas hazard inventories are kept locally and regularly updated (when there is a change) and reviewed at least annually. They must be shared with the Fire Safety Advisor for updating the fire 'premises information boxes.'
5. Local Managers must monitor the inspection regime (see Compressed Gas Safety Guidance Appendix 2) of the gas cylinders and regulators and replace gas regulators according to the manufacturer instructions.
6. Inform Estates on any piped installation so the service and maintenance could be arranged.

4.3 Handlers and users

All those who handle or use compressed gas cylinders must know how to identify the contents of a cylinder, be aware of the hazards, have received training and have completed, read and understood all applicable risk assessments. Personal protective equipment required by the relevant risk assessment should be worn. Users and handlers must follow the safe operating procedures when working with gas cylinders described below in this Guidance. This includes carrying out inspections (see Compressed Gas Safety Guidance).

Users and handlers must report any defects with equipment or deficiencies in work practices to their Manager / Supervisor as soon as possible for remedial action.
Do not use failed or condemned equipment until it has been repaired and fully fit for use.

4.4 Suppliers and Manufacturers

All gas cylinders must be designed and manufactured to an approved standard to withstand everyday use and to prevent danger. They must be initially inspected before they are put into service to ensure they conform to the approved standard and they must be periodically examined at the required intervals to ensure that they remain safe whilst in service. All gas cylinders should have details of the relevant inspection body stamped or etched onto the shoulder area of each gas cylinder itself (Fig. 1). Suppliers must deliver properly labelled compressed gas cylinders with safety caps in place and delivery should be accompanied with a written certificate from the supplier.

Most gas cylinders in use within the University will be supplied on a rental basis by gas suppliers and should be from a reputable supplier (e.g. BOC, Air Products etc.) who will routinely carry out these tests (on annual basis). However, if any department purchases their own cylinders, then **THEY** must ensure they are regularly tested.

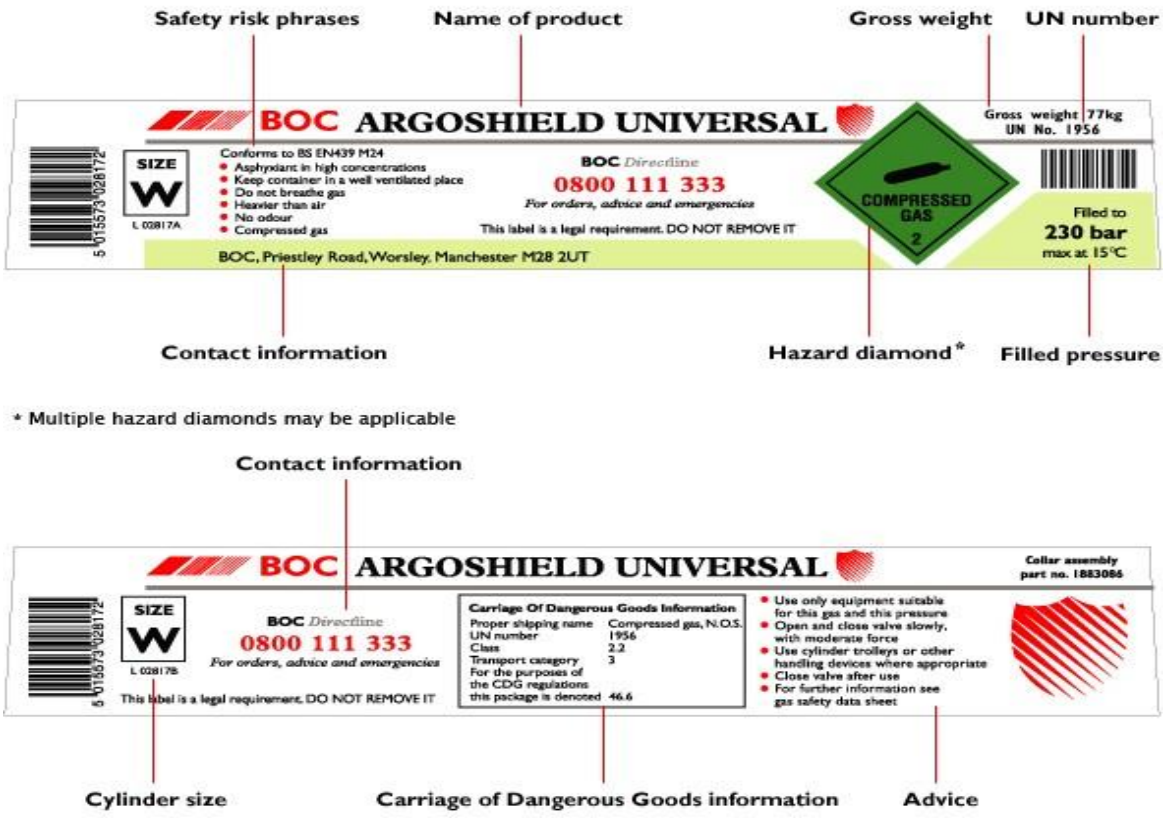


Fig. 1. Example of a Suppliers Label

It is the responsibility of compressed gas system suppliers to fully brief London Met client on the system safety and limitations.

4.5 Estates

It is responsibility of Estates to maintain and inspect gas manifolds and piped gas systems on University Premisses.

4.6 Health and Safety Team

The Health and Safety Team exists to help all schools and departments in effectively managing health and safety by providing advice and guidance on all workplace activities, including gas safety and gas supply installations.

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5. Procedures / Key Requirements

Risk Assessment

A risk assessment must be carried out to include the storage, handling, transporting, labelling and use of gas cylinders as well as procedures to deal with emergencies. Normally this will be done using the University's standard risk assessment form. See the Risk Assessment Policy for the details of the process. Departments should review their risk assessments especially if the circumstances in which particular cylinders are used change, leaving the original risk assessment invalid, e.g. cylinders are being transported in lifts or being used in confined spaces.

In 2016, an explosion of a pressure gauge during research work involving pressurised gases resulted in a PostDoc losing her arm. It was identified, that the most likely immediate cause of the accident was an electrostatic discharge between the postdoctoral researcher and the gas storage tank which led to this laboratory explosion. This incident highlighted the importance of conducting an adequate risk assessment for the whole process of using gas, as well as the experiment environment.

6. Information, Instruction and Training

All staff and students who use and/or handle gas cylinders or change regulators require to be suitably trained and have the necessary skills to carry out their job safely. They should understand the risks associated with the gas cylinder and its contents.

- New staff or students using gas cylinders should receive induction training and be supervised closely. Training should include safe handling and storage practices, identification, signage, storage, transportation, use and emergency procedures.

- Users should be able to carry out an external visual inspection of the gas cylinder, and any attachments (e.g. valves, flashback arresters, and regulators), to determine whether they are damaged.
- Users should satisfy themselves that the manufacturing requirements have been carried out by examining either the written certificate accompanying the gas cylinder or the stamp or mark of the relevant inspection body on the gas cylinder itself.
- Gas Safety training is organised via CPED and includes gas safety awareness training, gas safety practical handling course and manual handling courses for all staff and students who handle and transport cylinders.

Unless included in the practical session, further specialist training is required for any member of staff who examines or inspects gas regulators as part of an annual maintenance programme (usually this would be local manager). Within departments this individual will be recognised as the “competent” person.

7. Records and Monitoring

Departments must maintain appropriate records relating to the inspection, examination, maintenance and testing of gas cylinders and associated systems. Detailed requirements for records and monitoring are set out in the Compressed Gas Safety Guidance.

8. Legislation and Standards

The main sets of Regulations referred to in this document are:

- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (SI 2009 No. 1348)
- The Pressure Equipment Regulations 1999 (SI 1999/2001).
  These cover within their scope the design, manufacture and initial integrity of cylinders used in breathing appliances and portable fire extinguishers, together with valves and other accessories used with these gas cylinders, which have a direct safety function.
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 (SI 2776/2000).
- The Pressure Systems Safety Regulations 2000 (SI128/2000).

9. References

Health and Safety Executive

- HSE Website https://www.hse.gov.uk/
- Safe Use of Gas Cylinders http://www.bcga.co.uk/pages/index.cfm
- Cylinder design standards https://www.hse.gov.uk/cdg/stdcurr.htm
- Safety of Pressure Systems, The Pressure Systems Safety Regulations 2000
- Approved Code of Practice, L122 (HSE Books, ISBN 9780717617678)

BCGA

- BCGA Website http://www.bcga.co.uk/pages/index.cfm
- Cylinder Identification. Colour Coding and Labelling Requirements https://www.boconline.co.uk/en/
- Handle Gas Cylinders Safely. Information for Customers Handling Gas Cylinders https://www.boconline.co.uk/en/health-and-safety/safety-data-sheets/index.html
- Information for customers Collecting Gas Cylinders (Flammable, Inert and Oxidising Gases http://www.bcga.co.uk/pages/index.cfm
- BCGA Codes of Practice CP4 – Gas supply and distribution systems (excluding acetylene). Revision 5: 2020
- BCGA Guidance Note: Code of Practice 44, The storage of gas cylinders
- BCGA – Customer Leaflet: L6 Revision 6 2022

BOC

- BOC Website https://www.boconline.co.uk/en/index.html
- BOC safety data sheets https://www.boconline.co.uk/en/health-and-safety/safety-data-sheets/index.html

Air Products

- Air Products Website http://www.airproducts.co.uk

Appendix 1. Gas Categories

Hazard	Description	Safety Precautions
Corrosive	Gases that corrode material or tissue with which they come in contact, or if in the presence of water. Can also be reactive and toxic and/or flammable or an oxidiser. Most are hazardous in low concentrations over long periods of time.	
Flammable (e.g. acetylene, hydrogen, propane)	These can be high-pressure, toxic, reactive and displace oxygen in air. A change in temperature, pressure or oxidant concentration may vary the flammability range considerably.	All possible sources of ignition must be eliminated through proper design of facilities and the restriction of smoking and open flames. Use a vent line made of stainless steel, purge with an inert gas and use a flashback arrester.
Inert (e.g. Helium, Argon, Neon, Krypton, Xenon)	Gases that do not react with other materials at ordinary temperature and pressure are classified as inert. They are colourless and odourless, as well as non-flammable and nontoxic. The primary hazard of these gases is pressure. These gases are often stored at pressures exceeding 138 bar. They can displace the oxygen levels when released in a confined place.	Use of adequate ventilation and monitoring of the oxygen content in confined places will minimise the danger of asphyxiation.

Appendix 2. Gas Safety Procedures

A. Storage

- Rotate stocks of gas cylinders to ensure first cylinder in is the first cylinder used.
- Return corrosive gas cylinders to the gas supplier within one year, to avoid regulator and cylinder valve problems due to corrosion.
- Only purchase sufficient quantities of gas to cover short-term needs.
- Gas cylinders should not be stored for excessive periods of time.
- Ensure the cylinder valve is kept closed on empty cylinders to prevent contaminants getting in.
- Plastic caps used for valve protection should be kept on the cylinders at all times, except when the cylinder is actually being used.
- empty cylinders should be clearly labelled or marked as “EMPTY.”
- on cold weather particularly, cylinders should be allowed to warm up to room temperatures before transportation to labs. This will avoid the cylinder warming up too quickly to room temperature before gas is taken off as this can result in a build up of excess internal pressure.

B. Handling

- wear appropriate personal protective equipment, such as safety shoes, safety glasses or goggles and gloves when handling gas cylinders and safety spectacles when using them.
- damaged or leaking cylinders should be removed from service and tagged as DAMAGED or DEFECTIVE" and reported to the supplier for uplift.
- **No** gas cylinders may be cut, heated, welded or modified in any way.
- **No** gas cylinder may be used for any purpose other than that for which it was designed.
- The correct tools (e.g. appropriately sized cylinder keys) must be used to tighten cylinder connections and valves to avoid damage and over torque.

C. Visual Inspection

Users should be able to carry out an external visual inspection of the gas cylinder, and any attachments (e.g. valves, flashback arresters, and regulators), to determine whether they are damaged. Visible indicators may include dents, bulges, evidence of fire damage (scorch marks) and severe grinding marks, etc. It is necessary to keep a record of any departmental annual and formal inspections; at departmental level these must be carried out by a suitably trained person who has been deemed competent to do this.

D. Emergency Procedures in the event of various incidents

1. In the event of Fire

- **KEEP AWAY** – DO NOT approach or attempt to more the cylinder or operate the valve.
- Operate the nearest available Fire Alarm Call Point to raise the alarm and evacuate.
- Trip the remote emergency gas shutoff valve/button, if present.
- Dial 3333 (02073203333) from a safe place, giving details of incident (What gas, type, quantity? Where? What are other gases/hazards around?). Security will contact London Fire Brigade.
- If possible and safe to do so, isolate any piped supplies to the area affected.

Cylinders may burst, vent or explode when subjected to extreme temperatures, therefore avoid “first aid” fire fighting (e.g. using extinguishers) unless the fire is small and can be dealt with very quickly. If in any doubt, evacuate and leave to the professionals.
DO NOT extinguish a flame involving a combustible gas until the source of gas has been shut off.

2. Leakage from a Cylinder

- Supplies should be isolated if possible.
- If possible, increase ventilation by opening external windows, but only if safe to do so.
- Do not remove leaking cylinders from their ventilated enclosures until the leakage has stopped.
- Close the main cylinder valve if a leak is stopped or slow, hazardous gases are contained in their enclosure, and it is clearly safe to approach.
- Trip the remote emergency gas shutoff valve/button, if present.
- Evacuate the laboratory/area and take steps to prevent re-entry until safe to do so, especially in cases of an oxygen depleted atmosphere.

3. Leakage from a CO2 Cylinder

In addition to being an asphyxiant CO_2 has a Workplace Exposure Limit (WEL) of 5000ppm (8hr TWA) and 15000ppm (15mins STEL) (i.e. 1.5%). If the oxygen concentration drops to 19% v/v then the CO_2 concentration will increase to ~>or= 3% v/v. Exposure to this concentration of CO_2 would result in: headache (rise in blood pressure and pulse rate), breathing rate would double and hearing would be affected. If the assessment suggests that a CO_2 concentration of >10% v/v could arise then these concentrations would represent an immediate danger to life and health. Therefore, in these circumstances fixed point CO_2 monitoring should be considered.

4. Suspected over-pressurisation of a CO2 cylinder

Over-pressurisation will become apparent after attaching the regulator to the cylinder and opening the cylinder valve, so always check this carefully.

- If the pressure on the inlet gauge is in excess of the filled pressure, normally 50bar for CO_2; close the valve, remove the regulator, allow the cylinder to stand for a few more minutes then reconnect and check pressure again.
- If the cylinder is still over pressure; close the valve, orientate the cylinder with the bursting disc facing away from any circulation route. Do not put the cylinder into service.
- Do not handle the cylinder further as movement may result in the bursting disc failing.
- On no account should the cylinder valve be used to 'throttle back' the inlet pressure.
- Evacuate the laboratory/area and contact the cylinder supply company immediately and ask them to remove the cylinder.
- Report the incident to the Safety Office immediately and complete an S1 incident report form.

5. Rupture of Bursting Disc in Carbon Dioxide Gas Cylinder

Some cylinders such as carbon dioxide cylinders have bursting discs which operate if the pressure exceeds the maximum permissible service level (e.g. 50 bar). The bursting disc is designed to rupture at 180-200 bar - hence, if pressures approaching this value are noted when the regulator has been fitted, then rupture would appear to be imminent.

CO_2 is stored as a liquid under pressure, however it is possible for solid CO_2 to form at the base of the cylinder and over-filling to occur. The bursting disc failure allows total loss of contents i.e. it does not relieve pressure and re-set, in the same manner as a pressure relief valve.

If the cylinder discharges into an unoccupied room, there is a risk to staff of asphyxiation from lack of oxygen. Risk assessments should take into account the amount of gas that could be released into the room and whether this may result in an unsafe atmosphere. Where it is possible that oxygen levels could be reduced to below 19%, oxygen depletion monitoring should be considered.

Fixed point CO_2 monitoring should be considered where there is a risk that the WEL for CO_2 may be exceeded. (See section 4 above). Again, a risk assessment must be carried out to ascertain the circumstances and control measures which may be required to mitigate this risk.

6. Rupture of a bursting disc in any other cylinder.

- It will be immediately obvious to those present when a bursting disc ruptures, as gas will be emitted at very high pressure and velocity into the room.
- All personnel must immediately leave the laboratory and take steps to prevent re-entry until the full contents have been discharged and the oxygen levels within the room are safe (i.e. above 19%).
- If possible open any external windows, but only if safe to do so. This will assist in dispersing the gas and restoring oxygen to safe levels

Note: The above is aimed primarily at CO_2 cylinders, however all cylinders of compressed gas can be subject to over-pressurisation so the same principles should be applied, although there might be slightly different risks and calculations required depending on the actual gas in use. This must be considered as part of the department's risk assessment.