CODE OF PRACTICE 6

THE SAFE DISTRIBUTION OF ACETYLENE IN THE PRESSURE RANGE 0 - 1.5 BAR

Revision 3 : 2015

British Compressed Gases Association

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PREFACE

The British Compressed Gases Association (BCGA) was established in l971, formed out of the British Acetylene Association, which existed since l901. BCGA members include gas producers, suppliers of gas handling equipment and users operating in the compressed gas field.

The main objectives of the Association are to further technology, to enhance safe practice, and to prioritise environmental protection in the supply and use of industrial gases, and we produce a host of publications to this end. BCGA also provides advice and makes representations on behalf of its Members to regulatory bodies, including the UK Government.

Policy is determined by a Council elected from Member Companies, with detailed technical studies being undertaken by a Technical Committee and its specialist Sub-Committees appointed for this purpose.

BCGA makes strenuous efforts to ensure the accuracy and current relevance of its publications, which are intended for use by technically competent persons. However this does not remove the need for technical and managerial judgement in practical situations. Nor do they confer any immunity or exemption from relevant legal requirements, including by-laws.

For the assistance of users, references are given, either in the text or Appendices, to publications such as British, European and International Standards and Codes of Practice, and current legislation that may be applicable but no representation or warranty can be given that these references are complete or current.

BCGA publications are reviewed, and revised if necessary, at five-yearly intervals, or sooner where the need is recognised. Readers are advised to check the Association's website to ensure that the copy in their possession is the current version.

This document has been prepared by BCGA Technical Sub-Committee 3. This document replaces BCGA Code of Practice 6, Revision 2: 2009. It was approved for publication at BCGA Technical Committee 151. This document was first published on 23/02/2015. For comments on this document contact the Association via the website www.bcga.co.uk.

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* Throughout this publication the numbers in brackets refer to references in Section 13. Documents referenced are the edition current at the time of publication, unless otherwise stated.

TERMINOLOGY AND DEFINITIONS

Acetylene equipment	Acetylene equipment means any equipment containing compressed acetylene gas, excluding a cylinder and acetylene manifold, but including a pipe, hose, valve, or device that is: • Designed or manufactured for use with compressed acetylene gas; or • Used with compressed acetylene gas.
Acetylene generator	A unit which produces unpurified acetylene, e.g. by the reaction of calcium carbide with water.
Acetylene manifold system	A system of interconnected pipework in which compressed acetylene gas is contained and which connects to, but excludes, a cylinder. The manifold system will contain an assembly of devices delivering a regulated pressure under specified safe conditions, coupled to a user pipeline system.
Composite safety device (Flashback arrestor)	A unit which embodies 2 or more of the following devices: • Flame arrestor • Non-return valve • Temperature sensitive cut-off valve • Pressure sensitive cut-off valve
Cylinder bundle / Manifolded cylinder pallet (MCP)	An assembly of cylinders fastened together, interconnected by a manifold for collective filling and gas withdrawal, and intended to be transported as a single unit.
Cylinder installations	*Non-Permanent Cylinder Installations* A gas supply and equipment which is not fixed for use in one position, *Portable* Equipment, including the cylinders, that can be easily carried to the point of work by one person. *Mobile* Equipment which can be easily moved to the point of work, usually on a trolley, by one person. *Permanent Cylinder Installation* The supply being from single cylinders, cylinder manifolds or bundles.
Decomposition	The breakdown of acetylene into carbon and hydrogen.
Deflagration	A flame produced by decomposition or combustion that travels into the unreacted gas at less than sonic velocity.

	The rate of propagation of a deflagration flame increases with the density, the temperature and the turbulence of the unreacted gas. Since these three parameters tend to increase as a deflagration progresses, the rate of propagation is usually not steady but tends to increase continually and sometimes leads to a detonation.
Detonation	A flame produced by decomposition or combustion that travels into the unreacted gas at a rate above sonic velocity, usually at several times the speed of sound. Unlike a deflagration, where the pressure in front of and behind the flame front rises at the same time, a detonation involves a sharp difference in pressure between the reacted and unreacted gas. The change from the low pressure of the unreacted gas takes place in a shock wave at the front of the flame.
Flame arrestor	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.
High-pressure hose assembly (pigtail)	A flexible connection between the cylinder valve and manifold header. It may be manufactured from tube or flexible elastomeric materials.
High pressure valves	*Automatic quick-acting shut-off device* A self-acting device which closes quickly, e.g. when triggered by acetylene decomposition in the high pressure manifold pipework. *Change-over unit* A device in a two sided system allowing switching of the supply of gas from the system to either of its bank of cylinders or bundles without interrupting the supply. *Decomposition blocker* A safety device which stops acetylene decomposition incorporating a thermal or pressure-sensitive cut-off valve. *High pressure filter* A device to retain particles with a size of 100 μm or greater. *High-pressure stop valve* A device to prevent, when closed, the flow of gas on the high pressure side. *Manual quick-acting shut-off valve* A manually activated device to quickly stop the gas flow.

Non-return valve
A device which prevents the passage of gas in the direction opposite to normal flow.

Specifically a non-return valve shall be effective against the return of gas towards the cylinder.

Pressure limiting device
A device which limits the pressure downstream of the manifold regulator in the event of regulator failure or malfunction.

Examples of such devices are: (1) relief valve; (2) pressure actuated shut-off valves; (3) manual or automatic systems to cut the flow; (4) pressure actuated venting device.

Pressure regulator for manifold systems
A device for regulating a generally variable inlet pressure to as constant as possible an outlet pressure when controlling the output of a manifold of cylinders.

Purge valve
A device which enables a pipework system to reach atmospheric pressure or eliminate undesirable gases or residues by flushing.

Quick-acting shut-off device
A safety device which prevents the continued withdrawal of acetylene and/or gaseous products of decomposition from the manifold system if an acetylene decomposition or a flashback occurs.

Three way valve
A device which allows gas flow from one side of the high pressure manifold to enter the regulator while isolating flow from the second side.

Low pressure valves

Main shut-off valve
The main valve downstream of the system.

Pressure-sensitive cut-off device
A device which interrupts the gas flow in the event of a back pressure wave from the downstream side.

Temperature-sensitive cut-off device
A device which stops the gas flow when a predetermined temperature is reached

Manifold high-pressure pipework

Pipework system extending from the outlet connection of acetylene cylinders or bundles at full cylinder charging pressure to the inlet of the pressure regulator, including as required hose assemblies or coiled metal pipes, piping and high pressure valves.

May	Indicates an option available to the user of this Code of Practice.
Outlet point	An assembly with features as detailed in Section 6.4 fitted at the termination of the distribution pipework for connection of user equipment.
Outlet point regulator	A device for reducing distribution pipeline pressure to that required by the user.
Pressure	Within this Code of Practice the 'bar' is used as the unit of pressure. 1 bar = 100 kPa = 10^5 N/m^2 = 14.5 lbf/in²
	Pressures used are gauge pressures except where otherwise stated.
	High pressure: >1.5 bar and up to 25 bar.
	Low pressure: ≤1.5 bar
Reflection	During detonation, if the forward-moving shock wave hits an obstruction, such as the end of the pipework, a closed valve, a restriction or a sharp bend, the pressure increases considerably and the flame can travel back into the unburnt gas when reflected, considerably increasing the detonation energy.
Shall	Indicates a mandatory requirement for compliance with this Code of Practice and may also indicate a mandatory requirement within UK law.
Should	Indicates a preferred requirement but is not mandatory for compliance with this Code of Practice.

CODE OF PRACTICE 6

THE SAFE DISTRIBUTION OF ACETYLENE IN THE PRESSURE RANGE 0 - 1.5 BAR

1. INTRODUCTION

Acetylene has unique properties. Acetylene is an extremely flammable gas and can burn in the presence of air or oxygen. This generates very high flame temperatures, which is the reason why acetylene is so effective for cutting and welding. The acetylene (C_2H_2) molecule, however, if initiated by heat exposure of a cylinder in a fire, or through excessive fill pressure, can also decompose breaking up into one hydrogen molecule and two carbon atoms. This reaction delivers much less energy than combustion but can, in some circumstances, be strong enough to rupture a cylinder. Additionally, whereas acetylene is very soluble in the solvents used in dissolved acetylene cylinders, hydrogen, when released through decomposition, is much less soluble; giving a significant and irreversible pressure rise within the cylinder, which can be sufficient to cause its rupture. For these reasons the maximum working pressure of an acetylene cylinder is kept relatively low at 19 bar. Consequently, manifolds connected to an acetylene cylinder are designed and constructed to operate at pressures between 1.5 and 25 bar. In use, acetylene is delivered to the end user at pressures up to 1.5 bar.

NOTE: The design of a dissolved acetylene cylinder is also important. Each cylinder is filled with a porous material, which is a very effective obstacle for energy and fluid flow. A solvent is then added to the porous material, (typically acetone or dimethylformamide (DMF)), and the acetylene gas is then dissolved in this solvent. The dissolved acetylene cylinder is thus a complex system comprising a number of components interacting with each other. This system keeps acetylene in a safe condition inside the cylinder.

As a consequence of this potential hazard, acetylene is subject to specific legislation. Following a major review of legislation in 2014, acetylene was placed under The Acetylene Safety (England and Wales and Scotland) Regulations (9). This revision complies with these regulations.

The Acetylene Safety (England and Wales and Scotland) Regulations (9) require that all mobile systems shall be fitted with a purpose designed regulator for acetylene, a flashback arrestor incorporating a non-return valve and a pressure and/or temperature sensitive cut-off valve.

The manufacture of compressed acetylene gas; the compression of acetylene at pressures equal to or greater than 0.62 bar; or the filling of a cylinder with compressed acetylene gas cannot be carried out without a licence issued by the Health and Safety Executive (HSE). The licensee shall comply with the conditions of the licence and comply with the requirements of the Acetylene Safety (England and Wales and Scotland) Regulations (9), Schedule 1.

The content of this publication is in line with advice from the HSE. For more details refer to http://www.hse.gov.uk/fireandexplosion/acetylene.htm and leaflet HSE INDG 327 (15), *Working safely with acetylene.*

The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) (6) requires that employers undertake a risk assessment and put in place suitable controls where an explosive atmosphere may occur, such as where oxidising or flammable gases are used or stored.

It is recommended that users of oxy-fuel gas processes ensure that all new installations, or modifications to existing installations, comply with this Code of Practice for the products or services involved.

It is pointed out that this code represents the BCGA's views of minimum requirements for safe practices, reference should be made to Section 13 for further details on specific standards or Regulations.

2. SCOPE

This Code of Practice is for the safe distribution of acetylene within the pressure range 0 - 1.5 bar (0 - 22 lbf/in²).

The code recommends the minimum requirements for the safe supply of acetylene through permanent and non-permanent systems to the point of connection with the blowpipe or the point of usage.

The code is intended to assist all users of acetylene by setting out typical industrial systems that can be easily identified by users. The recommendations made cover the design of total systems and individual items of equipment and the choice of materials appropriate to the characteristics of acetylene gas.

The design and construction of acetylene manifolds is dealt with in BCGA Code of Practice (CP) 5 (45), *The design and construction of manifolds using acetylene gas from 1.5 - 25 bar*, but for convenience of the user some requirements of the gas supply system are included in this Code, as also are some requirements for oxygen distribution systems.

The Code makes recommendations for the safe and proper practice for the keeping of acetylene cylinders at user's premises. BCGA Guidance Note (GN) 2 (49), *Guidance for the storage of gas cylinders in the workplace*, provides guidance on the storage of all types of gas cylinders.

Information on gas distribution pipework for other industrial gases is covered in BCGA CP 4 (44), *Industrial gas cylinder manifolds and gas distribution pipework (excluding acetylene)*.

This code does not cover the processes of chemical synthesis or the safe operation of acetylene generators. The European Industrial Gases Association (EIGA) Document 123 (43), *Code of Practice Acetylene*, provides comprehensive guidance on the safety requirements for acetylene.

This Code takes into account the requirements of the Pressure Systems Safety Regulations (5) and BS EN ISO 14114 (39), *Gas welding equipment. Acetylene manifold systems for welding, cutting and allied processes. General requirements.*

3. ACETYLENE GAS

3.1 General data

Chemical symbol	C_2H_2
Flammable / non-flammable	Flammable
Lighter / heavier than air	Slightly lighter NOTE 1
Colour	Colourless
Odour	Slight odour NOTE 2
Taste	Tasteless
Toxicity	Non-toxic NOTE 2
Corrosivity	Non-corrosive

The body and shoulder of acetylene cylinders will be painted maroon (RAL 3007).

NOTES:

1. Mixtures of acetylene and acetone vapour can be heavier than air.
2. Commercial supplies of acetylene do contain trace impurities which are toxic and which can also give rise to slight odour. Normal precautions should be taken to avoid inhaling acetylene gas.

3.2 Special conditions

Acetylene differs from other fuel gases, such as natural gas, propane and butane, because of its ability to decompose in the absence of air or oxygen, when initiated by a source of heat energy. This decomposition reaction may proceed through deflagration to detonation depending on the gas pressure and pipe dimensions. The effects of an acetylene decomposition are similar to fuel gas-oxygen explosions, resulting in a loud noise, bright flame, rise in temperature and pressure and soot formation. As an example, testing has found that decomposition in a gas cylinder will lead to it bursting and it may either disintegrate into a small number of different pieces, or it may rip open while the shell remains in one piece. In the first case the fragments may travel more than 100 m.

The flammability range in air is from 2.2 % to 85 %.

Some materials, even in small quantities, can form compounds with acetylene under certain conditions and pose a risk or are liable to initiate decomposition. Refer to Section 7.

Decomposition in a gas cylinder will only occur after exposure to temperatures in excess of 350 °C. Factors, such as the presence of air, rust particles etc., can significantly lower this temperature in a manifold system.

NOTE: Mechanical shock alone to a cold acetylene cylinder, which remains intact and has not been exposed to fire, cannot initiate decomposition.

3.3 Safety

As a flammable atmosphere may exist a risk assessment shall be carried out in compliance with The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) (6) and suitable controls put in place. If an explosive atmosphere may exist signage shall be displayed, refer to Section 8.10.

NOTE: Guidance on the preparation of Risk Assessments under DSEAR (6) is contained in BCGA GN 13 (50), *DSEAR Risk Assessment.* Additional guidance is provided by the HSE, refer to HSE L138 (14), *Dangerous substances and explosive atmospheres DSEAR 2002. Approved Codes of Practice and Guidance*, and HSE INDG 370 (16), *Controlling Fire & Explosion risks in the workplace. A brief guide to DSEAR.*

The Dangerous Substances (Notification and Marking of Sites) Regulations (2) require, that if you hold 25 tonnes or more of a dangerous substance, that you notify the enforcing authority and the local Fire and rescue Service, and mark sites at the access points to warn of the presence or possible presence of dangerous substances.

Fire safety. A responsible person shall carry out a Fire Safety Risk Assessment on all storage sites and areas where acetylene is used, the findings from which are to be incorporated into the Site Fire Safety Management Plan that is to be implemented and maintained. As necessary, advice should be sought from the local fire authority. Each site should keep a record of the location of its hazardous store(s), this is to be made available to the emergency services in the event of an incident. Fire-fighting facilities as identified in the Site Fire Safety Management Plan shall be provided. Refer to The Regulatory Reform (Fire Safety) Order (7).

Although acetylene is non-toxic, acetylene-enriched atmospheres can cause asphyxiation through the depletion of oxygen.

Safety signs and warning notices shall be displayed, refer to Section 8.10.

Acetylene vented from safety / pressure relief devices and purge points should be discharged to an external area specifically classified for acetylene where there is no risk of ignition. All discharge pipes or orifices to the open air shall be designed and made in such a way as to avoid choking, obstruction or frictional pressure drop. Safety / pressure relief device discharge pipes should be separate and connection to a manifold should be avoided. The design of pipework shall take into account the working range of the acetylene for the pressures at the discharge point. The vent pipes and outlets shall prevent the ingress of contaminants and the accumulation of water, including that from snow, rain and condensation. Contaminants, as well as water accumulation that may lead to the formation of ice, could potentially cause blockages. Appropriate safety signs and warning notices shall be displayed at the vent outlet and drain points.

As a flammable atmosphere may exist at the vent outlet(s) a risk assessment shall be carried out in compliance with DSEAR (6) and suitable controls put in place.

Further information on venting is available in and EIGA Document 30 (42), *Disposal of gases*, and EIGA Document 123 (43).

Systems shall be effectively bonded and earthed against the build-up of static electricity, refer to BS 5958 (30), *Code of practice for control of undesirable static electricity.*

All piping and building components shall be protected from electrostatic charges by maintaining an electrical conductivity with a maximum resistance of 10^6 ohm.

The use of electrical equipment in an area where a flammable atmosphere may exist should be kept to the minimum necessary for the safe and practical operation of the installation. All such electrical equipment shall be suitable for use with acetylene [Gas Group IIC Temperature Classification T2]. The equipment shall be designed, installed and maintained in accordance with BS EN 60079 (41), *Electrical apparatus for explosive gas atmospheres.*

The repair of electrical equipment within a hazardous area shall be carried out in accordance with BS EN 60079 Part 19 (41), *Electrical apparatus for explosive gas atmospheres. Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives).*

Pipework shall have a separation distance of at least 50 mm from electrical systems.

Pipework shall be segregated from other pipework carrying oxidising gases and sources of ignition to prevent combustion occurring.

Pipework shall be purged out of service with an inert gas, such as nitrogen, until the residual acetylene is below 0.6 %. Pipework shall be purged into service using an inert gas, such as nitrogen, until the oxygen level is less than 0.1 %. Carbon dioxide is not recommended due to the risk of a static charge.

Each outlet point of the system shall terminate in a left hand thread.

Acetylene equipment shall have a pressure regulator fitted. The pressure regulator shall be designed and be constructed for use with acetylene, and positioned as close as reasonably practical to the manifold, or where no manifold is used, to the cylinder.

Decomposition can be initiated in the event of a flashback occurring. The cylinder / mass combination has been designed to contain and deal with a single flashback - but repeated flashbacks into a cylinder caused by faulty equipment or operation can ultimately lead to decomposition which could overcome the cylinder's ability to withstand such. A cylinder which is known to have suffered multiple flashbacks should be withdrawn from use and returned to the gas supplier with a clear notice as to what is known. To prevent a flashback the use of flashback arrestors is mandatory. They shall be fitted within 1 metre downstream of the regulator.

Each system shall be fitted with a non-return device, to prevent the flow of gas towards the cylinder, and a quick-acting shut-off device, both fitted as close as is reasonably practical to the acetylene manifold, or where no manifold is used, to the cylinder.

For further information on the design and construction of acetylene manifolds refer to BCGA CP 5 (45).

3.4 Working ranges

(EIGA) Document 123 (43), identifies the types of hazard normally present in an acetylene installation. The type of hazard, under certain conditions, is determined by pressure, internal pipe diameter and pre-detonation distance. These hazards are categorised into three working ranges, which are simply identified by a graph relating pipeline pressure to pipe diameter, refer to Appendix 1.

- Working Range I
  Acetylene decomposition hazard is slight, but not impossible.

- Working Range II
  On ignition, acetylene decomposition in form of deflagration may occur.

- Working Range III
  On ignition, acetylene decomposition will start as a deflagration and in sufficiently long pipelines transition to detonation may occur.

The internal diameter of the pipe and the maximum gas pressure will place each pipeline into one of the Working Ranges. The material used in the construction and the size of the pipeline will depend on the Working Range.

4. CLASSIFICATION OF INDUSTRIAL USE OF ACETYLENE

4.1. Categories

Acetylene installations fall within two categories - non-permanent cylinder installations and permanent cylinder installations.

4.2 Classification

Industrial uses are classified in seven classes. Classes 1 to 4 in the non-permanent category and Classes 5 to 7 in the permanent category.

Class 1 P*ortable single cylinder*
Non-permanent equipment that can be carried by one person.

Class 2 *Mobile single cylinder*
Non-permanent for general purpose use. Class 2 accounts for a significant number of users of acetylene.

NOTE: BCGA CP 7 (46) *The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply),* covers Class 1 & 2.

Class 3 *Coupled cylinders to a maximum of 3.*
Non-permanent in general use where the volume and withdrawal rate is in excess of that available from a single cylinder, e.g. heating, flame cleaning, medium and heavy cutting etc.

This is no longer recommended for use with acetylene, refer to Section 5.2.

Class 4 *Bundle supply system (more than 3 cylinders).*
Non-permanent cylinder installation, higher volume supply system.

Class 5 *Single cylinder manifold*
Permanent installation to supply low demand, intermittent requirement.

Class 6 *Multiple cylinder manifold*
Permanent installation of more than one cylinder in a conventional manifold which may supply any demand rate either continuously or intermittently.

Class 7 *Cylinder bundle manifold*
Permanent installation of cylinder bundles usually in conjunction with high demand rates either continuous or intermittent.

5. MINIMUM SAFETY REQUIREMENTS - NON-PERMANENT INSTALLATIONS

Safety devices for non-permanent installations shall conform to BS EN 730 (20), *Gas welding equipment. Safety devices*. All safety devices should be tested and shown to be suitable for the required conditions of service (e.g. type of gas used, maximum operating pressure and maximum operating flow, etc.). The incorporation of safety devices such as flashback arrestors etc. should in no way be considered to be a substitute for safe operating procedures.

5.1 Portable and mobile oxygen and acetylene single cylinder supply Classes 1 and 2

For full details of these Classes refer to BCGA CP 7 (46) and Appendix 2.

The cylinder shall be adequately supported and protected from damage. The pressure regulator shall conform to BS EN ISO 2503 (24), *Gas welding equipment. Pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa)*, having a maximum outlet pressure of 1.5 bar.

The flexible hose from the regulator outlet shall conform to BS EN ISO 3821 (28), *Gas welding equipment. Rubber hoses for welding, cutting and allied processes*, with hose connections to BS EN 560 (19), *Gas welding equipment. Hose connections for welding, cutting and allied processes*. The hose clamping ferrule or clip should be of a non-re-usable type and the hose assembly should conform to BS EN 1256 (21), *Gas welding equipment. Specification for hose assemblies for equipment for welding, cutting and allied processes.*

Minimum requirement for all hose sizes and lengths:

(i) A non-return valve shall be fitted to each blowpipe connection.

(ii) A flashback arrestor with pressure **or** temperature sensitive cut-off valve shall be fitted in both the oxygen and fuel gas lines.

Recommended for additional safety, and especially if access to cylinders is difficult or they are remote from the operator, making them difficult to isolate, the following may be used:

(iii a) A flashback arrestor with a non-return valve shall be fitted to each blowpipe connection.

(iii b) A flashback arrestor with pressure **or** temperature sensitive cut-off valve shall be fitted in both the oxygen and fuel gas lines.

Or

(iv a) A non-return valve shall be fitted to each blowpipe connection.

(iv b) A flashback arrestor with pressure **and** temperature sensitive cut-off valve shall be fitted in both the oxygen and fuel gas lines.

NOTE: The use of additional flashback arrestors will provide increased safety. However in such cases, the flow capacity of the system will be less than the rated flow of each individual flashback arrestor. Therefore, care should be taken to ensure flow capacity is adequate for the correct and safe use of the equipment in accordance with the supplier's operating instructions.

Requirements are summarised in Table 1 and illustrated in Appendix 2.

Requirements	**Fit to both blowpipe inlets**	**Fit between regulator outlet & blowpipe in both gas lines**
Minimum	NV	FA + PV or TV
Recommended	FA + NV NV	FA + PV or TV FA + PV and TV
Key: NV Non-Return Valve FA Flame Arrestor PV Pressure Sensitive Cut-Off Valve TV Temperature Sensitive Cut-off Valve		

Table 1: Safety devices – Installation requirements.

NOTES:

1. All flashback arrestors are designed to arrest the flame at the point of installation.

2. A temperature sensitive cut-off valve will not cut off the gas until heated to a sufficient level. This may require several flashbacks or internal burning. After cut off they cannot be reset. After investigation and rectification of cause of flashback they shall be replaced.

3. A pressure sensitive cut-off valve will automatically cut off the gas flow immediately. After cut off they can be reset, after investigation and rectification of cause of flashback.

5.2 Two or three acetylene cylinder supply - Class 3

No longer recommended for acetylene. This is a mobile system with multiple cylinders supplying acetylene, it does not include the additional safety features required for a system with a manifold. Existing systems should be changed to a single system (refer to Section 5.1), changed to a bundle supply system (refer to Section 5.3) or upgraded to a fixed system (refer to Section 6).

5.3 Acetylene bundle supply - Class 4

The gas supplier's recommendation for connecting procedures for bundles shall be followed. The solvent used in bundles may be DMF or acetone. The connecting pipework (rigid) or high pressure flexible hoses from the unit header and terminating in the pressure regulator shall have adequate strength to resist a detonation at full cylinder pressure, refer to BCGA CP 5 (45). Flexible hoses shall be protected from external damage and conform to BS EN ISO 14113 (38), *Gas welding equipment. Rubber and plastics hose and hose assemblies for use with industrial gases up to 450 bar (45 MPa).*

Between the unit header connection and the pressure regulator inlet connection shall be fitted:

- High-Pressure non-return valve as close as possible to the bundle connection.
- Manual quick-acting shut-off valve **or** automatic quick-acting shut off device.
- Pressure sensitive shut-off valve **or** pressure relief valve

At the outlet connection of the pressure regulator, or within one metre of the outlet connection, shall be fitted:

- Flame arrestor.
- Cut-off valve (temperature or pressure sensitive).
- Low-pressure non-return valve.
- Isolating valve.
- Pressure relief valve, if no pressure sensitive cut-off valve fitted.

An example is displayed in Appendix 3.

6. MINIMUM SAFETY REQUIREMENTS - PERMANENT INSTALLATIONS

All safety devices should be tested and shown to be suitable for the required conditions of service (e.g. marked acetylene, maximum operating pressure etc.). The incorporation of safety devices such as flashback arrestors etc. should in no way be considered to be a substitute for suitable operating procedures.

6.1 Single cylinder manifold - Class 5

Shall consist of:

- A framework to support and secure the cylinder.
- High pressure non-return valve as close as possible to the cylinder.
- High-pressure hose assembly to BS EN ISO 14113 (38), or pigtail.
- A manual quick-acting shut-off valve.
- Main pressure regulator (to BS EN ISO 7291 (32), *Gas welding equipment. Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar)*, with a maximum outlet pressure of 1.5 bar.
- Pressure sensitive shut-off valve or pressure relief valve.
- Flashback arrestor incorporating a cut-off valve (thermal or pressure sensitive) fitted within 1 metre of the downstream side of the main regulator where it is not reasonably practical to connect between the regulator and the flashback arrestor with metal pipework, a hose that complies with BS EN ISO 3821 (28) may be used.
- Low-pressure isolating valve.

An example is displayed in Appendix 4.

6.2 Cylinder manifold - Class 6

Refer to BCGA CP 5 (45)

Shall consist of:

- A framework to support and secure cylinders.
- High-pressure hose assembly to BS EN ISO 14113 (38), or pigtail.
- High-pressure non-return valves fitted to each high-pressure hose assembly (pigtail) as close as possible to the cylinders.
- High-pressure tube terminating in a high-pressure stop valve.
- Manual quick-acting shut-off valve or an automatic quick-acting shut-off device.
- Main pressure regulator to BS EN ISO 7291 (32) with a maximum outlet pressure of 1.5 bar.
- Low pressure non-return valve.

- Flashback arrestor incorporating a cut-off valve (thermal or pressure sensitive) fitted within 1 metre of the downstream side of the main pressure regulator.

- A pressure relief valve, where no pressure sensitive cut-off valve is fitted.

- Low pressure isolating valve.

- Outlet points as detailed in Section 6.4.

Additionally, filters may be fitted either as a separate unit or as an integral part of the main pressure regulator.

Provision may also be made for a vent / purge valve venting to a safe location.

An example is displayed in Appendix 5.

6.3 Cylinder bundle manifold - Class 7

Shall consist of:

- Fixed high-pressure tube terminating in high-pressure stop valves and having one or more inlet connections to connect the cylinder bundle(s).

- High-pressure non-return valves as close as possible to each bundle.

- Automatic quick-acting shut-off device.

- Pressure sensitive shut-off valve, or pressure relief valve downstream of the main pressure regulator.

- Main pressure regulator to BS EN ISO 7291 (32) having a maximum outlet pressure of 1.5 bar.

- Low-pressure non-return valves.

- Flashback arrestor incorporating a cut-off valve (thermal or pressure sensitive) fitted within 1 metre downstream of the main pressure regulator.

- Low pressure isolating valves.

- Vent / purge valves – optional.

- Outlet points as detailed in Section 6.4.

NOTE: Provision may be made within the bundle connection to permanent pipework for a purge valve connected to a suitably situated vent pipe, which shall vent to a safe location. The integral bundle pipework should be thoroughly purged of air prior to

passing acetylene into the permanent pipework system. Gas suppliers' recommended procedure for connecting and disconnecting cylinder bundles should be followed.

An example is displayed in Appendix 6.

6.4 Outlet point for permanent installations

Shall consist of:

- Manual isolating valve.
- Non-return valve.
- Flashback arrestor incorporating a cut-off valve (temperature or pressure sensitive).

An outlet point regulator is required for standard applications, except where the process pressure and flowrate efficiency is compromised.

If other supply lines carrying oxidants or fuel gases are connected to the device served by the acetylene outlet point, they too shall each be fitted with a non-return valve or a flashback arrestor as near to the point of mixing as practicable.

7. MATERIALS

7.1 General

All materials used, including non-metallic parts for joints, seals, diaphragms, hoses, etc. shall conform to BS EN ISO 9539 (34), *Gas welding equipment. Materials for equipment used in gas welding, cutting and allied processes*, and be resistant to the action of the acetylene, its impurities and other substances (for example, acetone or DMF, i.e. solvent from the acetylene cylinder) under the operating conditions (for example, temperature, pressure) to which they are subjected and, where applicable, to atmospheric corrosion.

Materials which do not have adequate resistance may be used provided they are suitably protected (by coatings such as paint, baked enamel and sprayed metal) and provided that damage to or breakdown of the protection cannot give rise to the formation of dangerous compounds or conditions.

7.2 Recommended materials

Recommended standards for pipes for Working Range I are:

- BS EN 10255 (37), *Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions*, which is suitable for screwing.
- ISO 4200 (29), *Plain end steel tubes, welded and seamless. General tables of dimensions and masses per unit length*. Light series 'B' which is suitable for welding.

Better grades of material, for example stainless steels, may be substituted but for welded pipelines they shall have suitable welding characteristics.

Material	Conditions for use
Copper and Copper Alloys containing more than 70 % of Copper	Not allowed.
Mercury	Not allowed.
Copper Alloys containing up to 70% Copper	Permitted. Special consideration should be given to the use of copper alloys for filters, etc in view of the large surface in contact with acetylene and for parts in contact with moist unpurified acetylene. Any heat or chemical / corrosion process which produces copper enrichment on the surface of the copper alloy shall be avoided, or copper alloy shall not be used.
Silver	Not allowed.
Silver Alloys	Suitable for brazing provided that the silver content does not exceed 43 % and the copper content does not exceed 21 % and that the gap between the two parts to be brazed does not exceed 0.3 mm. Special care shall be taken to minimise the area of filler metal exposed to acetylene and to remove as far as practical all traces of flux. For additional information refer to BS EN ISO 9539 (34).
Aluminium Aluminium Alloys Magnesium Alloys Zinc Alloys	Not recommended for components that come into contact with moist acetylene contaminated with lime or ammonia (unpurified generator gas).
Zinc	Suitable as external anti-corrosion protective coating.
Glass	Should generally be used only for sight glasses. Such devices should either be protected against external damage or designed so that breakage will not cause a hazard.
Organic materials	May be used if it has been proved that they are resistant against acetylene, solvents and impurities.
For fittings, valve housing and similar components, the ferrous materials listed below may be used: • Grey cast iron • Malleable cast iron • Spheroidal graphite cast iron • Wrought iron	

Table 2: Materials not allowed or recommended only under certain conditions

7.3 Materials not allowed or recommended only under certain conditions

Certain metals, such as copper, silver and mercury can form compounds with acetylene under certain conditions, which even in small quantities may explode when subjected to friction or shock.

This means that the unrestricted use of these metals even, for instance, as a brazing alloy, could introduce the possibility of acetylene decomposition.

Studies of the conditions of formation of the explosive acetylene compounds have shown that the likelihood of their formation increases with the copper or silver content of the alloy, together with flux residues in the presence of acetylene. Other metals, such as aluminium, magnesium or zinc may suffer severe corrosion under the influence of the impurities that occur in unpurified acetylene.

For these or other reasons, the restrictions and conditions stated in Table 2 shall be observed.

8. DESIGN

8.1 General

In order to determine the number of cylinders required in a manifold system, the designer or user should consult the gas supplier for the maximum withdrawal rate from the cylinder. The system shall be designed in accordance with BS EN ISO 14114 (39) and conform to the appropriate requirements of the Pressure Systems Safety Regulations (5).

All pipework and equipment shall be designed in accordance with correct procedures for the applicable working range.

If the design pressure of the installation can be exceeded, the system shall be suitably protected by a pressure activated shut-off valve or a pressure relief valve, which should be vented to a safe place.

The wall thickness of pipelines in Working Range 1 shall be determined in the same way as that on pipelines for other fuel gases, refer to BCGA CP 4 (44).

For ranges other than Working Range 1 refer to BCGA CP 5 (45).

8.2 Manifold pipework

For pipework for manifolds refer to BCGA CP 5 (45).

8.3 Distribution pipework - Bore size

Distribution pipework should always be designed to ensure that it is sized to fall within Working Range I, refer to Section 3.4. Select materials in accordance with the maximum bore sizes as detailed in Table 3.

If the bore size/pressure is not adequate to support the required flow, consideration must be given to the introduction of a second supply point into the distribution system.

Materials shall be selected in accordance with Section 7.

Bore size	Maximum operating pressure
23 mm	1.5 bar
25 mm	1.3 bar
35 mm	1.0 bar
42 mm	0.8 bar
54 mm	0.5 bar
72 mm	0.35 bar

Table 3: Bore size of distribution pipework related to maximum operating pressure

8.4 Distribution pipework - Installation

All pipework shall be adequately supported and protected from damage, vibration or corrosion.

Sections of pipework in buildings should be kept to the minimum reasonably practicable length.

Where pipes have to be run inside buildings they should, so far as is practicable, be run in well-ventilated rooms. Routing in enclosed spaces (roof and floor spaces, ducts etc.) should be avoided. When routing pipelines underground refer to Section 8.5. Where pipes have to be routed through enclosed spaces they should be installed in accordance with BS 9999 (36), *Code of practice for fire safety in the design, management and use of buildings*, and BS 8313 (33), *Code of Practice for accommodation of building services in ducts*, with the following precautions incorporated:

(i) The space should be provided with adequate permanent natural ventilation to prevent the accumulation of a dangerous concentration of gas in the event of a reasonably foreseeable leakage; or

There shall be no mechanical joints within the enclosed pipe run; or

Joints shall be fusion-welded and certified leak free by pressure test at 4 bar with inert gas; or

The pipe run shall be made within a larger diameter pipe (i.e. sheathed), both ends of the outer pipe being open to well ventilated positions.

(ii) Acetylene pipework should not be installed in the same enclosed space as other services, as specified in BS 9999 (36) and BS 8313 (33) (including oxygen and gas pipes etc.).

(iii) Acetylene pipelines shall be at least 50 mm from electrical apparatus and wiring and shall not be used as an electrical earth.

(iv) Pipework shall be designed for ease of cleaning and purging, dead legs where foreign matter could accumulate should be avoided and pipework should be as straight as possible to avoid excessive pressure drop.

8.5 Distribution pipework - Underground routing

Pipework should only be installed underground where there is no alternative, for example, in order to cross roads, railway lines or to enter buildings. Several different methods may be used:

- Pipes installed on pipe racks or supports inside concrete or metal ducts, which may be closed by the use of masonry slabs or which may be covered using open grid covers.

- Pipes laid in trenches and backfilled.

- Pipes laid in trenches and encased in concrete.

Acetylene and oxidising gases should not be run in the same trench or duct unless:

- The ventilation is adequate e.g. in a large ventilated duct; or

- The trench is back filled with an inert non-corrosive material and the oxygen and flammable gas lines have a minimum separation distance of 500 mm; or

- The lines are encased in concrete and the minimum separation distance is 300 mm.

Inert gases may be run in the same trenches as acetylene.

Piping shall be at least 50 mm away from any electrical power cables.

Mechanical joints shall not be used underground. Joints shall be welded or brazed and tested in accordance with Section 8.8. Flanges or other mechanical joints shall only be permissible when they are essential for assembly and disassembly. Where valves are used, they should be accessible from the surface (via a suitable access pit, e.g. concrete or brick lined) and be of a high integrity leak tight design. Where the piping is to be laid underground on private property under tarmac or grass areas where there is no likelihood of heavy traffic, trenches shall be at least 600 mm deep. Where the pipe is to be laid under a road, the trench shall be a minimum of 500 mm deep. Where subsidence may be a problem, consideration should be given to using concrete slabs or steel plates positioned on a bed of sand above the pipe.

Where the ground at the base of the trench is of irregular consistency, the depth of excavation should be increased by approximately 75 mm in order to allow the pipe to be laid on a bed of sand.

Pressure testing should take place prior to back-filling, although this is not essential if all joints and connections are left exposed for such tests. The backfill at the sides of the pipe and immediately above it should be of the same material as that used under the pipe. The

initial cover of backfill over the pipe should be carried out by hand and compacted such that there is a good support between the sides of the pipe and the trench and a firm layer over the top of the pipe.

Where piping is to enter a building, the entry point should be above ground wherever this is practicable. Pipework shall not pass under the foundations of the building, under the base of a wall or under the footings. Where the pipework passes through the wall of the building, a metal sleeve shall be used and where appropriate, the same principles of construction used as if the pipework were passing through a cavity.

Plastic pipe work shall not be laid in chemically corrosive soils containing tars, oils or other acidic type residues. Manufacturers of such pipe should be consulted where there is any doubt.

8.6 Distribution pipework - Joints

Pipes shall be fusion welded wherever practicable. Screwed joints shall be kept to a minimum. Only compression fittings designed and approved for the specific gas application shall be used (this excludes domestic plumbing fittings). Compression fittings should not be used in systems where they may be exposed to wide temperature variations. They should be confined to the installation of instrument lines and similar small bore connections up to 15 mm. It is essential that manufacturer's installation instructions be followed when compression fittings of any type are used.

All welding should be made to qualified procedures of which the following are recommended:

- BS 2640 (26), *Specification for Class 2 oxy-acetylene welding of carbon steel pipework for carrying fluids*.

NOTE: This standard is classified as withdrawn by BSI.

- BS 2971 (27), *Specification for Class 2 arc welding of carbon steel pipework for carrying fluids.*

- BS 1821 (23), *Specification for Class 1 oxy-acetylene welding of ferritic steel pipework for carrying fluids*.

NOTE: This standard is classified as withdrawn by BSI.

- BS 2633 (25), *Specification for Class 1 arc welding of ferritic steel pipework for carrying fluids*.

- BS EN ISO 15607 (40), *Specification and qualification of welding procedures for metallic materials. General rules.*

- BS EN 287 (17), *Qualification test of welders. Fusion welding*.

- BS EN ISO 9606 (35), *Qualification testing of welders. Fusion welding*.

8.7 Distribution pipework - Supports

Table 4 provides a guide for the spacing of pipe supports.

Normal pipe size (mm)	Support spacing (m)
Up to 15	2.0
20	2.2
25	2.5
35	2.7
40	3.0
50	3.0

Table 4: Pipe supports - spacing

Supports shall be capable of supporting the pipe system without causing distortion. Supports shall also be adequate for the concentrated loads imposed by valves and risers and for axial loading due to expansions / contractions and the pressure of the fluid.

8.8 Distribution pipework - Protection

A number of different options are available.

8.8.1 Painting

Where painting is required, layers should be built up with compatible coats of primers, undercoat and finish coat.

Paint should be applied to supplier's recommendation on clean dry and rust free surfaces.

Paint colours should conform with Section 8.9.

8.8.2 Wrapping

For buried pipework / pipelines, or in corrosive atmospheres, a protective wrapping shall be applied. The protection shall be applied as a continuous wrap with sufficient overlap to prevent exposure of the pipe surface.

8.9 Distribution pipework - Identification

Pipelines shall be clearly identified by the name 'ACETYLENE' or by colour coding, refer to BS 1710 (22), *Specification for identification of pipelines and services*. A combination of both methods is preferred.

The identification markings shall be repeated as often as is necessary to ensure that the pipeline is clearly identified and will not be confused with adjacent pipelines carrying other substances.

8.10 Safety signs and warning notices

Gas cylinder stores, or stores where acetylene gas cylinders are connected to a manifold, shall have adequate signage to provide warnings and safety information, refer to BCGA

GN 2 (49). Outlets from manifolds and distribution pipework shall be appropriately identified.

Signage shall comply with:

- The Health and Safety (Safety Signs and Signals) Regulations (3).

- BS ISO 7010 (31), *Graphical symbols. Safety colours and safety signs. Registered safety signs.*

For additional advice refer to HSE L64 (12), *Safety signs and signals. The Health and Safety (Safety Signs and Signals) guidance on regulations*.

Signs and pictograms shall be clearly displayed. As appropriate, signs for the following hazards should be displayed:

- NO SMOKING

- NO NAKED LIGHTS

- NO SOURCES OF IGNITION

- NO MOBILE PHONES OR OTHER ELECTRONIC DEVICES

- FLAMMABLE GAS

- ASPHYXIATION HAZARD

With flammable gases there is a risk of the development of an explosive atmosphere. In accordance with DSEAR (6) if an explosive atmosphere may exist display the explosive atmosphere "EX" sign.

The Dangerous Substances (Notification and Marking of Sites) Regulations (2) require that if you hold 25 tonnes or more of a dangerous substance that you mark sites at the access points to warn of the presence or possible presence of dangerous substances.

Examples of signage are displayed in Figure 1.

In addition a notice shall be displayed showing:

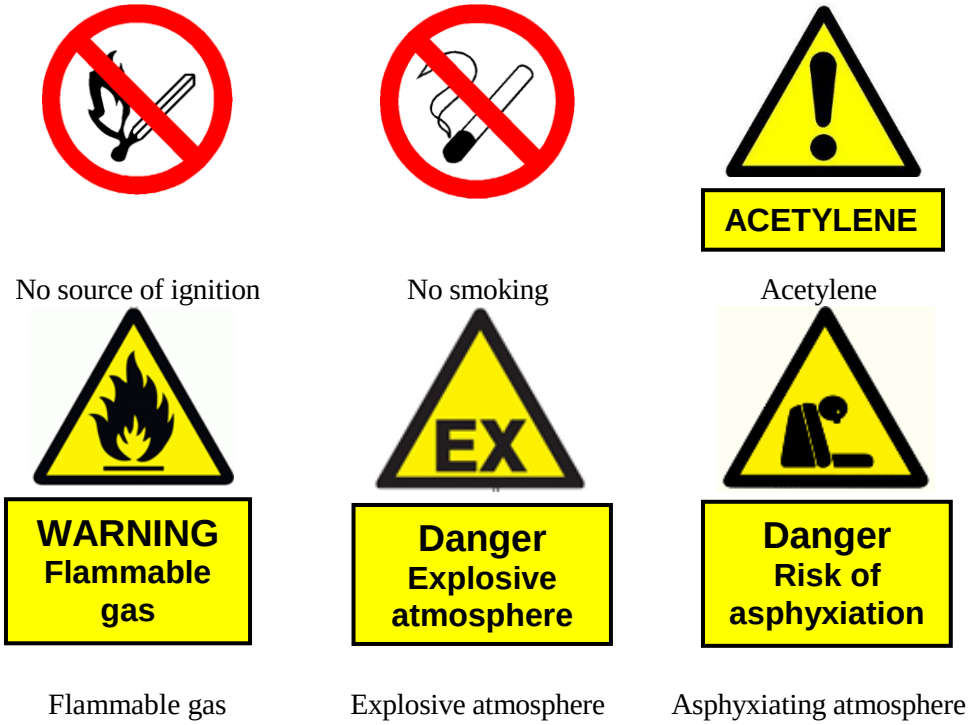
(i) Actions to take in the event of an emergency.

(ii) The site operator's routine contact details.

(iii) Emergency contact information including an emergency phone number, for example of the gas supplier and/or the site operator.

(iv) The emergency services phone number.

This information should also be available at a control point, for example the site control room or site security.



No source of ignition | No smoking | Acetylene

Flammable gas | Explosive atmosphere | Asphyxiating atmosphere

Figure 1: Examples of signage

8.11 Electrical equipment

Following the assessment of the installation under DSEAR (6), and where equipment is within zoned areas) electrical equipment shall be suitably explosion-protected and properly selected, installed, used and maintained as recommended in BS EN 60079 (41).

8.12 Winter precautions

In locations where low temperatures may affect operation of the system, heating of the enclosure may be advisable. There shall be no direct heating of acetylene stores and non-classified electrical equipment in stores should be avoided.

The method of heating the enclosure or equipment shall ensure that:

- The temperature of the manifold, cylinders and pipework systems does not exceed 30 °C.

- Any direct heating of acetylene cylinders is not allowed.

9. KEEPING OF ACETYLENE CYLINDERS

Gas cylinder stores, or stores where acetylene gas cylinders are connected to a manifold, are to be located in a safe, secure, well-ventilated position preferably in the open air, away from potential sources of ignition. Gas cylinder stores shall comply with BCGA GN 2 (49). Only authorised personnel shall have access to cylinder storage areas.

9.1 General

So far as is reasonably practicable, the supply of acetylene (and associated oxygen etc.) should be by a permanent piped system from cylinders sited in a location specially designed for the keeping of cylinders.

Acetylene cylinders shall only be used in the vertical position. If a cylinder has been stored or transported horizontally, it should be stood upright for a minimum of 1 hour prior to use. This will allow the acetone to evenly re-distribute within the cylinder and prevent acetone being carried into the flame during use causing a 'flame thrower' effect.

9.2 Storage of unconnected cylinders

Cylinders not connected for use shall be stored in a gas cylinder store.

Full and nominally empty cylinders of acetylene should be stored in the vertical position. All cylinders, including nominally empty cylinders, shall be stored with the cylinder valves closed, except acetylene bundles where the individual valves should be left open and the outlet valve closed.

9.3 Permanent piped systems

Single, or manifolded acetylene cylinders connected to permanent systems, shall be located in a gas cylinder store. Where siting in the open air is not reasonably practicable, specially designed storage buildings should be used which are in accordance with Section 9.5. Cylinders connected to permanent systems should not be kept within occupied rooms, workrooms, etc.

9.4 Non-permanent systems

Cylinders of acetylene and gases used in association (for example, oxygen), connected for non-permanent use, should be kept in the gas cylinder store when not required for use. Where this is not reasonably practicable, such cylinders may be kept in a workroom provided that:

- The workroom is a secure work environment where only authorised personnel can access the cylinders.

- The quantity of cylinders is restricted to the smallest reasonably practicable number.

- The workroom is provided with a high standard of permanent natural ventilation at high and low level.

- The cylinders are kept well away from any source of fire hazard (for example, storage of flammable or combustible materials) or heat (refer to Section 8.12) and where reasonably practicable, in a well-defined area marked with a conspicuous marking (refer to Section 8.10).

- Cylinder valves are closed when the gas is not in use; especially outside working hours.

- Where cylinders are left in buildings outside hours of occupation, a warning notice is prominently displayed outside the workroom indicating the presence of

gas cylinders (including acetylene cylinders) inside the workroom, refer to Section 8.10.

9.5 Buildings for fixed manifolds and storage of unconnected acetylene cylinders

Any structure used to keep acetylene cylinders should be so positioned or constructed that the cylinders within it are not liable to damage (for example, from a fire or by physical impact). The structure shall be provided with a very good standard of permanent natural ventilation directly to the open air, at high and low levels, and should be constructed of non-combustible materials. The structure shall be separated by an impermeable partition. Such partitions should be of at least 30 minutes' fire-resisting construction, imperforate and constructed of materials such as solid masonry or concrete (for example, a double brick wall), refer to BS 476 (18), *Fire tests on building materials and structures*, from any other area of a building to which the cylinder housing is attached, or which is less than 5 m (horizontal distance) from it.

The structure housing the cylinders should be provided with adequate explosion relief, equivalent to at least the area of the roof or one of the largest sides. This explosion relief should only be incorporated into the external walls or roof on the building and it should be designed so that if an explosion occurs, it satisfactorily vents the explosion without dangerous fragmentation.

9.6 Minimum recommended separation distance

Minimum recommended separation distances are largely dependent upon individual circumstances. The supply source may be located adjacent to the building it is to serve, or other buildings, provided the building is constructed of fire-resistant material of at least 30 minutes' fire-resisting construction, (refer to Section 9.5).

For cylinders, or bundles in use, the horizontal minimum recommended separation distances are given in Appendix 7.

9.7 Cylinder transportation

Gas cylinders comply with the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (8). These regulations implement the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) (10), which provides a framework for dangerous goods to be carried internationally in road vehicles subject to compliance with standards for the packaging and labelling of the dangerous goods, and appropriate construction and operating standards for the vehicles and crew. Gases are classified as Class 2 dangerous goods.

BCGA provide specific guidance for transporting gas cylinders in BCGA GN 27 (51), *Guidance for the carriage of gas cylinders on vehicles*. Where gas cylinders are transported in mobile workshops and other specialist vehicles refer to BCGA CP 31 (47), *The safe storage and use of cylinders in mobile workshops and service vehicles*.

10. TESTING NEW OR MODIFIED INSTALLATIONS

The system shall be adequately purged with an inert gas both before testing on existing installations and after testing to remove air before the introduction of acetylene.

For manifold testing refer to BCGA CP 5 (45).

All pipework used for the supply and distribution of acetylene shall be tested before being taken into use to ensure that all joints etc. are leak free. There shall be no noticeable pressure drop in the system when it is tested with an inert gas at a pressure of not less than 4 bar over a minimum period of half hour. A record of this test shall be retained and kept available for inspection.

Where an existing installation is modified it shall be tested in the same way as a new installation.

NOTE: Specialist safety equipment and pressure gauges may need to be removed or isolated for this test.

10.1 Function tests

Check stop valves for closure tightness and gland leakage.

Check manifold changeover valves for closure tightness and gland leakage. Automatic changeover devices should be checked for correct operation.

Check cut-off devices for correct operation and set pressure.

Check regulators for correct operation and outlet pressures.

11. IN-SERVICE REQUIREMENTS FOR PRESSURE EQUIPMENT

11.1 Introduction

The Health and Safety at Work etc. Act (1), places duties on organisations and employers to protect the health and safety of employees and/or members of the public. The duties include the provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health. This includes the use of pressure equipment.

The in-service examination, maintenance and inspection of pressure systems is regulated by the Pressure Systems Safety Regulations (5). It should be noted that the overall intention of the Pressure Systems Safety Regulations (5) is to prevent serious injury from the hazard of stored energy, as a result of the failure of a pressure system or one of its component parts.

The primary responsibility for compliance with these regulations lies with the user of the pressure equipment and it is his responsibility to enlist the assistance he requires to comply with the Regulations.

HSE L122 (13), *Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice*, provides further guidance on the Pressure Systems Safety Regulations (5).

All equipment is subject to the Provision and Use of Work Equipment Regulations (PUWER) (4) which requires that work equipment should not result in health and safety

risks, regardless of its age, condition or origin. The PUWER (4) requires that the employer selects suitable equipment and carries out appropriate maintenance, inspection, identifies any specific risks and provides suitable information, instructions and training.

HSE L22 (11), *Safe use of work equipment. Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance*, provides further guidance on the PUWER (4).

HSE have advised owners and users of portable and mobile oxy-fuel welding and cutting sets that do not contain safety devices as defined in the Regulations, that Written Schemes of Examination are not required. HSE emphasises that, although gas welding sets are not considered to pose a risk from the release of stored energy, they do pose a risk of fire or explosion if they are not assembled, operated or maintained correctly. Under the Health and Safety at Work etc. Act (1), employers and self-employed people who use gas-welding sets need to take appropriate steps to ensure that such risks, particularly risks from inadequate maintenance, are properly controlled.

BCGA CP 39 (48), *In-service requirements of pressure equipment (gas storage and gas distribution systems)*, provides guidance on the requirements for pressure equipment in service.

11.2 Repair and modification

It is the responsibility of the employer of a person who installs, repairs or modifies a pressure system to ensure that nothing about the way it is repaired or modified gives rise to danger, or otherwise impairs the operation of any protective device (for example, pressure relief valve or bursting disc) or inspection facility.

All repairs and modifications must be carried out to the same design and construction standards as the original system so as not to reduce its integrity. Full testing of the repaired or modified system will be required on completion.

System records, flowsheets / schematics, general layout drawings, operating instructions etc. will need to be updated following repair and modification. Consideration shall also be given to the need to amend the system safe operating limits.

11.3 Provision of information

The designer, supplier or the employer of a person who installs, modifies or repairs a pressure system shall provide sufficient written information to enable the user of a pressure system to determine the safe operating limits within his responsibility. Such information may include the following:

- System flowsheets / schematics.
- Design pressure.
- Operating instructions (including emergency procedures).
- Written Scheme of Examination.
- Test Certificates.

- System schematics or flowsheets.

Such information shall be included in the handover documentation or operating instructions supplied to the user.

11.4 Written scheme of examination

In order to conform with the requirements of the Pressure Systems Safety Regulations (5), the user of an installed system shall not allow it to be operated without a Written Scheme of Examination certified by a Competent Person.

A Written Scheme of Examination is not required for portable or mobile systems.

The Written Scheme of Examination should cover the following items as a minimum requirement:

- All protective devices.
- All manifold pressure regulators (when they are a primary protective device).
- All high pressure hoses and pigtails.
- All pipework where a failure would give rise to danger.

11.5 Operation

Suitable instruction cards shall be displayed to indicate operation of controls and a system flowsheet / schematic shall be available.

Safety signs and warning notices appropriate to the installation shall be clearly displayed as well as emergency contact information refer to Section 8.10.

The supplier shall provide the user with information on operating conditions and these shall not be changed such that safe working could be jeopardised. Any change shall be approved by a competent authority.

All operators shall receive adequate instruction and training before operating manifolds and pipelines.

11.6 Maintenance

Maintenance is required to ensure equipment remains in a safe condition. It is the responsibility of the user to ensure that this is carried out.

Important differences exist between maintenance and Written Scheme of Examination activities. The latter are formal assessments of the pressure system, or part of it, in regard to its ability to operate safely for a further specified period. The assessment only considers potential danger from the uncontrolled release of stored energy.

Formal postponement procedures and restrictive controls apply to Written Scheme of Examination activities but not to maintenance. Maintenance however, covers a wide range of activities ranging from such items as servicing, lubrication, adjustment,

performance checks and painting through to routine safety inspections. The latter may partially overlap Written Scheme of Examination activities but they are not as comprehensive and do not provide a complete assessment. As such they are not subject to formal postponement procedures and restrictive controls.

The maintenance schedule for a system should include a weekly (Section 11.6.1) and an annual (Section 11.6.2) inspection as a minimum requirement. These check lists are not exhaustive and may need to be expanded for specific installations.

11.6.1 Weekly inspection

A weekly inspection is to be carried out by the user. Check that:

- Visually equipment is in good order, is being correctly used and all the required equipment is fitted.
- Manifold, framework and chains are in good condition.
- Pigtails and flexible hoses are not corroded or damaged.
- Valves shut-off and open correctly.
- Regulators are identified as being suitable for the gas and pressures and are not damaged. They remain within their allocated life span.
- System is operating normally, i.e. report if system is using more gas than normal, an unusual drop in pressure or smell of gas which could indicate a malfunction or leak.
- Manifold house is free from oil and combustible materials and is not being used as a store room.

11.6.2 Annual inspection

An annual inspection is to be carried out by a person with appropriate experience and knowledge. Check that:

- All changes (including removals and additions of components) and extensions carried out, conform to this Code of Practice.
- Changes in the vicinity of the installation do not affect its operation or safety.

  Examples are location of heat sources or burners, moving of machines or workplaces, occurrence of vibrations, use of a pipeline as an electrical earth or as a support for other items, proximity to electrical installations and to other pipe systems.
- There is adequate identification of above ground pipelines and route markers for buried pipelines.

- Leak testing of permanent installations at the designated operating pressure under static conditions has been carried out at intervals of not more than 12 months during the service life of the installation. Records of these tests shall be retained for not less than 15 months and kept available for inspection, for example, to an inspector from the relevant enforcing authority.

- Buried pipelines are in ground which is free from erosion, subsidence, and encroachment by other services, buildings or civil structures. Also check damage to cathodic protection and record readings where applicable.

- Filters are in good condition and are not blocked. Clean or replace where necessary.

- Valves to be used in normal operation or for emergency are accessible and are easy to operate. Valves at service point outlets and vent valves are to be checked for tightness.

- The setting and operation of regulators is satisfactory.

- The operation of safety devices is correct, for example, safety shut-off valve, non-return valves, flashback arrestors and cut-off valves. Safety devices shall only be repaired by the manufacturer or agent.

- Safety signs and warning notices are present and legible.

- The external finish of pipelines and their protection against corrosion is acceptable.

- Pipeline hoses and associated equipment are free from damage and acceptable for further use.

- The condition of equipment connected to cylinders and outlet points (Classes 1-7) is acceptable.

11.7 Keeping of records

The following records shall be kept by the user (or the owner in the case where there is a written agreement in place for the owner to undertake the examination and maintenance of the system):

- Written Scheme of Examination.

- The last report in accordance with the Written Scheme of Examination.

- Previous reports if they assist in assessing whether the system is safe to operate.

- Details of any repairs or modifications carried out.

- Any designer's/manufacturer's/supplier's documents relating to parts of the system included in the written scheme.

- All other reports which contain information relevant to the assessment of matters of safety.

- Agreement to postpone an examination and notification to the enforcing authority.

- Details of any out of service periods and storage conditions (where appropriate).

These records shall be kept either at the premises where the equipment is installed or at the office of the user or owner when applicable. Examination reports and the written scheme of examination may be kept in hard copy form, stored electronically or on computer disc. If a computer system is used to keep this information then it must be able to reproduce it as a written copy when necessary, for example to an inspector from the relevant enforcing authority. It should be protected from unauthorised alteration and be authenticated only by the competent person who carried out the examination.

12. EMERGENCY PROCEDURES

The user should have a site-specific emergency procedure in place for fire situations in compliance with The Regulatory Reform (Fire Safety) Order (7).

BCGA Leaflet 6 (52), *Cylinders in fires*, provides guidance on dealing with gas cylinders involved in a fire. Additional information is available on the BCGA website under 'Cylinders in Fire'.

The correct location of cylinders, the correct assembly of equipment and correct operation will all contribute to minimising the risk of an incident involving gas cylinders.

12.1 Action in the event of a fire

(i) KEEP AWAY, do not approach or attempt to move the cylinder or open the valve.

(ii) Sound the alarm.

(iii) Evacuate the danger area.

(iv) Call the Fire and Rescue Service.

NOTE: Inform the Fire and Rescue Service of the type of gas (acetylene, and any other gases in the store), the quantity of cylinders, their size and location. They will also be interested in other stores on the premises where hazardous goods are stored so they can take appropriate safety precautions.

If gas cylinders are directly involved in a fire, keep well clear until the Fire and Rescue Service arrive and then follow their instructions. The Fire and Rescue Service have operational procedures in place for dealing with gas cylinders in a fire. The Fire and Rescue Service will inform you when it is safe to handle a cylinder.

Cylinders which are not directly involved in the fire and which have not become heated, should be moved as quickly as possible to a safe place, provided that this can be done without undue risk. Ensure that cylinder valves are closed.

As required, contact the gas supplier for advice on the gases or the gas cylinders involved in a fire.

12.2 Action after a fire

The gas supplier shall **ALWAYS** be notified of any cylinder involved in a fire.

Do not use any fire-damaged cylinders.

After the fire is out, and the area has been declared safe by the Fire and Rescue Service, quarantine any fire-damaged cylinders in a safe place. Mark, or label, fire-damaged cylinders to clearly show that they have been in a fire. Arrange collection of fire damaged cylinders with the gas supplier at a mutually convenient date. Further information, including contact numbers, is available in BCGA Leaflet 6 (52).

13. REFERENCES

	Document Number	Title
1.		The Health and Safety at Work etc. Act 1974
2.	SI 1990 No. 304	The Dangerous Substances (Notification and Marking of Sites) Regulations 1990.
3.	SI 1996 No 341	The Health and Safety (Safety Signs and Signals) Regulations 1996.
4.	SI 1998: No. 2306	The Provision and Use of Work Equipment Regulations 1998 (PUWER).
5.	SI 2000 No 128	The Pressure Systems Safety Regulations 2000 (PSSR).
6.	SI 2002 No 2776	The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).
7.	SI 2005 No. 1541	The Regulatory Reform (Fire Safety) Order 2005.
8.	SI 2009 No. 1348	The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended).
9.	SI 2014 No. 1639	The Acetylene Safety (England and Wales and Scotland) Regulations 2014.
10.	ECE/TRANS/215	European Agreement concerning the international carriage of dangerous goods by road (ADR).
11.	HSE L22	Safe use of work equipment. Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance.
12.	HSE L64	Safety signs and signals. The Health and Safety (Safety Signs and Signals) guidance on regulations.
13.	HSE L122	Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice.
14.	HSE L138	Dangerous substances and explosive atmospheres. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Codes of Practice and Guidance.
15.	HSE INDG 327	Working safely with acetylene.
16.	HSE INDG 370	Controlling fire and explosion risks in the workplace. A brief guide to DSEAR.

	Document Number	Title
17.	BS EN 287	Qualification test of welders. Fusion welding.
18.	BS 476	Fire tests on building materials and structures.
19.	BS EN 560	Gas welding equipment. Hose connections for welding, cutting and allied processes.
20.	BS EN 730: Part 1 Part 2	Gas welding equipment. Safety devices. 1. Incorporating a flame (flashback) arrestor. 2. Not incorporating a flame (flashback) arrestor.
21.	BS EN 1256	Gas welding equipment. Specification for hose assemblies for equipment for welding, cutting and allied processes.
22.	BS 1710	Specification for identification of pipelines and services.
23.	BS 1821	Specification for Class 1 oxy-acetylene welding of ferritic steel pipework for carrying fluids. NOTE: This standard has been withdrawn by BSI.
24.	BS EN ISO 2503	Gas welding equipment. Pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa).
25.	BS 2633	Specification for Class 1 arc welding of ferritic steel pipework for carrying fluids.
26.	BS 2640	Specification for Class 2 oxy-acetylene welding of carbon steel pipework for carrying fluids. NOTE: This standard has been withdrawn by BSI.
27.	BS 2971	Specification for Class 2 arc welding of carbon steel pipework for carrying fluids.
28.	BS EN ISO 3821	Gas welding equipment. Rubber hoses for welding, cutting and allied processes.
29.	ISO 4200	Plain end steel tubes, welded and seamless. General tables of dimensions and masses per unit length.
30.	BS 5958 Part 1 Part 2	Code of practice for control of undesirable static electricity. 1. General requirements. 2. Recommendations for particular industrial situations.
31.	BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs.

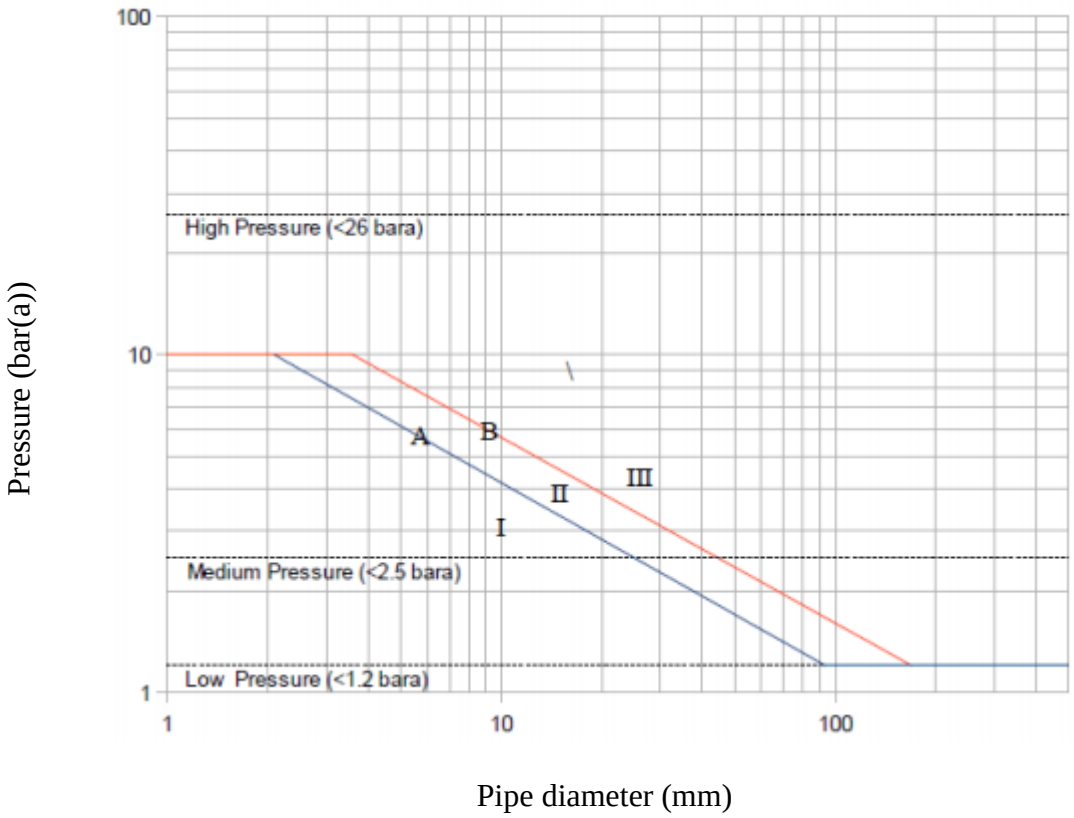
	Document Number	Title
32.	BS EN ISO 7291	Gas welding equipment. Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar).
33.	BS 8313	Code of Practice for accommodation of building services in ducts.
34.	BS EN ISO 9539	Gas welding equipment. Materials for equipment used in gas welding, cutting and allied processes.
35.	BS EN ISO 9606	Qualification testing of welders. Fusion welding. Steels.
36.	BS 9999	Code of practice for fire safety in the design, management and use of buildings.
37.	BS EN 10255	Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions.
38.	BS EN ISO 14113	Gas welding equipment. Rubber and plastics hose and hose assemblies for use with industrial gases up to 450 bar (45 MPa).
39.	BS EN ISO 14114	Gas welding equipment. Acetylene manifold systems for welding, cutting and allied processes. General requirements.
40.	BS EN ISO 15607	Specification and qualification of welding procedures for metallic materials. General rules.
41.	BS EN 60079 Part 19	Electrical apparatus for explosive gas atmospheres. 19. Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives).
42.	EIGA IGC Document 30	Disposal of gases.
43.	EIGA IGC Document 123	Code of practice acetylene.
44.	BCGA Code of Practice 4	Industrial gas cylinder manifolds and distribution pipework (excluding acetylene).
45.	BCGA Code of Practice 5	The design and construction of manifolds using acetylene gas from 1.5 - 25 bar.
46.	BCGA Code of Practice 7	The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply).

	Document Number	Title
47.	BCGA Code of Practice 31	The safe storage and use of cylinders in mobile workshops and service vehicles.
48.	BCGA Code of Practice 39	In-service requirements of pressure equipment (gas storage and gas distribution systems).
49.	BCGA Guidance Note 2	Guidance for the storage of gas cylinders in the workplace.
50.	BCGA Guidance Note 13	DSEAR Risk Assessment.
51.	BCGA Guidance Note 27	Guidance for the carriage of gas cylinders on vehicles.
52.	BCGA Leaflet 6	Cylinders in fires.

Further information can be obtained from:

UK Legislation	www.legislation.gov.uk
Health and Safety Executive (HSE)	www.hse.gov.uk
International Organization for Standardization (ISO)	www.iso.org
British Standards Institute (BSI)	www.bsigroup.co.uk
European Industrial Gases Association (EIGA)	www.eiga.eu
British Compressed Gases Association (BCGA)	www.bcga.co.uk

ACETYLENE WORKING RANGES



KEY:

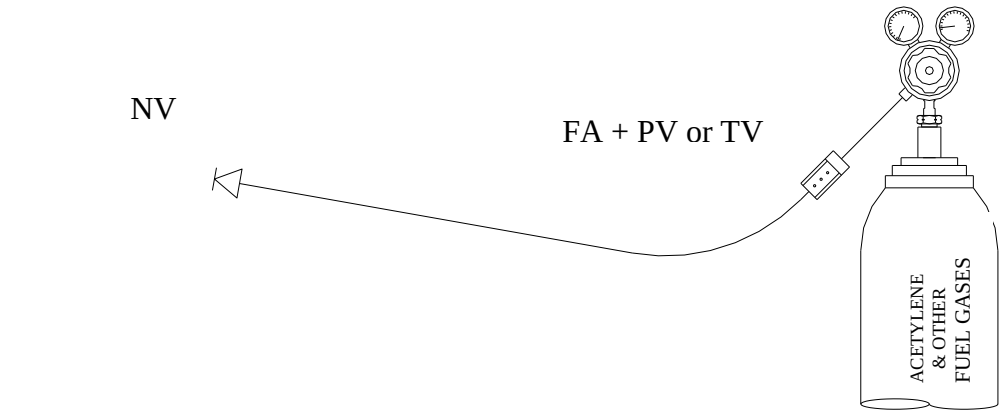
Working Ranges I, II, III

A: Deflagration limit pressure line
B: Detonation limit pressure line

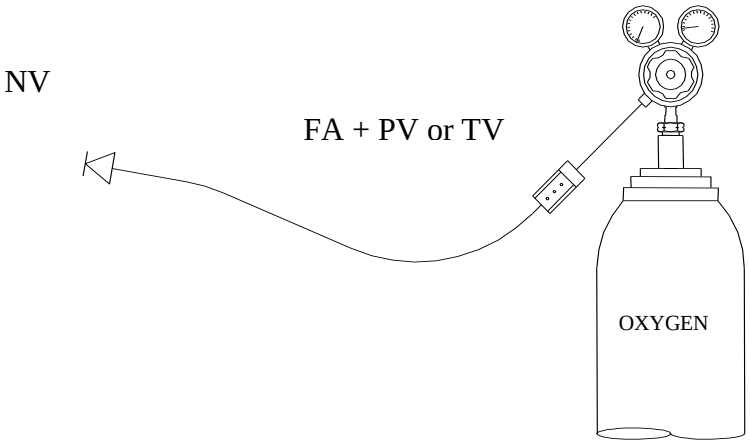
Source: EIGA Document 123 (43)

NON-PERMANENT, PORTABLE OR MOBILE INSTALLATION: CLASSES 1 & 2

Minimum requirement for all hose sizes and lengths



BLOWPIPE

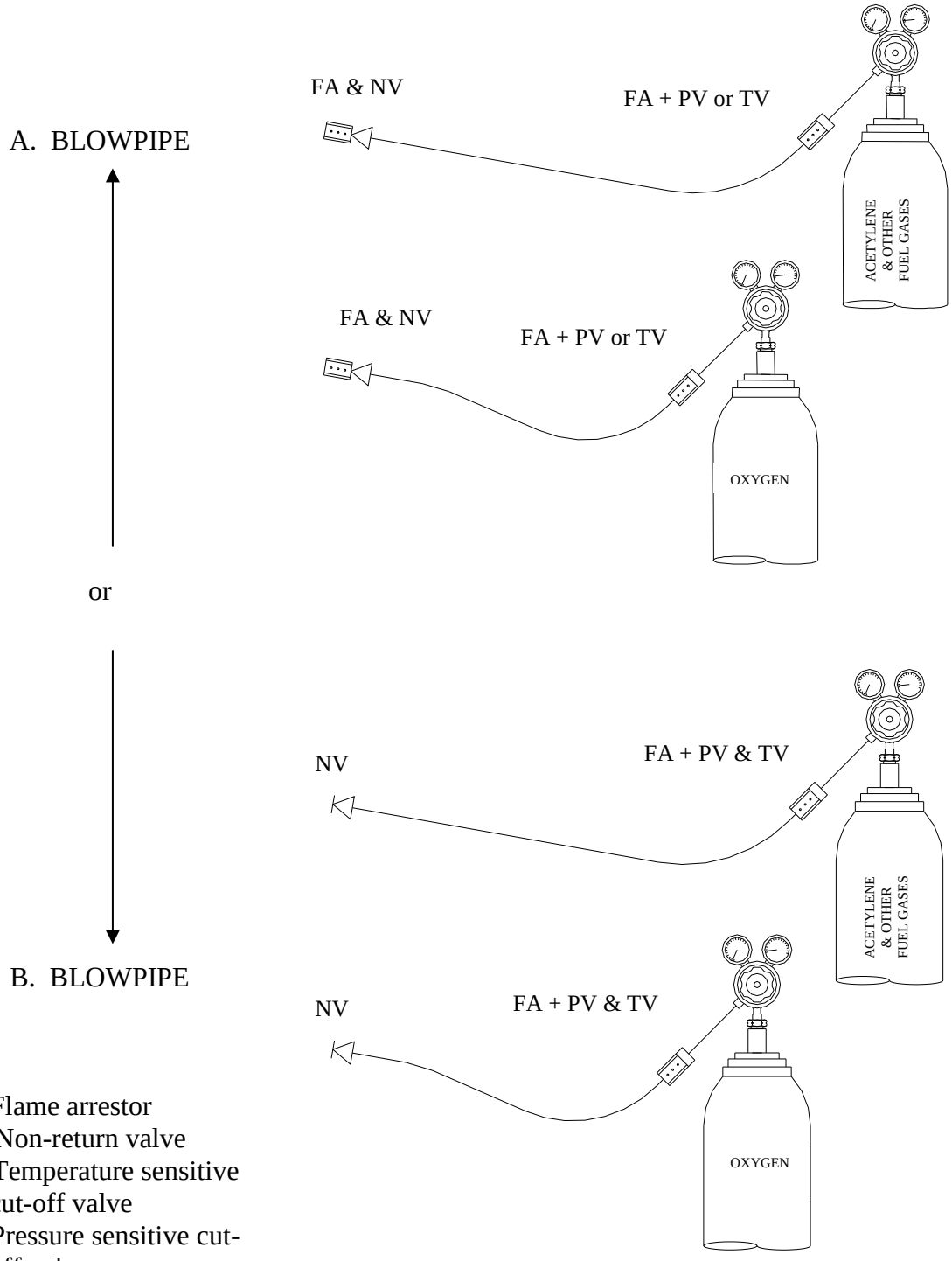


KEY:
FA Flame arrestor
NV Non-return valve
TV Temperature sensitive cut-off valve
PV Pressure sensitive cut-off valve

NOTE: Oxygen is included for clarity

NON-PERMANENT, PORTABLE OR MOBILE INSTALLATION: CLASSES 1 & 2

Recommended installation providing increased safety

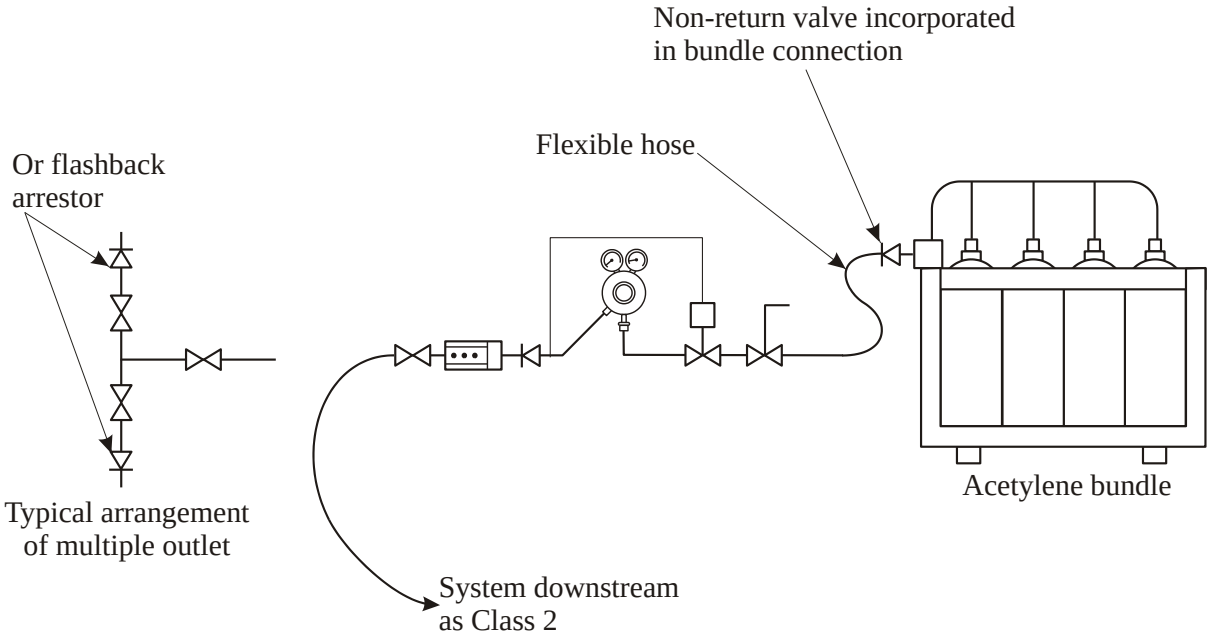


KEY:

FA Flame arrestor
NV Non-return valve
TV Temperature sensitive cut-off valve
PV Pressure sensitive cut-off valve

NOTE: Oxygen is included for clarity

MOBILE INSTALLATION USING A BUNDLE: CLASS 4



KEY

Isolation valve

Non-return valve

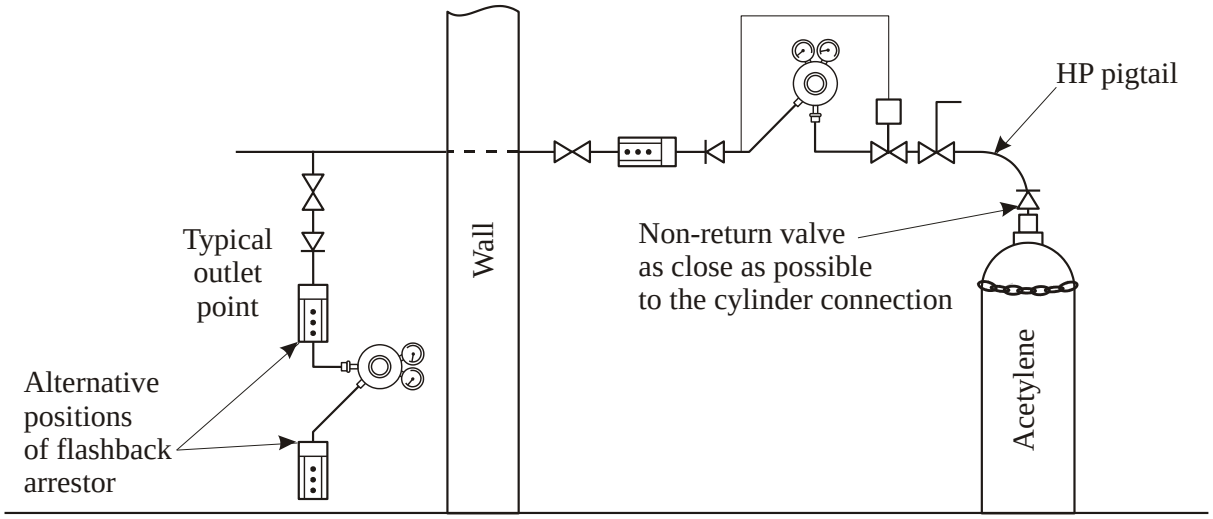
Pressure sensitive shut-off valve or relief device

Flashback arrestor and cut-off valve
(temperature or pressure sensitive)

Manual quick acting shut-off valve
or automatic quick acting shut-off device

Pressure regulator

PERMANENT SINGLE CYLINDER SUPPLY INSTALLATION: CLASS 5



KEY

Isolation valve

Non-return valve

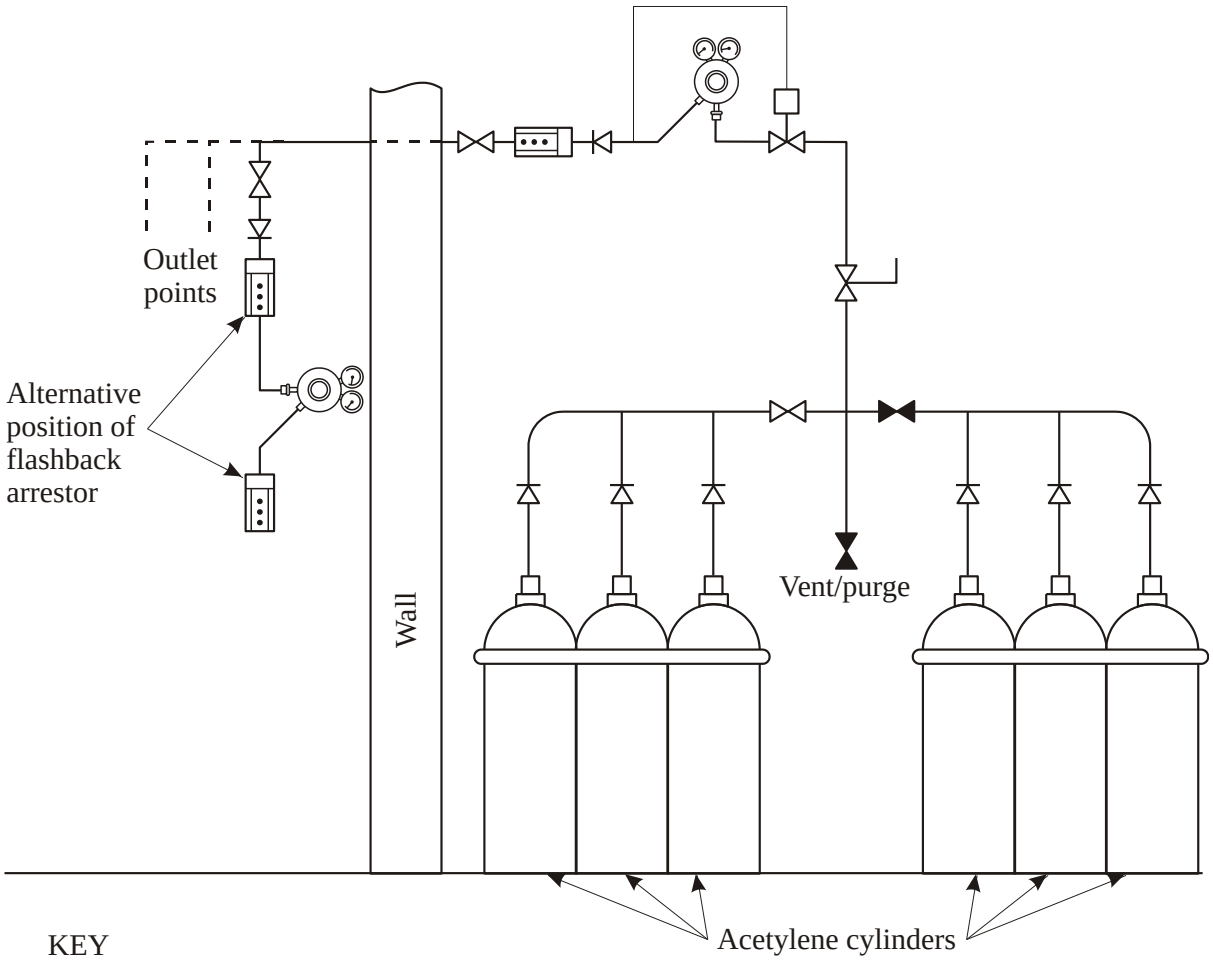
Pressure sensitive shut-off valve or relief device

Flashback arrestor and cut-off valve
(temperature or pressure sensitive)

Manual quick acting shut-off valve or
automatic quick acting shut-off device

Pressure regulator

PERMANENT INSTALLATION MANIFOLD SUPPLY: CLASS 6



KEY

Isolation valve

Isolation valve in closed position

Non-return valve

Pressure sensitive shut-off valve or relief device

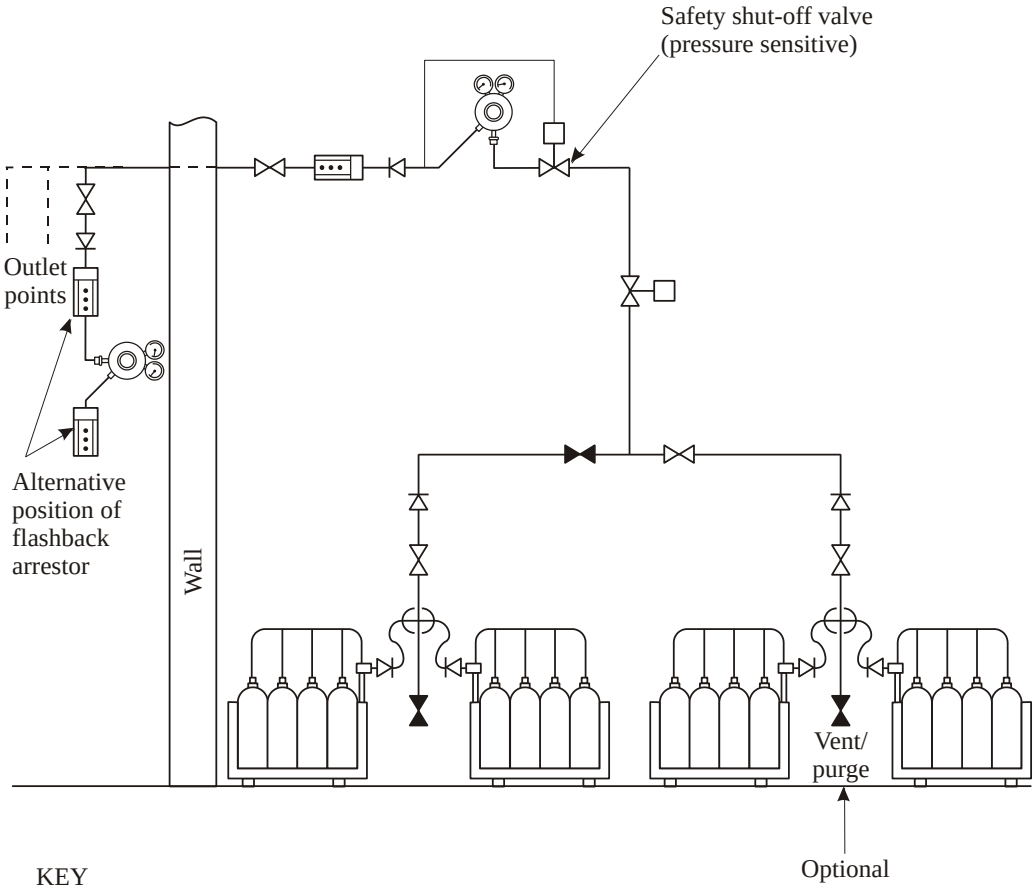
Manual quick acting shut-off valve
or automatic quick acting shut-off device

Flashback arrestor and cut-off valve
(temperature or pressure sensitive)

Pressure regulator

PERMANENT INSTALLATION : BUNDLE MANIFOLD : CLASS 7

Typical arrangement



KEY

Isolation valve

Isolation valve in closed position

Non-return valve

Pressure sensitive shut-off device

Pressure regulator

Flashback arrestor and cut-off valve
(temperature or pressure sensitive)

Automatic quick acting shut-off device

MINIMUM RECOMMENDED SEPARATION DISTANCE

For cylinders, or bundles in use, the horizontal minimum recommended separation distance from the following are displayed in Table A9-1.

- Gaseous oxygen storage and supply
- Non-flammable gas storage (liquid or gaseous other than oxygen)
- Naked flame, smoking and other sources of ignition
- Public roads
- Site boundaries
- Electrical equipment which is not suitably explosion-protected
- Car parks
- Flammable gas cylinder storage
- Openings in walls of offices, workshops etc.

Table A9-1 shows the minimum recommended separation distance depending upon the number of acetylene cylinders in use (including an equal number of connected standby cylinders).

Cylinders	Safety distance
1 to 2	2 m
3 to 12	3 m
13 to 60	5 m
61 and over	Seek advice from gas supplier

Table A9-1:

For the following, the separation safety distance shall never be less than 5 metres:

- Liquid oxygen fixed installations
- Combustible materials
- Bulk flammable liquids and bulk LPG storage
- Buildings of non-fire resisting materials
- Air compressor intakes

Where the required horizontal separation cannot be achieved, half hour fire-resistant walls (refer to Section 9.5) should be used. The safety distance may then be measured as the shortest distance around the ends of the wall to the acetylene installation. The height of the wall should not be less than 2.5 m. This approach may only be adopted to a limited extent and providing that the standard of ventilation of the acetylene installation is not significantly reduced.
Such partitions should be of at least 30 minutes' fire-resisting construction, imperforate and constructed of materials such as solid masonry or concrete.

British Compressed Gases Association

www.bcga.co.uk