RISCAuthority

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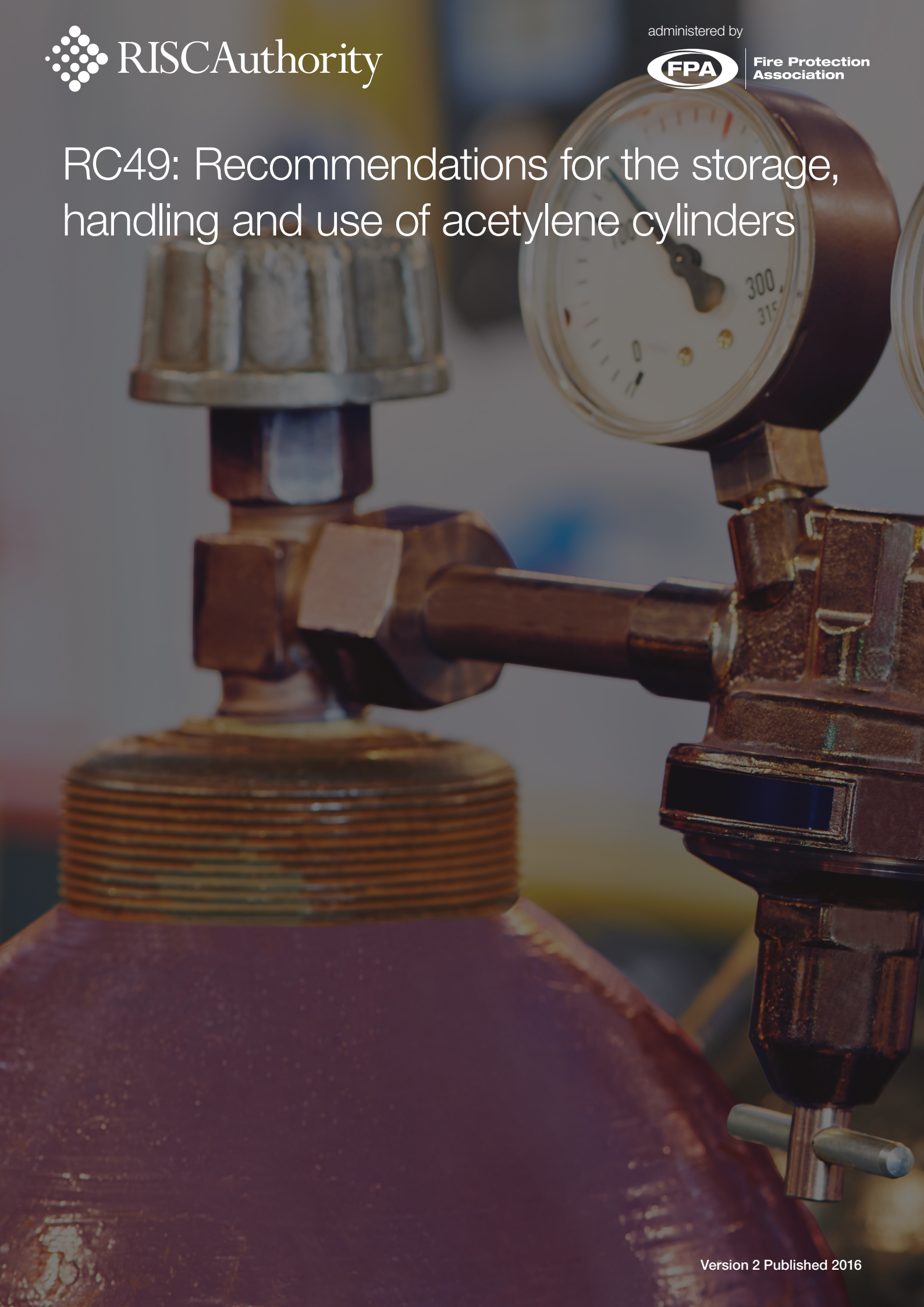
RC49: Recommendations for the storage, handling and use of acetylene cylinders



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Symbols used in this guide

Good practice

Bad practice

Discussion topic

FAQ Frequently asked question

Acknowledgements

Figure 1 was provided by the Health and Safety Executive.

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Summary of Key Points

Complying with the law	• When carrying out a fire risk assessment, staff remote from the process area and other people in the neighbourhood who may be affected by the effects of a fire should be considered as well as the staff handling and using the acetylene cylinders.
Ensuring the continuity of the business	• Due to the potential for serious damage if an incident was to occur while handling or using acetylene cylinders, it is particularly important that a suitable emergency plan is drafted and rehearsed periodically to test its effectiveness and suitability.
Managing the risk	• Alternative practical options to the use of acetylene (including the cost of providing or developing suitable skills) should be assessed with a view to eliminating the need for acetylene in the workplace wherever practicable. • The number of acetylene cylinders held on the premises should be minimised. • Acetylene cylinders should be so positioned that they are not exposed to heat sources such as direct sunlight, ovens, dryers and furnaces.
Storing acetylene cylinders	• Stored LPG cylinders should be separated from acetylene and other gas cylinders by a suitable fire wall. • Empty cylinders should be kept separate from full ones, although they may be kept in the same store provided they are clearly marked ‘MT’. • The acetylene cylinder store should be indicated by prominent notices for the information of the fire and rescue service.
Handling acetylene cylinders	• Even though it has been established that decomposition of acetylene within a cylinder cannot be initiated by mechanical shock alone, cylinders should not be dropped or allowed to come into violent contact with one another or with any hard object. • When cylinders are not being used, protective caps should be screwed on to protect the valves.
Leaking acetylene cylinders	• In the event that acetylene leaking from a cylinder valve ignites, make no attempt to shut the valve manually; call the fire and rescue service without delay and evacuate the building. • In the case of acetylene escaping from a cylinder valve with no fire in the vicinity, the valve should be closed, if this can be done safely, and the area ventilated thoroughly.

1 Synopsis

These recommendations give guidance to insurers and fire safety managers regarding the unique risk that acetylene cylinders present in the workplace.

Of particular importance is the threat to business continuity if an acetylene cylinder is involved in a fire. A hidden threat may be acetylene cylinders being involved in a fire on neighbouring premises.

Highlighted in the information are the results of research that has led to major changes in fire and rescue service procedures when dealing with incidents involving acetylene cylinders.

These recommendations describe the impact that incidents involving acetylene cylinders can have on a business. They outline the need for the use of acetylene cylinders in the workplace to be minimised and hot work undertaken with the minimum of risk. Business continuity plans should take into account the effects of an incident involving acetylene cylinders, especially where premises are situated in an urban or city centre environment.

2 Scope

These recommendations address the identification and fire and explosion hazards of acetylene in cylinders. They also concern the storage, use and handling of the cylinders. The need to consider eliminating the use of acetylene in the workplace is emphasised, and, where this is not practicable, reducing the risk by appropriately managing the minimum number of cylinders necessary on site.

3 Introduction

Acetylene is a flammable gas that, when burned with oxygen, produces a flame with a temperature approaching 3500°C. This is suitable for cutting and welding, as a result of which acetylene has many industrial applications, and cylinders may be encountered on construction sites, in vehicle repair workshops, engineering workshops and in some laboratories where it is used in conjunction with oxygen or nitrous oxide for atomic absorption spectroscopy.

Acetylene is very hazardous in that it may detonate at elevated temperatures and pressures, even in the absence of air; the Explosives Directorate has thus deemed acetylene an explosive.

When an acetylene cylinder is heated, decomposition of the acetylene may occur. This is an exothermic process which produces further heat. The resulting build up of heat from the unstable gas may result in a heated acetylene cylinder exploding; thus these cylinders present a unique hazard to firefighters.

Because of the possibility of an explosion, fire and rescue service safe working practices require the establishment of a hazard zone around an acetylene cylinder involved in a fire to limit exposure of the cylinder to personnel and allow it to be cooled and its safety ensured before removal.

All gas cylinders involved in a fire or exposed to heat are potentially dangerous, but acetylene cylinders are much more so. This has serious implications not only for the business concerned, but for the whole neighbourhood. The occurrence of incidents involving gas cylinders is significant and not only results in buildings being evacuated but also elements of the transport infrastructure, including roads and railways, being unavailable for use to the public for a period of time, with potential delays for some time later while services return to normal.

Implementing statutory requirements and best practice for the storage, handling and use of cylinders containing acetylene may help reduce the probability of an incident occurring, but may do little to reduce the consequent business interruption if an incident does occur. It is therefore important for businesses to consider the consequences of an acetylene incident

as part of their fire risk assessment and business continuity analysis. The business continuity plan for every site should include an analysis of potential threats, not only from within the organisation, but also from neighbouring businesses.

Acetylene cylinders

Acetylene is supplied in steel cylinders that are painted maroon; the new style cylinders of composite construction that are used for gases such as LPG are not used for the supply of acetylene.

Acetylene cylinders are filled with a porous mass that has been charged with a solvent (usually acetone) in which the acetylene is dissolved. This ensures that the gas is maintained in a stable condition and assists with cooling heated cylinders. In older cylinders, the porous mass consisted of kieselghur (a diatomaceous earth – a fine powder) along with charcoal and asbestos. Modern-day cylinders use a silica lime filler with additives such as fibreglass.

Acetylene is stable at ambient conditions but may become unstable at elevated temperatures and pressures. When subject to heating, acetylene in cylinders may decompose with the production of heat and this is a potentially dangerous situation. Even though acetylene cylinders are designed to withstand decomposition and cool naturally, catastrophic failure can still occur under certain circumstances. The tensile strength of steel used in manufacturing acetylene cylinders begins to be lost when the temperature reaches 300°C; cylinders that reach this temperature are therefore likely to fail explosively.

Decomposition of acetylene in a gas cylinder may only be initiated by excessive temperature; recent research has shown that it cannot be initiated by mechanical shock alone.

Older acetylene cylinders may occasionally be encountered which are fitted with pressure relief devices in the form of fusible plugs situated in the neck or on the bottom of the cylinder, or even a bursting disc built into the base of the valve. Tests conducted by the Health and Safety Laboratory of the Health and Safety Executive (HSE) in the mid-1990s, however, concluded that these venting devices were not effective in preventing cylinder failure under fire conditions and thus they are no longer a feature of cylinders available in the UK and Europe. They are, however, still fitted to cylinders manufactured in the United States, and might be encountered elsewhere.

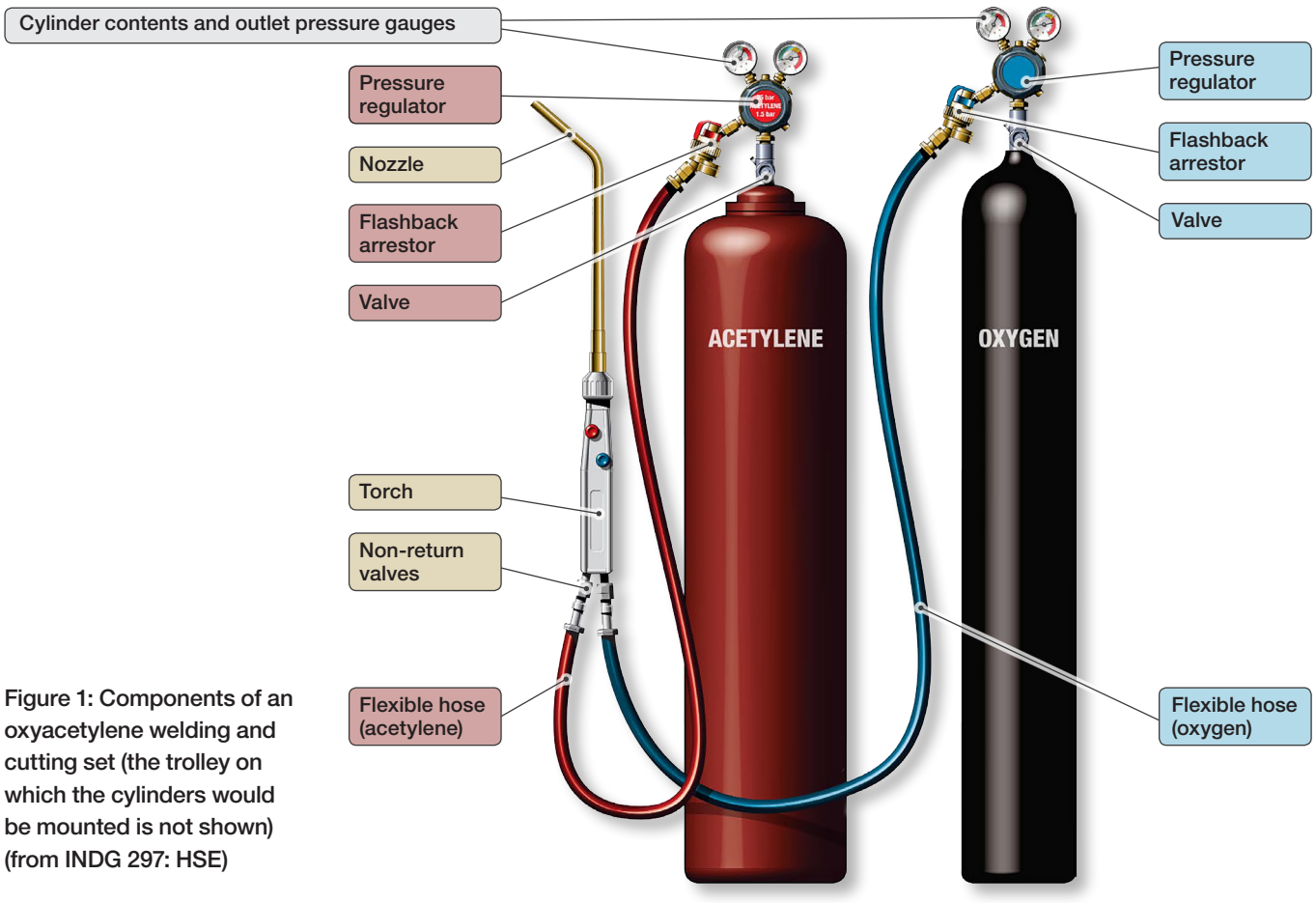


Figure 1: Components of an oxyacetylene welding and cutting set (the trolley on which the cylinders would be mounted is not shown) (from INDG 297: HSE)

FAQ

What is a hazard zone?

A hazard zone is a prohibited area for members of the public and other non-essential personnel. Certain fire service personnel may enter the area to carry out specified tasks under the supervision of a safety officer in accordance with the fire service dynamic risk assessment.

- Ensure that all relevant staff are trained in the correct handling, use and storage of acetylene cylinders.
- Identify methods of cutting, welding and brazing that are appropriate for your business following a risk assessment concerning life safety, property protection and business continuity.

The hazard zone

In the event of a fire involving an acetylene cylinder the procedures followed by fire and rescue services are based on ensuring the safety of firefighters and the general public and reducing damage to property. One of the initial actions when arriving at the fire ground is for the incident commander to establish if gas cylinders are involved. If they are, then the type, number and location of the cylinders must be determined without delay. Prominent hazard warning signs at the entrance to the site are thus important to warn firefighters of the potential hazard.

When it is suspected that acetylene cylinders are involved in a fire, the procedure followed is likely to include the following:

- establishing, in liaison with the police, an initial hazard zone of up to 200m around the cylinder(s). This area may later be reduced depending on the topography of the surrounding land and the degree of protection provided by nearby buildings and structures;
- determining the identity of the cylinders and whether or not they have been exposed to heat, for example by examining the identifying paintwork;
- establishing an inner cordon to manage and control access to the cylinders by firefighters, following the assessment of the hazard zone;
- considering whether any further measures are necessary to ensure the safety of the public and non-essential fire and rescue service personnel;
- undertaking firefighting activities in accordance with the fire service's dynamic risk assessment. (This assessment includes an evaluation of the situation, tasks and persons at risk and is used as an incident command tool at all fires and other emergencies); and
- maintaining the hazard zone while cooling and testing activities are carried out.

Where the fire and rescue service have established a hazard zone around a fire damaged cylinder there is likely to be a significant impact on business operations, even if it is subsequently established that no acetylene cylinders have been involved.

Standard procedures involve cooling the cylinder for one hour before carrying out a wetting test. If the wetting test provides a satisfactory result the test will be repeated every 15 minutes for the following hour. This is to ensure that there is no heat being produced within the acetylene cylinder as a result of decomposition of the gas. Thermal imaging cameras may also be used to establish if internal heating is occurring.

A successful conclusion of this monitoring phase will result in the cylinder being declared safe and arrangements being made, in conjunction with the appropriate representative from the premises, for its removal.

The reduction in the area of the hazard zone and its final removal remain at the discretion of the fire and rescue service and police operational commanders according to the results of their risk assessments.

It should be noted that the cooling operations will involve substantial quantities of water being released in the area of the cylinders. The fire and rescue service should be informed of the location of any basement stores or substances in the vicinity that are incompatible with water.

A small leak from an acetylene cylinder can result in a large volume of potentially explosive gas at room temperature and atmospheric pressure. Acetylene readily forms ignitable mixtures with air over an exceptionally wide range of concentrations and is, therefore, extremely hazardous. A mixture of acetylene and air is liable to explode when in contact with an ignition source such as a lighted match or an electrical spark.

Further information regarding gas cylinders is set out in RISCAuthority recommendations RC8: *Recommendations for the storage, use and handling of common industrial gases in cylinders* (ref 1).

4 Recommendations

Having more acetylene cylinders on your premises than required for the work in hand may have implications for the continuity of your business (as well as those of your neighbours) in the event of a fire.

4.1 Complying with fire safety legislation

4.1.1 Because of the hazards associated with the storage and use of acetylene, cylinders of the gas should be a major consideration when preparing the fire risk assessment for the premises in compliance with the Regulatory Reform (Fire Safety) Order 2005 or equivalent legislation for Scotland and Northern Ireland (refs 2 to 6).

4.1.2 As well as considering the staff handling and using acetylene cylinders, the assessment should also consider staff remote from the process area who may be affected by the effects of the fire. Where acetylene cylinders are in use or stored the implications for other people in the neighbourhood should also be addressed. In business critical areas the implications for property protection and business continuity, as well as life safety, should feature prominently in the assessment. It is therefore important that the risk assessment process for all premises should take into consideration the potential impact on business continuity of a hazard zone being identified not only in their own premises but also in other premises in the neighbourhood.

4.1.3 An assessment should be undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (as amended) (DSEAR) (ref 7). In common with the fire risk assessment, this should be undertaken by a competent person; it should identify any hazard zones in the workplace.

4.1.4 Risk assessments should be subject to periodic review, including when any change to the process, the mechanism for storing acetylene or handling acetylene is made.

4.1.5 Equipment used with acetylene cylinders should comply with the Acetylene Safety (England and Wales and Scotland) Regulations 2014 (ref 8).

4.1.6 The response by fire and rescue services to 999/112 calls and signals routed via fire alarm monitoring organisations varies widely throughout the UK, and differs from day to night time. Fire safety managers should refer to the relevant fire and rescue service to make themselves aware of the levels of response in the areas in which their premises are located and consider this information when undertaking and reviewing their fire risk assessments.

4.2 Business continuity

Even a small fire can have a disproportionate effect on a business if it occurs in a critical area. The use of acetylene is hazardous and must be carefully managed to avoid unnecessary disruption to the efficient functioning of the business.

4.2.1 All businesses should take steps to maintain the continuity of their operations by making a suitable emergency plan. Guidance for this is set out in *Business resilience: A guide to protecting your business and its people* (ref 9). The emergency plan should address the implications of a fire, flood or other perceived disaster on all facets of the business model. It should indicate the lines of communication that should be followed and the contact details for specialist assistance, providers of alternative accommodation and suppliers of replacement equipment.

4.2.2 The business continuity strategy should include the backing up of critical business information to other sites away from any potential hazard zone and duplicating storage of key elements of raw materials or stock. Further information is set out in the guidance note: *Business resilience: A guide to protecting your business and its people* (ref 9).

4.2.3 Tabletop exercises should be held periodically to test the effectiveness and suitability of the emergency plan.

4.2.4 Consideration may be given to applying commercially available computer programmes, such as the ROBUST software (Resilient Business Software Toolkit) that is available free of charge (ref 10), or similar product, to develop and check the adequacy of the plan.

4.3 Fire safety management

4.3.1 In all businesses, the processes to be employed should be assessed and reflect best practice in balancing effective working practices against the risk to life and property. Thus processes with the minimum of hazard should be employed wherever possible. In all cases a plan should be formulated for the actions that should be taken should an incident, such as a fire or an escape of gas, occur in the immediate area.

Table 1: Summary of some alternative cutting and welding options

Some alternative welding methods	
Manual arc welding	A versatile fusion method of welding suitable for a variety of components Low productivity
Metal inert gas welding (MIG)	Suitable for a variety of materials. High productivity and high quality results
Tungsten inert gas welding (TIG)	Less productive than MIG. Suitable for sheet metal or the root run of pipe butt welds
Spot welding	Usually used for steel sheet in automotive applications
Plasma welding	Usually used in automated processes, mainly for stainless steel containers and high pressure piping
Alternative fuel gases	May be suitable depending on the temperatures required. See Table 3
Some alternative heating and cutting methods	
Plasma arc cutting	Suitable for any electrically conductive metal up to 50mm in thickness
Oxygen lance	Very rough finish and capable of cutting very thick materials. Usually used for the cutting of scrap metal
Some alternative fuel gases	
Propane	Lower flame temperature than acetylene, less focused flame, very high oxygen/fuel gas ratio
MAPP (methylacetylene-propadiene)	Lower flame temperature than acetylene, but can be used at higher pressures. High oxygen/fuel gas ratio
Propylene	Similar to MAPP, very high oxygen/fuel gas ratio
Natural gas	Low flame temperature, low total heat value
HFlame (hydrogen and oxygen)	Suitable for small scale work and brazing produced by electrolysis of water

Display prominent signs on the entrance to the site and storage areas to warn firefighters of the presence of acetylene cylinders. A nominated member of staff should inform the fire service on their arrival of any acetylene cylinders in the workplace.

4.3.2 All businesses that currently use acetylene should, as a matter of urgency, assess if alternative fuel gases or cutting and welding processes can be utilised and the need for acetylene on the site be reduced or eliminated (see Table 1). Alternative methods of work should be adopted where possible and suitable fire hazard management controls should be implemented to reduce the likelihood of an incident and consequential business interruption.

4.3.3 Site management should maintain an up-to-date plan indicating the location of storage areas containing acetylene and other cylinders. This plan should be held at the gatehouse or reception area and be made available to the fire and rescue service on their arrival.

4.3.4 Prominent signs should be displayed at the entrance to the site and on storage areas to indicate the location and nature of compressed gases that are present.

4.3.5 Cylinders used in the UK are colour coded maroon and are manufactured in accordance with BS EN ISO 3807 (ref 11). They should be subjected to a visual inspection prior to each refill and a full inspection at regular intervals as outlined in BS EN ISO 10462 (ref 12).

4.3.6 All gas cylinders should be treated with care. They should be prevented from falling during use, in storage and when being transported by chaining the cylinders in place

in their designated storage area or securing them on trolleys while being moved. They should never be rolled along the floor or ground.

Can decomposition of acetylene in a cylinder be initiated by means of a mechanical impact?

No. Research has now established that decomposition cannot be initiated by mechanical shock alone. Cylinders should, however, be kept out of sunlight and away from sources of heat.

4.4 VICES

4.4.1 The HSE guidance regarding flammable liquids in booklet HS(G)51 (ref 13) suggests the use of the acronym VICES to help apply five basic principles which ensure that any flammable or highly flammable liquid that is necessary in the workplace is used and stored with appropriate care. These principles can also be applied to the use and storage of gas cylinders.

4.4.2 Suitable staff training should be in place to ensure all personnel are aware of the hazards associated with the use of gas cylinders in the workplace and they apply VICES to ensure a safer working environment for all.

4.4.3 The acronym may be explained as follows:

V Ventilation

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

I Ignition

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

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

C Containment

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

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

Are nominally empty cylinders properly managed?

E Exchange

Although the fourth heading of the acronym, this asks the basic question can the use of gas cylinders be eliminated from the workplace?

Can hazardous materials be replaced by less hazardous substances?

S Separation

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

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

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

Detailed advice regarding the application of the VICES principles to the storage of gas cylinders is set out in RC8 (ref 1).

4.5 Assessing and managing the risk

There have been many incidents that have highlighted the widespread disruption that has been caused to businesses by an incident involving an acetylene cylinder that was some distance from their premises. If a business is sited within an area which becomes cordoned off, if only for a short time, this can result not only in staff, but customers, visitors and clients being unable to reach the premises, and in some cases the complete cessation of business activities. This can have knock-on effects resulting in additional custom for competitors, loss of income and loss of perishable stock.

Eliminating the need for acetylene in the workplace is probably a difficult decision to make as it involves an analysis of the suitability of alternative options currently available and the cost implications, including the cost of providing or developing suitable skills within the workplace.

A summary of some of the alternative cutting and welding options presently available is set out in Table 1 and some properties of alternative gases are compared in Table 3.

4.5.1 When determining the potential cost implications, the following should be taken into consideration:

- the cost of replacement equipment;
- if an alternative fuel gas is under consideration, the cost of the replacement gas and the cost implications due to any difference in the oxygen/fuel gas ratio. Some gases have a ratio two to three times higher than acetylene;
- the number of cylinders that will need to be held on the premises;
- the size of the cylinders, and their storage and handling requirements;
- any additional costs associated with improving or providing skills within the workplace due to the change in process.

4.5.2 Where there is no viable alternative to using acetylene, then the probability of incidents involving acetylene occurring must be minimised.

4.5.3 Fire and the associated decomposition of acetylene in cylinders should be prevented through adequate training, safe working practices and use of the correct equipment. This will include applying best practice regarding the storage and use of acetylene cylinders, safe working practices to prevent fire and flashbacks, and effective inspection and maintenance of cutting and welding equipment.

4.5.4 The likelihood of a fire occurring in the vicinity of equipment should be reduced as far as possible.

4.5.5 All extraneous conductive materials in the vicinity of an area where acetylene is to be used or stored should be bonded and earthed to prevent potential electrostatic sources of ignition.

4.6 Storing acetylene cylinders

4.6.1 Acetylene cylinders should be so positioned that they are not exposed to heat sources such as ovens, dryers and furnaces. They should be stored under cover where they can be protected from frost and direct sunlight. Where possible, the store should take the form of a detached, non-combustible building or a fixed, lockable cage located, where possible, at least 4m from buildings, structures and boundary fences.

4.6.2 If it is necessary for the store to be part of a building used for other purposes, then it should be:

- on the ground floor in a room against an outside wall, with the door or doors leading directly to the open;
- entirely of non-combustible construction;
- separated from other parts of the building by walls and floors built to fire break standards as specified in *Approved Document B: Fire Safety (Volume 2) Buildings other than dwellinghouses incorporating insurers' requirements* (ref 19).

4.6.3 Means of venting an explosion should be provided, for example a lightly constructed roof on a single-storey building or lightweight panels in external walls in cases where there are storeys above. Such features are planned so that, in the event of an explosion, the weak points in the structure blow out into a safe area.

4.6.4 Stores should have good ventilation at high and low levels and no heating should be provided.

Table 2: Fire safety management guidelines for cylinders in the workplace

Training and procedures	Handling and storage
• Follow the correct procedure for lighting torches • Follow the correct procedure for shutting down torches and securing cylinders at the end of the working day • Follow the correct procedure if a flashback occurs • Follow hot work procedures • Do not use the equipment if you have not been trained	• Keep secure in upright position • Do not drop or roll • Keep away from heat and combustible materials • Keep ignition sources away • Follow recommended practice for outdoor cylinder storage, such as storing empty and full acetylene cylinders away from oxidising gases in a secure covered area with good ventilation • Special provisions apply to indoor storage • Keep quantities in the workplace to a minimum and return to storage when not in use
Inspection and maintenance	**Correct equipment**
• Inspect the equipment regularly to ensure it is in good condition and free from defects • Submit cylinders and other components such as regulators and torches for inspection by suppliers, as recommended by the manufacturer	• Use correct regulators for the gas as required under the Acetylene Safety Regulations (ref 8) • Use colour-coded hoses • Ensure non-return valves are fitted to torches • Ensure flashback arrestors are fitted to regulators (and torches if long hoses used) • Keep supply hoses as short as practicable

4.6.5 Electrical equipment for use in atmospheres which may contain flammable concentrations of acetylene should be of a suitable type. Guidance is given in the BS EN 60079 (ref 14).

4.6.6 As no standard flameproof enclosures are adequate for acetylene, lighting should preferably be indirect, with lights arranged to shine through sealed glazed apertures in the walls or roof.

4.6.7 The store should not be used for other goods or for any other purpose than cylinder storage.

Table 3: Some properties of alternative fuel gases

	Property					
Fuel gas	Odour	Auto-ignition temperature ^{0}C	Flammable range in air (% by volume)	Flammable range in oxygen (% by volume)	Normal flame temperature in oxygen	Oxygen/fuel gas ratio
Acetylene C_2H_2	Garlic	305	2.2 to 82	2.8 to 93	3106	1.1:1
Propane C_3H_8	Fishy	480	2.2 to 9.5	2.3 to 45	2810	3.75:1
Propylene C_3H_6	Fishy	460	2.0 to 11.1	2.1 to 53	2872	3.1:1
Methane CH_4	Odourless	580	5.3 to 15	5.0 to 6.0	2770	1.6:1
Hydrogen H_2	Odourless	572	4.9 to 75	4.0 to 95	2834	0.36:1

FAQ

Does a hazard zone remain in place for 24 hours?

Although it was often the case that a hazard zone remained in place for up to 24 hours, research into the subject, coupled with work done by fire and rescue services, has established a protocol that allows the hazard zone to be scaled back and sometimes removed after just two hours without compromising the safety of firefighters and others in the area.

4.6.8 Oxygen and chlorine cylinders should not be kept in the same store as acetylene cylinders.

4.6.9 Stored LPG cylinders should be separated from acetylene and other gas cylinders by a suitable fire wall. Where the provision of a fire wall is impractical, there should be clear space of at least 3m between the two types of cylinders.

4.6.10 Empty cylinders should be kept separate from full ones, although they may be kept in the same store. Distinctive notices or markings should be displayed to prevent confusion. A common practice is to chalk 'MT' on empty cylinders.

4.6.11 The store should be indicated by suitable notices under the Dangerous Substances (Notification and Marking of Sites) Regulations 1990 (ref 15), if more than 25 tonnes of hazardous substances such as acetylene, are stored on site. (The Dangerous Substances (Notification and Marking of Sites) Regulations (Northern Ireland) 1992 (ref 16) apply in Northern Ireland.) The local fire authority and relevant enforcing authority must be notified and specified signs displayed.

4.6.12 The location of the doors and the layout of the stores should be such that cylinders may be removed easily in the event of a fire. Exits should be kept free from obstruction.

4.6.13 Acetylene stores should be kept locked.

4.6.14 Cylinders should be stored (and used) upright to prevent acetone and the dissolved acetylene being discharged through the valves, as this would cause excessive release of acetylene.

4.6.15 Sites where acetylene is stored should be properly fenced to prevent unauthorised entry.

4.6.16 Areas around acetylene cylinder stores should be kept free of dry vegetation and foliage without the use of chlorate-based weed killers.

4.6.17 Smoking should be prohibited within 10m of external acetylene stores.

4.7 Handling acetylene cylinders

4.7.1 When cylinders are not being used, protective caps should be screwed on to protect the valves.

4.7.2 With the exception of blowpipe tips, metal containing more than 70% copper should not be used for any pipes, fittings or valves which will come into contact with acetylene.

4.7.3 Even though it has been established that decomposition of acetylene within a cylinder cannot be initiated by mechanical shock alone, cylinders should not be dropped or allowed to come into violent contact with one another or with any hard object. If cylinders are lifted by crane, rope slings should be used and they should be moved individually, unless a special container for holding several cylinders, slung by chains, is available.

4.7.4 Cylinders must not be moved by rolling on the ground or be used as 'rollers' for moving other objects.

4.7.5 All gas cylinders should be transported on site by use of purpose-made cylinder trolleys with cylinders held in place by suitable straps or chains.

4.7.6 A reducing valve (automatic pressure regulator) should always be used to maintain the outlet pressure at a proper and uniform value. Before attaching a reducing valve to a cylinder, the pressure regulating screw should be released in order to prevent damage to the valve.

4.7.7 Valves and fittings should not be lubricated.

4.7.8 Cylinders and valves should be kept clean.

4.7.9 Cylinder keys should not be extended to give greater leverage, as this can damage valve spindles. Cylinders with damaged valves or threads should immediately be labelled appropriately and returned to the suppliers.

4.7.10 When one cylinder is exchanged for another, the valves should be closed before the connections are transferred. After the connection has been remade, the valve on the new cylinder should be opened cautiously in order to detect any leakage before a serious escape can occur. Cylinder valves should always be opened slowly.

4.7.11 Free acetylene gas should not be used at pressures greater than 1 bar and the gas should not be handled in lines or fittings with a bore greater than 13mm

4.7.12 Cylinders, lines and equipment should be electrically bonded and earthed.

4.7.13 Cylinders should be kept away from acids and other corrosive substances at all times.

4.7.14 Cylinders should be removed from working areas and returned to the store at the end of individual jobs or at the end of the working period, as appropriate.

4.7.15 Further detailed recommendations for the handling, storage and use of gas cylinders are contained in RISCAuthority Recommendations RC8 (ref 1) and the HSE publications *Safety in gas welding, cutting and similar processes* and *Working safely with acetylene* (refs 17 and 18).

FAQ

What is a wetting test?

A wetting test involves firefighters wetting the surface of an acetylene cylinder with water. If the surface of an acetylene cylinder remains wet for some time after the application of cooling water has ceased, this may indicate that the cylinder has regained its tensile strength and thus the likelihood of catastrophic failure is less. (This is just one factor taken into consideration by the fire and rescue service incident commander when carrying out a risk assessment during the cooling period.) The wetting test is only applicable to dissolved acetylene cylinders.

4.8 Using acetylene cylinders

4.8.1 When preparing cylinders for use:

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

4.8.2 Ensure that the correct valve set has been fitted when connecting a cylinder for use.

4.8.3 The air in storage and working areas should be regularly sampled using a gas detector to check for leaks. In the event of a serious leak, the area should be evacuated immediately.

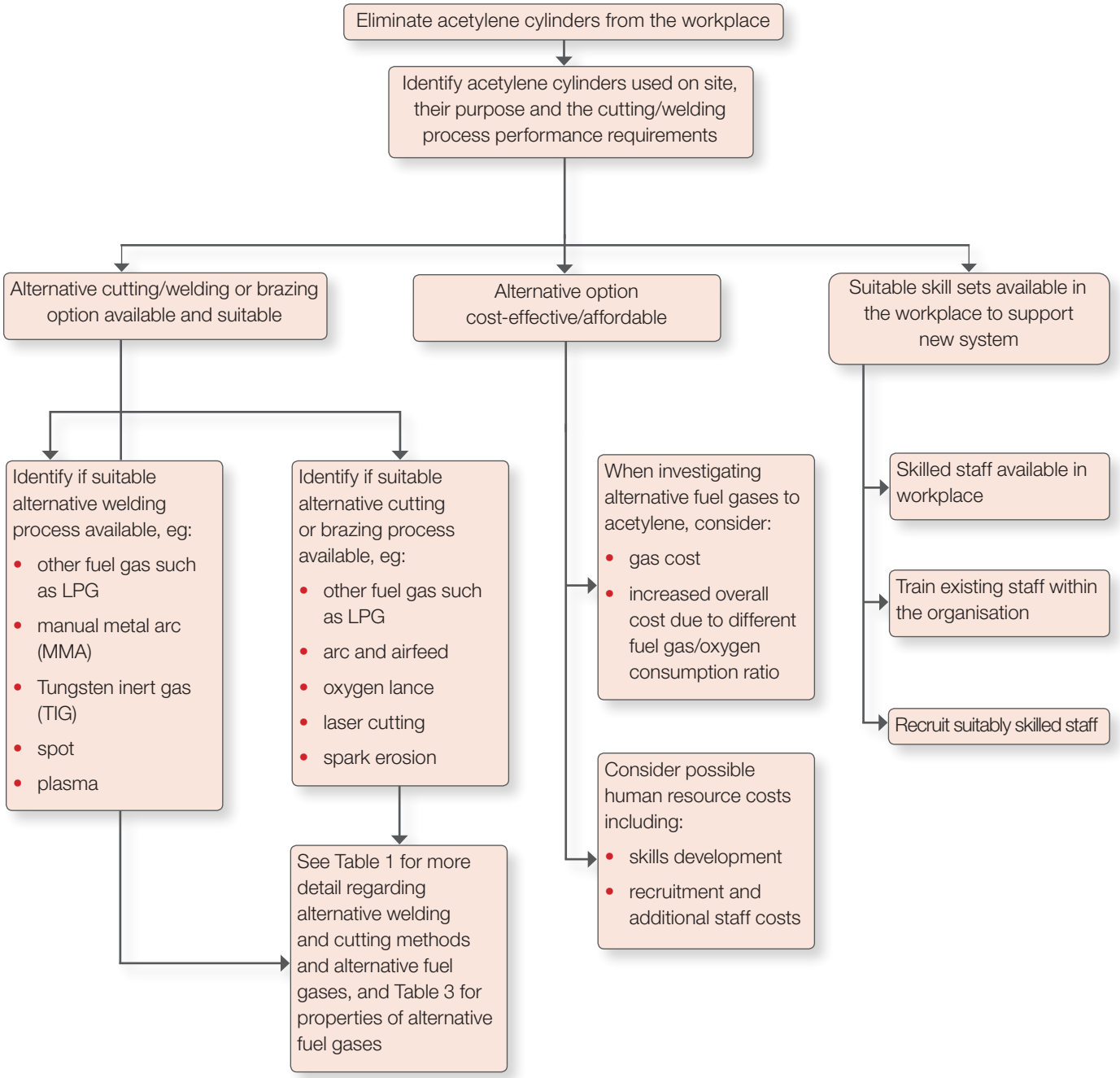
4.8.4 Tests for locating leaks should be made by brushing with soapy water; never with a naked flame.

4.8.5 In the event that acetylene leaking from a cylinder valve ignites, make no attempt to shut the valve manually; call the fire and rescue service without delay and evacuate the building.

4.8.6 Make no attempt to fight a secondary fire that may be burning in the vicinity of a leaking cylinder as there would be a danger of extinguishing the flames from the burning gas, allowing acetylene to escape with the danger of an explosion occurring.

4.8.7 In the case of acetylene escaping from a cylinder valve with no fire in the vicinity, the valve should be closed, if this can be done safely, and the area ventilated thoroughly.

Figure 2: Risk reduction framework – eliminate acetylene component



5. Checklist

		Yes	No	N/A	Action required	Due date	Sign on completion
5.1	**Complying with fire safey legislation (section 1)**						
5.1.1	Because of the hazards associated with the storage and use of acetylene, are cylinders of the gas a major consideration when preparing the fire risk assessment for the premises in compliance with the Regulatory Reform (Fire Safety) Order 2005 or equivalent legislation for Scotland and Northern Ireland? (4.1.1)						
5.1.2	As well as considering the staff handling and using acetylene cylinders, does the assessment also consider staff remote from the process area who may be affected by the effects of the fire? (4.1.2)						
5.1.3	Does the risk assessment process take into consideration the potential impact on business continuity of a hazard zone being identified not only for their own premises but also for other premises in the neighbourhood? (4.1.2)						
5.1.4	Has an assessment also been undertaken by a competent person in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)? (4.1.3)						
5.1.5	Are the risk assessments subject to periodic review, including when any change to the process, the mechanism for storing acetylene or handling acetylene is made? (4.1.4)						
5.1.6	Does equipment used with acetylene cylinders comply with the Acetylene Safety Regulations? (4.1.5)						
5.1.7	Do fire safety managers refer to the relevant fire and rescue service to make themselves aware of the levels of response in the area and consider this information when undertaking and reviewing their fire risk assessments? (4.1.6)						
5.2	**Business continuity (section 2)**						
5.2.1	Has an emergency plan been drawn up that addresses the implications of a fire, flood or other perceived disaster on all facets of the business model? Does it indicate the lines of communication that should be followed and the contact details for specialist assistance, providers of alternative accommodation and suppliers of replacement equipment? (4.2.1)						
5.2.2	Does the business continuity strategy include the backing up of critical business information to other sites away from any potential hazard zone and duplicating storage of key elements of raw materials or stock? (4.2.2)						
5.2.3	Are tabletop exercises held periodically to test the effectiveness and suitability of the emergency plan? (4.2.3)						
5.2.4	Has consideration been given to applying commercially available computer programmes, such as the ROBUST software (Resilient Business Software Toolkit) or similar product, to develop and check the adequacy of the plan? (4.2.4)						
5.3	**Fire safety management (section 3)**						
5.3.1	Are processes with the minimum of hazard employed wherever possible? (4.3.1)						

		Yes	No	N/A	Action required	Due date	Sign on completion
5.3.2	Has an assessment been made to determine if alternative fuel gases or cutting and welding processes can be utilised or other measures taken to reduce or eliminate the need for acetylene on the site? (4.3.2)						
5.3.3	Does site management maintain an up-to-date plan indicating the location of storage areas containing acetylene and other cylinders? (4.3.3)						
5.3.4	Is this plan held at the gatehouse or reception area and made available to the fire and rescue service on their arrival? (4.3.3)						
5.3.5	Are prominent signs displayed at the entrance to the site and on storage areas to indicate the location and nature of compressed gases that are present? (4.3.4)						
5.3.6	Are acetylene cylinders subject to a visual inspection prior to each refill and a full inspection at regular intervals as outlined in BS EN ISO 10462? (4.3.5)						
5.3.7	Are all cylinders treated with care during storage, transportation and use? (4.3.6)						
5.4	**VICES (section 4)**						
5.4.1	Are all flammable or highly flammable gases that are necessary in the workplace used and stored with appropriate care? (4.4.1)						
5.4.2	Is suitable staff training in place to ensure all personnel are aware of the hazards associated with the use of acetylene cylinders in the workplace and they apply VICES to ensure a safer working environment for all? (4.4.2)						
5.5	**Assessing and managing the risk (section 5)**						
5.5.1	When determining the potential cost implications of reducing and eliminating the need for acetylene, are the following taken into consideration? (4.5.1) • the cost of replacement equipment; • the cost of the replacement gas and the cost implications due to any difference in the oxygen/fuel gas ratio; • the number of cylinders that will need to be held on the premises; • the size of the cylinders, their storage and handling requirements; • any additional costs associated with improving or providing skills within the workplace.						
5.5.2	Where there is no viable alternative to using acetylene, has the probability of incidents involving acetylene occurring been minimised? (4.5.2)						
5.5.3	Has the possibility of fire involving acetylene in cylinders been prevented through adequate training, safe working practices and use of the correct equipment? (4.5.3)						
5.5.4	Has the likelihood of a fire occurring in the vicinity of equipment been reduced as far as possible? (4.5.4)						
5.5.5	Have all extraneous conducting materials in the vicinity of acetylene cylinders been bonded and earthed? (4.5.5)						

		Yes	No	N/A	Action required	Due date	Sign on completion
5.6	**Storing acetylene cylinders (section 6)**						
5.6.1	Are acetylene cylinders stored under cover where they can be protected from frost and direct sunlight and not exposed to heat sources such as ovens, dryers and furnaces? (4.6.1)						
5.6.2	If it is necessary for the store to be part of a building used for other purposes, is it: • on the ground floor in a room against an outside wall, with the door or doors leading directly to the open; • of entirely of non-combustible construction; • separated from other parts of the building by walls and floors providing the appropriate level of fire separation? (4.6.2)						
5.6.3	Are means for venting an explosion provided? (4.6.3)						
5.6.4	Do stores have good ventilation at high and low level and are smoking and naked lights prohibited? (4.6.4)						
5.6.5	Is all electrical equipment for use in atmospheres which may contain flammable concentrations of acetylene of a suitable type? (4.6.5)						
5.6.6	As no standard flameproof enclosures are adequate for acetylene, is lighting indirect, with lights arranged to shine through sealed glazed apertures in the walls or roof? (4.6.6)						
5.6.7	Is the store used solely for the purpose of the storage of acetylene cylinders? (4.6.7)						
5.6.8	Are oxygen and chlorine cylinders stored safely away from the acetylene cylinder store? (4.6.8)						
5.6.9	Are stored LPG cylinders separated from acetylene and other gas cylinders by a suitable fire wall? (4.6.9)						
5.6.10	Are empty cylinders kept separate from full ones (although they may be kept in the same store provided that they are clearly marked 'MT')? (4.6.10)						
5.6.11	Is the store indicated by suitable notices? (4.6.11)						
5.6.12	Is the location of the doors and the layout of the stores such that cylinders may be removed easily in the event of a fire? (4.6.12)						
5.6.13	Are acetylene stores kept locked? (4.6.13)						
5.6.14	Are cylinders stored and used upright? (4.6.14)						
5.6.15	Are sites where acetylene is stored properly fenced to prevent unauthorised entry? (4.6.15)						
5.6.16	Are areas around acetylene cylinder stores kept free of dry vegetation and foliage without the use of chlorate-based weed killers? (4.6.16)						
5.6.17	Is smoking prohibited within 10m of external acetylene stores? (4.6.17)						
5.7	**Handling acetylene cylinders (section 7)**						

		Yes	No	N/A	Action required	Due date	Sign on completion
5.7.1	When cylinders are not being used, are protective caps screwed on to protect the valves? (4.7.1)						
5.7.2	With the exception of blowpipe tips, is care taken that metal containing more than 70% copper is not used for any pipes, fittings or valves which will come into contact with acetylene? (4.7.2)						
5.7.3	Even though decomposition of acetylene within a cylinder cannot be initiated by mechanical shock alone, is care taken not to drop or allow cylinders to come into violent contact with one another or with a hard object? (4.7.3)						
5.7.4	If cylinders are lifted by crane, are rope slings used, unless a special container slung by chains is available for holding several cylinders? (4.7.3)						
5.7.5	Are staff aware that cylinders must not be moved by rolling on the ground or used as 'rollers' for moving other objects? (4.7.4)						
5.7.6	Are all gas cylinders transported on site by use of purpose-made cylinder trolleys with cylinders held in place by suitable straps or chains? (4.7.5)						
5.7.7	Is a reducing valve (automatic pressure regulator) always used to maintain the outlet pressure at a proper and uniform value? (4.7.6)						
5.7.8	Are valves and fittings kept free of lubrication? (4.7.7)						
5.7.9	Are cylinders and valves kept clean? (4.7.8)						
5.7.10	Are staff aware that cylinder keys should not be extended to give greater leverage, as this can damage valve spindles? (4.7.9)						
5.7.11	When one cylinder is exchanged for another, are the valves closed before the connections are transferred? (4.7.10)						
5.7.12	Is care taken not to use acetylene at pressures greater than 1 bar or handle the gas in lines or fittings with a bore greater than 13mm? (4.7.11)						
5.7.13	Are cylinders, lines and equipment electrically bonded and earthed? (4.7.12)						
5.7.14	Are cylinders kept away from acids and other corrosive substances at all times? (4.7.13)						
5.7.15	Are cylinders removed from working areas and returned to the store at the end of individual jobs or the working period? (4.7.14)						
5.8	**Using acetylene cylinders (section 8)**						
5.8.1	Are cylinder valves opened slowly, not subject to excessive torque, not left open against the backstop and kept closed if the gas supply is not in current use? (4.8.1)						
5.8.2	Are checks made that a correct valve set has been fitted before an acetylene cylinder is used? (4.8.2)						
5.8.3	Is the air in storage and working areas regularly sampled using a gas detector to check for leaks? (In the event of a serious leak, would the area be immediately evacuated? (4.8.3)						
5.8.4	Are tests for locating leaks made by brushing with soapy water rather than with a naked flame? (4.8.4)						

		Yes	No	N/A	Action required	Due date	Sign on completion
5.8.5	In the event that acetylene leaking from a cylinder valve ignites would the fire and rescue service called without delay and without any attempt to shut the valve manually? (4.8.5)						
5.8.6	Are staff aware that in the event of a fire involving an acetylene cylinder, no attempt should be made to fight a secondary fire in the vicinity as there is a danger of extinguishing the flames from the burning gas and allowing acetylene to escape with the danger of an explosion occurring? (4.8.6)						
5.8.7	In the case of acetylene escaping from a cylinder valve with no fire in the vicinity, would the valve be closed, if this can be done safely, and the area ventilated thoroughly? (4.8.7)						

6 References

1. RC8: *Recommendations for the storage, use and handling of common industrial gases in cylinders*, 2016, Fire Protection Association.
2. Regulatory Reform (Fire Safety) Order 2005, SI 2005 No 1541, The Stationery Office.
3. The Fire (Scotland) Act 2005, asp 5, The Stationery Office.
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5. Fire and Rescue Services (Northern Ireland) Order 2006, SI 2006 No 1254 (NI9), The Stationery Office.
6. Fire Safety Regulations (Northern Ireland) 2010, SI 2010 No 325 (NI).
7. Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), 2002, SI 2002 No 2776 (as amended), The Stationery Office.
8. The Acetylene Safety (England and Wales and Scotland) Regulations 2014, SI 2014 No 1639, The Stationery Office.
9. *Business resilience: A guide to protecting your business and its people*, 2005, Fire Protection Association.
10. The ROBUST software (Resilient Business Software Toolkit) may be found at https://robust.riscauthority.co.uk
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12. BS EN ISO 10462: 2013: *Gas cylinders. Acetylene cylinders. Periodic inspection and maintenance*, British Standards Institution.
13. HSG 51: *Storage of flammable liquids in containers*, 2015, Health and Safety Executive.
14. BS EN 60079: *Electrical apparatus for explosive gas atmospheres* (various parts), British Standards Institution.
15. Dangerous Substances (Notification and Marking of Sites) Regulations 1990, SI 1990No 304, The Stationery Office.
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17. NDG 297: *Safety in gas welding, cutting and similar processes*, 2012, Health and Safety Executive.
18. INDG 327: *Working safely with acetylene*, 2014, Health and Safety Executive.
19. *Approved Document B: Fire Safety (Volume 2) Buildings other than dwellinghouses incorporating insurers' requirements for property protection*, 2015, RIBA Publishing.

Further reading

L6: *Cylinders in fires*, 2008, British Gas Cylinder Association (BGCA).

7 Annex 1: Acetylene – Further information

Uses

Acetylene is commonly used from cylinders, in conjunction with oxygen, to provide fuel for flame-cutting and welding. It is also used in the production of chlorinated organic solvents, vinyl chlorides and other organic compounds such as acetaldehyde, acetic acid, acetic anhydride and acetone. It can also be used in the manufacture of carbon black. Acetylene in cylinders is in common use as an analytical reagent in some laboratories.

Hazards

Acetylene is manufactured by calcium carbide reacting with water, the thermal cracking of hydrocarbons or the partial combustion of methane in oxygen.

Acetylene is a colourless, highly flammable gas with a garlic-like odour when slightly impure, and a chemical composition that renders it unstable under certain conditions. It readily forms ignitable mixtures with air over an exceptionally wide range of concentrations.

Acetylene is liable to decompose explosively when subjected to heat, even in the absence of air, and particularly when under pressure. In cylinders the gas is dissolved in acetone and dispersed in a porous filling.

Free acetylene (not dissolved in a solvent) can start to decompose at pressures above 1.5 bar, generating heat which may produce violent explosions. Explosive acetylides may be produced if acetylene comes into direct contact with unalloyed copper, silver or mercury.

Explosions of acetylene gas develop higher pressures and are, therefore, more damaging than explosions of most other gases.

Although non-toxic, acetylene is an asphyxiant and can have an analgesic or narcotic effect in low concentrations.

Acetylene reacts dangerously with oxidising agents such as chlorine.

Characteristics

Formula: C_2H_2 or CH CH

Other name: Ethyne

State: Colourless gas

Odour: Garlic-like

Auto-ignition temperature: 305°C in air and 206°C in oxygen

Flammable limits: 2.5% to 82% by volume in air. (The upper flammable limit is quoted as 100% in some sources.)

Boiling point: -83°C

Vapour density: 0.91 (air = 1)

Solubility: Very soluble in acetone, soluble in alcohol, soluble in its own volume of water.

Chemical reactions: Forms explosive compounds with copper, mercury and silver. Explodes violently when mixed with chlorine. Can undergo explosive decomposition even in the absence of air. May react violently with oxidising substances.

Cylinders

Acetylene cylinders are made of carbon steel and, in the UK, are painted maroon. All fittings, with the exception of the cylinder valve spindle key (which is operated clockwise to close the valve), have left-handed threads. The inside of each cylinder is filled with a porous material, soaked in acetone. The acetylene is dissolved in the acetone. Cylinders in the UK are no longer manufactured with pressure-relief devices.

UN number: 1001

Hazchem code: 2SE

Action in the event of fire

Due to the dangers presented by gas cylinders involved or exposed to fire, especially acetylene cylinders, the following actions should be taken:

- call the fire and rescue service;
- warn neighbouring premises;
- evacuate the area;
- quickly move any cylinders not directly involved or exposed and that have not become heated to a safe place – but only if it is safe to do so and there is no undue risk;
- when the fire and rescue service arrives, inform them of the number, type and location of the gas cylinders involved and provide the details of your gas cylinder supplier; and
- inform your gas cylinder supply company.

Even after the fire has been extinguished, acetylene cylinders will need to be cooled; the hazard zone established by the fire and rescue service will remain during this period.

Action in the event of a small leak from a valve

Ensure that the cylinder is not heating up and that the leak has not ignited. If it has, follow the action for fire. If the cylinder is not getting hot:

- check to see if the cylinder valve is closed;
- extinguish all ignition sources;
- evacuate people in the area, particularly those downwind;
- call the fire and rescue service;
- ensure maximum ventilation by opening doors and windows;
- providing the leak is small, take the cylinder to a place of safety, but only if it is safe to do so; and
- inform the supplier of the gas cylinder.

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