Recommendations

RC49

for reducing business interruption Part 1: Acetylene cylinders involved in fires

FPA

InFiReS

LOSS PREVENTION RECOMMENDATIONS

The aim of the FPA series of Recommendations is to provide loss prevention guidance for industrial and commercial premises and systems. The series continues a long tradition of providing authoritative guidance on loss prevention issues started by the Fire Offices' Committee (FOC) of the British insurance industry more than a hundred years ago and builds upon earlier publications from the Loss Prevention Council and the Association of British Insurers.

Lists of other publications on loss control including other documents in the RC series are available at www.thefpa.co.uk and from the FPA at London Road, Moreton-in-Marsh, Gloucestershire GL56 0RH. Copies of publications can be purchased from the FPA at that address or else by calling 01608 812524 or by e-mailing sales@thefpa.co.uk.

Technical contact:

Adair Lewis

Fire Protection Association, 3rd Floor, Hampton House,
20 Albert Embankment, London SE1 7TJ

E-mail: alewis@thefpa.co.uk

IMPORTANT NOTICE

Insurers' Fire Research Strategy scheme (InFiReS) membership comprises a group of UK insurers that actively support a number of expert working groups developing and promulgating best practice for the protection of people, property, business and the environment from loss due to fire and other risks. The technical expertise for this document has been provided by the Technical Directorate of the Fire Protection Association (FPA), external consultants, and experts from the insurance industry who together form the various InFiReS Steering Groups. Although produced with insurer input it does not (and is not intended to) represent a pan-insurer perspective. Individual insurance companies will have their own requirements which may be different from or not reflected in the content of this document.

The FPA have made extensive efforts to check the accuracy of the information and advice contained in this document and it is believed to be accurate at the time of printing. However, the FPA make no guarantee, representation or warranty (express or implied) as to the accuracy or completeness of any information or advice contained in this document. All advice and recommendations are presented in good faith on the basis of information, knowledge and technology as at the date of publication of this document.

Without prejudice to the generality of the foregoing, the FPA make no guarantee, representation or warranty (express or implied) that this document considers all systems, equipment and procedures or state of the art technologies current at the date of this document.

Use of, or reliance upon, this document or any part of its content is voluntary and is at the user's own risk. Anyone considering using or implementing any recommendation or advice within this document should rely on his or her own personal judgement or, as appropriate, seek the advice of a competent professional and rely on that professional's advice. Nothing in this document replaces or excludes (nor is intended to replace or exclude) entirely or in part mandatory and/or legal requirements howsoever arising (including without prejudice to the generality of the foregoing any such requirements for maintaining health and safety in the workplace).

Except to the extent that it is unlawful to exclude any liability, the FPA accept no liability whatsoever for any direct, indirect or consequential loss or damage arising in any way from the publication of this document or any part of it or any use of or reliance placed on the content of this document or any part of it.

First published by
Fire Protection Association
London Road
Moreton in Marsh
Gloucestershire GL56 0RH

Tel: +44 (0)1608 812500 Fax: +44 (0)1608 812501
E-mail: sales@thefpa.co.uk Website: www.thefpa.co.uk

2007 © The Fire Protection Association, on behalf of Insurers' Fire Research Strategy

Copies of this document may be obtained from the publications department of the FPA, at the above address.

Printed by Modern Colour Solutions 1.5/11.07

CONTENTS

SCOPE

This document provides guidance for both insurance surveyors and end-users to assist them in reducing business interruption and property damage resulting from incidents involving acetylene cylinders.

The recommendations emphasise the need to consider eliminating the use of acetylene in the workplace, and, where this is not practicable, reducing the risk by appropriately managing the minimum number of cylinders necessary on site.

SYNOPSIS

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 eliminated or minimised. They emphasise that business continuity plans should take into account the effects of an incident involving acetylene cylinders, especially if the premises may come within a cordon resulting from the use of acetylene elsewhere in the neighbourhood.

DEFINITION

Wetting test

If the surface of a 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 24-hour cooling period.) The test is only applicable to dissolved acetylene cylinders.

INTRODUCTION

Acetylene is a flammable gas that is commonly used to provide fuel for flame-cutting and welding. It is very hazardous as it is liable to decomposition at elevated temperatures and pressures or following impact. Under these conditions, acetylene in cylinders may become unstable and thus constitute a unique firefighting hazard. Fire and rescue service safe working practices include the establishment of a 200m hazard zone around an incident and for cylinders involved to be left undisturbed for 24 hours or more prior to removal. Reducing or removing the 200m hazard zone will only be undertaken when the fire and rescue service Incident Commander considers the danger to firefighters and the general public to be negligible.

The occurrence of incidents involving gas cylinders is significant and the disruption to working activities will not be confined to the business concerned, but will extend to all organisations with interests within the cordon. This will not only result in buildings being evacuated but elements of the transport infrastructure, including roads and railways, being unavailable for use for a period of up to 24 hours or more. 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.

Case history 1: As a result of the exposure of an acetylene cylinder to heat from a fire involving a van on the M25 motorway near St Albans, a 200m radius hazard zone was established around the incident by the emergency services. For 24 hours, the M25 was closed between junctions 21a and 23, as was the Abbey Flyer railway that runs over the motorway and was within the exclusion zone.

Michael Crabtree/PA Archive/PA Photos

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 properties. Businesses that may use acetylene in their daily operations include construction sites, vehicle repairers, engineering workshops and some laboratories.

Ian Nicholson/PA Archive/PA Photos

Case history 2: Severe disruption was caused by a fire that involved two acetylene cylinders on a building site near to King's Cross railway station. A 200m radius hazard zone was established. Homes, businesses and main line rail services were disrupted, and the main line railway station was closed for a 24-hour period.

Every effort must be made to eliminate acetylene cylinders from the workplace and plan for the actions that should be taken should an incident involving acetylene occur in the immediate area. All business that currently use acetylene should, as a matter of urgency, assess if alternative fuel gases or cutting and welding processes could be utilised.

The business continuity strategy should include the backing up of critical business information to other sites over 200m away 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. 1).

All gas cylinders involved in a fire or exposed to heat are potentially dangerous, but acetylene is even more so. A hazard zone is still likely to be established during firefighting operations where cylinders containing other fuel gases and oxygen are involved. However, it is likely to be reduced or removed without the need for a 24-hour cooling period if the cylinders are deemed to be safe after cooling and pass the wetting test.

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 5). Acetylene should also be considered in assessments prepared in compliance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (ref. 6).

Acetylene cylinders

Acetylene is stable at ambient temperatures and pressures yet unstable at elevated temperatures and pressures. Full details of the properties of the gas are set out in Annex 1. Acetylene is stored in cylinders filled with a porous mass that has been charged with a solvent (usually acetone) into which the acetylene is dissolved. This ensures that the gas is dispersed evenly within the cylinder and is maintained in a stable condition. In older cylinders, the porous mass consisted of Kieselghur (a diatomaceous earth) along with charcoal and asbestos. Modern-day cylinders use a silica lime filler with additives such as fibreglass. The porous mass is also designed to slow the decomposition process and cool the cylinder.

Even though acetylene cylinders are designed to withstand decomposition and cool naturally, catastrophic failure can still occur under certain circumstances. Decomposition within a cylinder will render it potentially dangerous. This can occur due to severe mechanical shock – for example, caused by dropping the cylinder or exposing it to severe heat, such as in a fire or flashback.

Older acetylene cylinders may be 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. However, live destructive tests conducted by the Health and Safety Laboratory of the Health and Safety Executive (HSE) in the mid-1990s 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, so may be encountered on sites elsewhere in the world.

Cylinders used in the UK are colour-coded maroon and are manufactured in accordance with BS EN 1800: 2006: *Transportable gas cylinders. Acetylene cylinders. Basic requirements, definitions and type testing* (ref. 7). They should be subjected to a visual inspection prior to each refill and a full inspection at regular intervals as outlined in BS EN 12863: 2002: *Transportable gas cylinders. Periodic inspection and maintenance of dissolved acetylene cylinders* (ref. 8).

The hazard zone

Fire and rescue service operating procedures are often reviewed in the light of experience and the results of research and testing. The procedure for the handling of acetylene cylinders involved in fires is no different. After the results of the live destructive tests conducted by the HSE Health and Safety Laboratory in the mid-1990s were made available, further research was conducted in 2000 by way of a joint study involving London Fire Brigade and the Fire Research Division of the Department for Transport, Local Government and the Regions (DTLR). The findings were that it is

not always possible to detect decomposition within a cylinder and it is possible for decomposition to be present within the core of the cylinder even though it may appear cool on the outside surface.

In 2003, the new *Fire Service Manual, Volume 2 Fire Service Operations, Acetylene Cylinder Incidents and Natural Gas Incidents* (ref. 9) was published and included revised procedures for the handling of fires involving acetylene cylinders. This was followed in 2004 by the British Compressed Gases Association publication *BCGA Guidance Note GN15, Managing Gas Cylinders Involved in a Fire* (ref. 10). The purpose of this document was to provide advice and guidance on a new support service offered by the BCGA for incidents involving gas cylinders. This service includes the attendance of a 'competent person' from the relevant gas supplier.

The procedures presently followed by the fire and rescue service are based on ensuring the safety of firefighters and the general public and reducing damage to property. When it is suspected that acetylene cylinders are involved in a fire, the procedure followed is likely to include the following:

- the establishment, in liaison with the police, of an initial hazard zone of up to 200m around the cylinder/s (this is based on the possible travel distance of fragments from an exploding cylinder in the open air. It is also referred to by some authorities as an exclusion zone). The actual area of the hazard zone will be influenced by the type and extent of adjacent structures and the topography of the surrounding area;
- determining the identity of the cylinders and whether or not they have been exposed to heat;
- the establishment of an inner cordon to manage and control access to the vicinity of the cylinders, following the assessment of the hazard zone;
- consideration as to whether to evacuate the public and non-essential fire and rescue service personnel;
- firefighting actions, conducted in accordance with the 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;
- maintenance of the hazard zone for 24 hours, as acetylene cylinders are only considered safe after a cooling period of this length.

Due to the difficulty in determining both the presence of gas cylinders at incidents and the type of gas involved, fire and rescue service standard working procedures are likely to recommend the establishment of a 200m hazard zone when it is suspected that gas cylinders are involved. The zone is likely to be maintained for at least 24 hours when acetylene cylinders are suspected to be present.

There is likely, therefore, to be a significant impact on business operations in many incidents, even when it is subsequently established that no acetylene (or other) cylinders have been involved.

Following cooling of the cylinder, the area of the hazard zone is reduced in a controlled manner to deny access to the cylinder by unauthorised personnel. Only when the Incident Commander is satisfied, as a result of his risk assessment, that the cylinder is safe, will the responsibility for the cylinder be transferred to the appropriate representative from the premises.

RECOMMENDATIONS

1. Assessing and managing the risk

In the past, when routine fire risk assessments were carried out at premises, the presence of acetylene may have been considered part of the residual risk profile for the premises and efforts directed towards ensuring that it was managed effectively.

Recent incidents, however, have highlighted the widespread disruption that can be caused to businesses by an incident involving an acetylene cylinder which may be some distance from their premises. If a business is sited within an area which becomes cordoned off, this can result not only in staff, customers, visitors and clients being unable to reach the premises, but 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.

It is important that the risk assessment process for all premises should take into consideration the potential impact on business continuity of a hazard zone in the neighbourhood.

If a business uses acetylene, then the possibility of eliminating or reducing the need for acetylene cylinders should receive serious consideration. 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.

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.

The fire hazard assessment and abatement framework set out below outlines the key issues that should be considered.

Eliminating the need for acetylene

This option, which is probably the most difficult to achieve, involves an analysis of the suitability of alternative options presently 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 set out in Table 2.

1.1 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.

Managing acetylene cylinders in the workplace

1.2 Where there is not a viable alternative to using acetylene, then the probability of incidents involving acetylene occurring must be minimised.

1.3 Fire or decomposition 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.

1.4 The likelihood of a fire occurring in the vicinity of equipment should be reduced as far as possible and it should be ensured that acetylene cylinders are not exposed to heat sources such as ovens, dryers, furnaces etc.

2. Storage of acetylene cylinders

2.1 Cylinders should be stored under cover where they can be protected from frost and the direct rays of the sun. Where possible, the store should be a detached, non-combustible building.

2.2 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 fire-resisting walls and floors.

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 2
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

Table 2: Some properties of alternative fuel gases

Fuel gas	Property					
	Odour	Auto-ignition temperature (°C in air)	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 60	2770	1.6:1
Hydrogen (H_2)	Odourless	572	4.9 to 75	4.0 to 95	2834	0.36:1

2.3 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.

2.4 Stores should have good ventilation at high and low levels. Smoking and naked lights should be prohibited and no heating should be provided.

2.5 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: *Electrical apparatus for explosive gas atmospheres* suite of documents (ref. 11).

2.6 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.

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

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

2.9 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.

2.10 The store should be indicated by suitable notices. Under the Dangerous Substances (Notification and Marking of Sites) Regulations 1990 (ref. 12), if more than 25 tonnes of hazardous substances, such as acetylene, are stored on site, the local fire authority and relevant enforcing authority must be notified and specified signs displayed.

2.11 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.

2.12 Acetylene stores should be kept locked.

2.13 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.

2.14 Where stored outside the building, cylinders should be:

- in a fixed, lockable cage;
- at least 6m from the building, wherever possible, and at least 2m from boundary fences; and
- protected from direct sunlight.

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

2.16 Areas around acetylene cylinder stores should be kept free of dry vegetation and foliage.

3. Precautions when handling acetylene cylinders

3.1 When cylinders are not being used, protecting caps should be screwed down over the valves.

3.2 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 the gas.

3.3 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.

3.4 Cylinders must not be used as 'rollers' for moving objects.

3.5 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.

3.6 Valves or fittings should not be lubricated.

3.7 Cylinders and valves should be kept clean. Loose dirt can be removed from inside the valve sockets by rapidly opening and closing the valves before connecting up the cylinders. The operator must stand clear of the outlet while doing this.

3.8 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.

3.9 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.

3.10 The free gas should not be used at pressures greater than 1 bar. Gas should not be handled in lines or fittings with a bore greater than 13mm.

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

3.12 The air in the 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.

3.13 Tests for locating leakage should be made by brushing with soapy water. Never test with a naked flame.

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

3.15 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.

Further detailed recommendations for the handling, storage and use of cylinders are contained in RC8: *Recommendations for the storage, use and handling of common industrial gases in cylinders including LPG* (ref. 13) and the HSE publications *Safety in gas welding, cutting and similar processes* and *Take care with acetylene* (refs. 14 and 15).

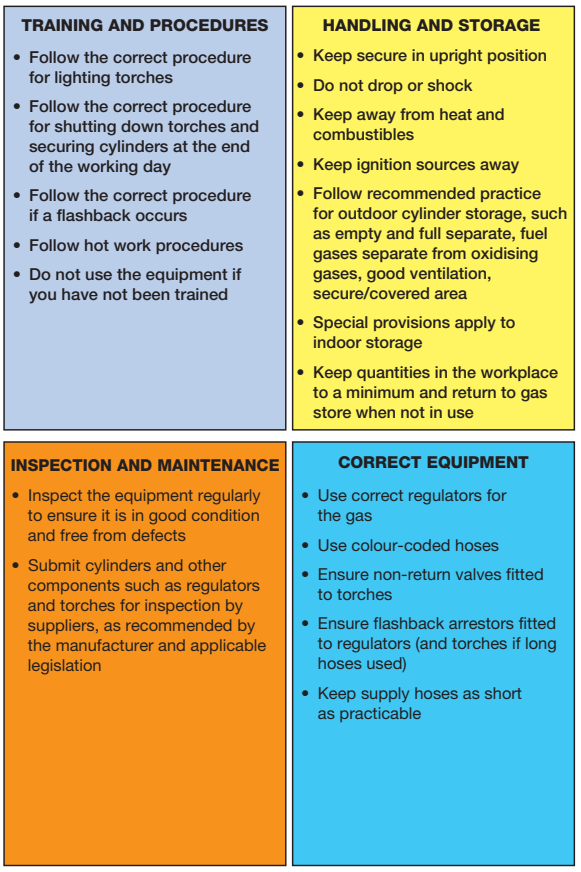

Figure 1: Fire safety management guidelines for cylinders in the workplace

Figure 1 summarises basic guidance on the safe use of cylinders in the workplace.

4. Risk assessment framework

The framework in Figures 2, 3 and 4 has been developed using fault tree logic utilising 'AND' gates and 'OR' gates, which are represented by the symbols in the key.

The 'AND' gate indicates that, for a particular 'output', all the 'input' criteria should be considered.

An 'OR' gate indicates that, if any one of the 'inputs' are adequately satisfied, then the 'output' above will have been met. More than one input can, however, be considered. Alternatively, the logic gates can be ignored and the framework used as a simple flowchart.

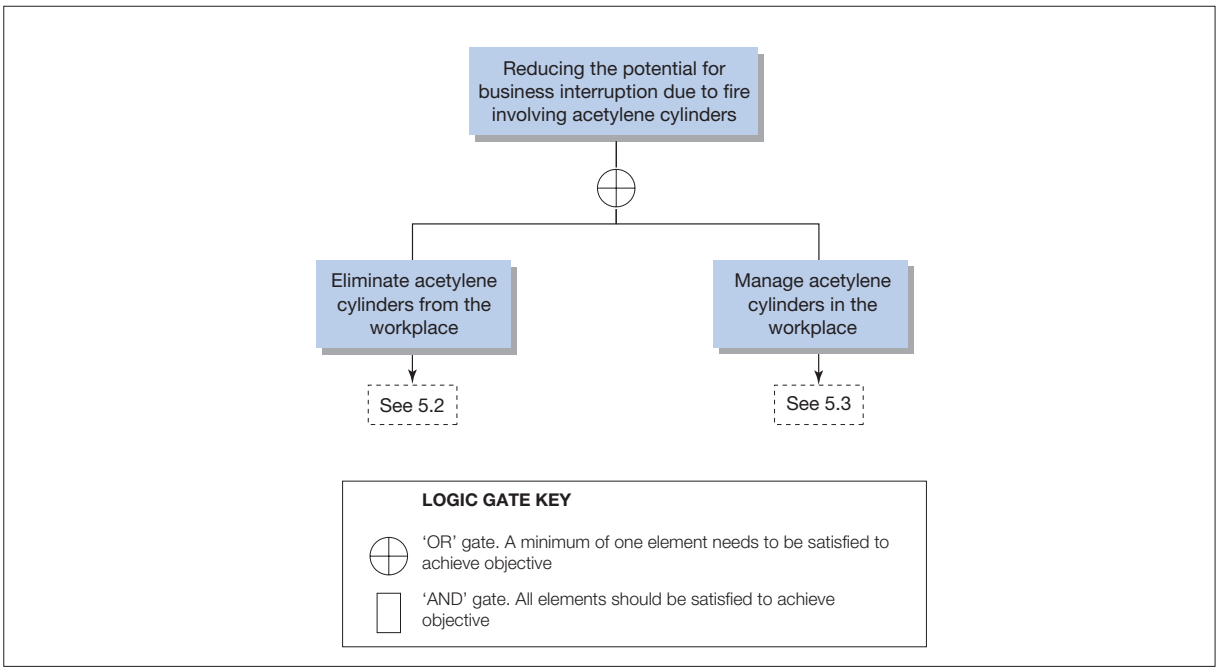

Figure 2: Risk reduction framework – key options component

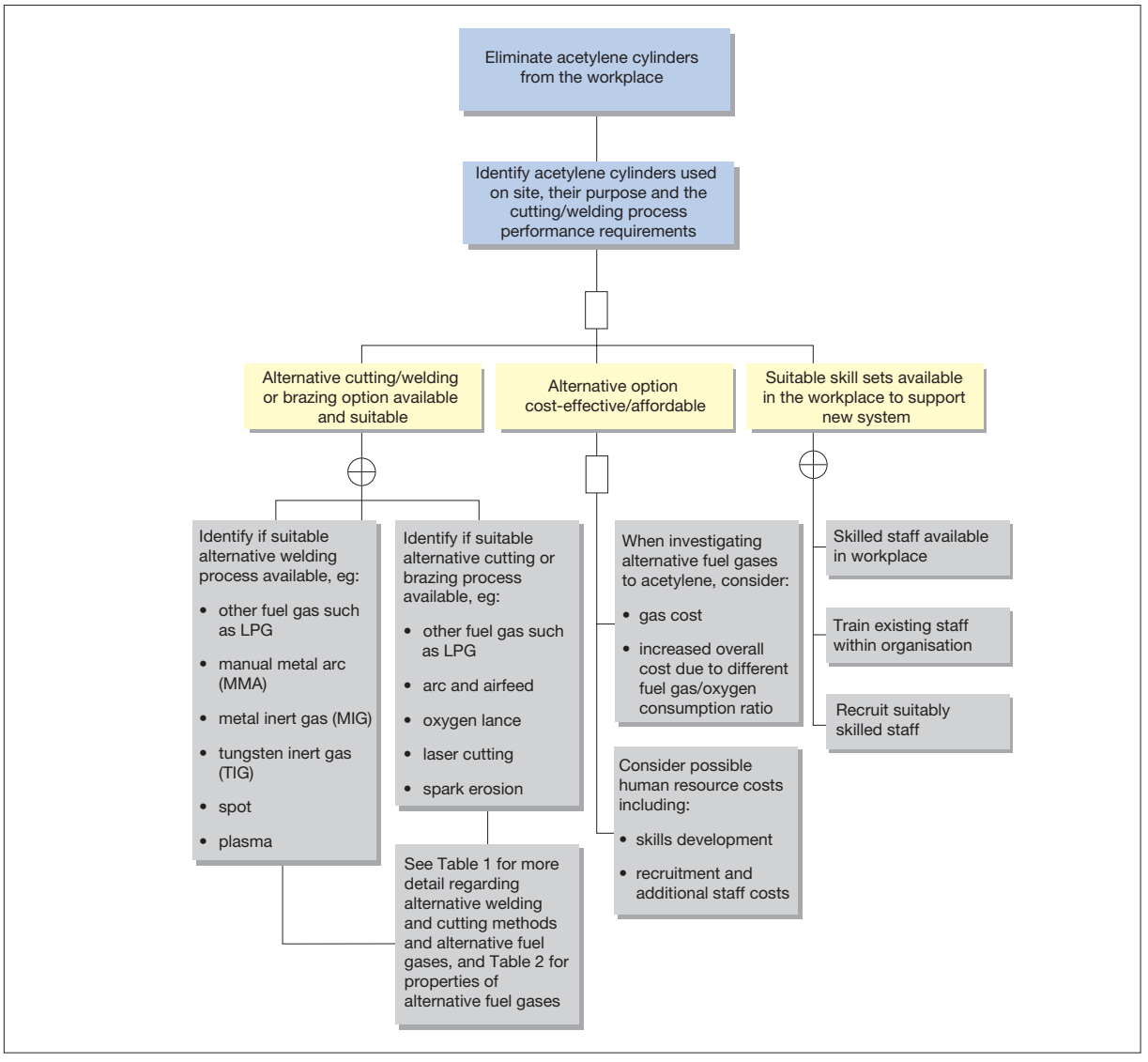

Figure 3: Risk reduction framework – eliminate acetylene component

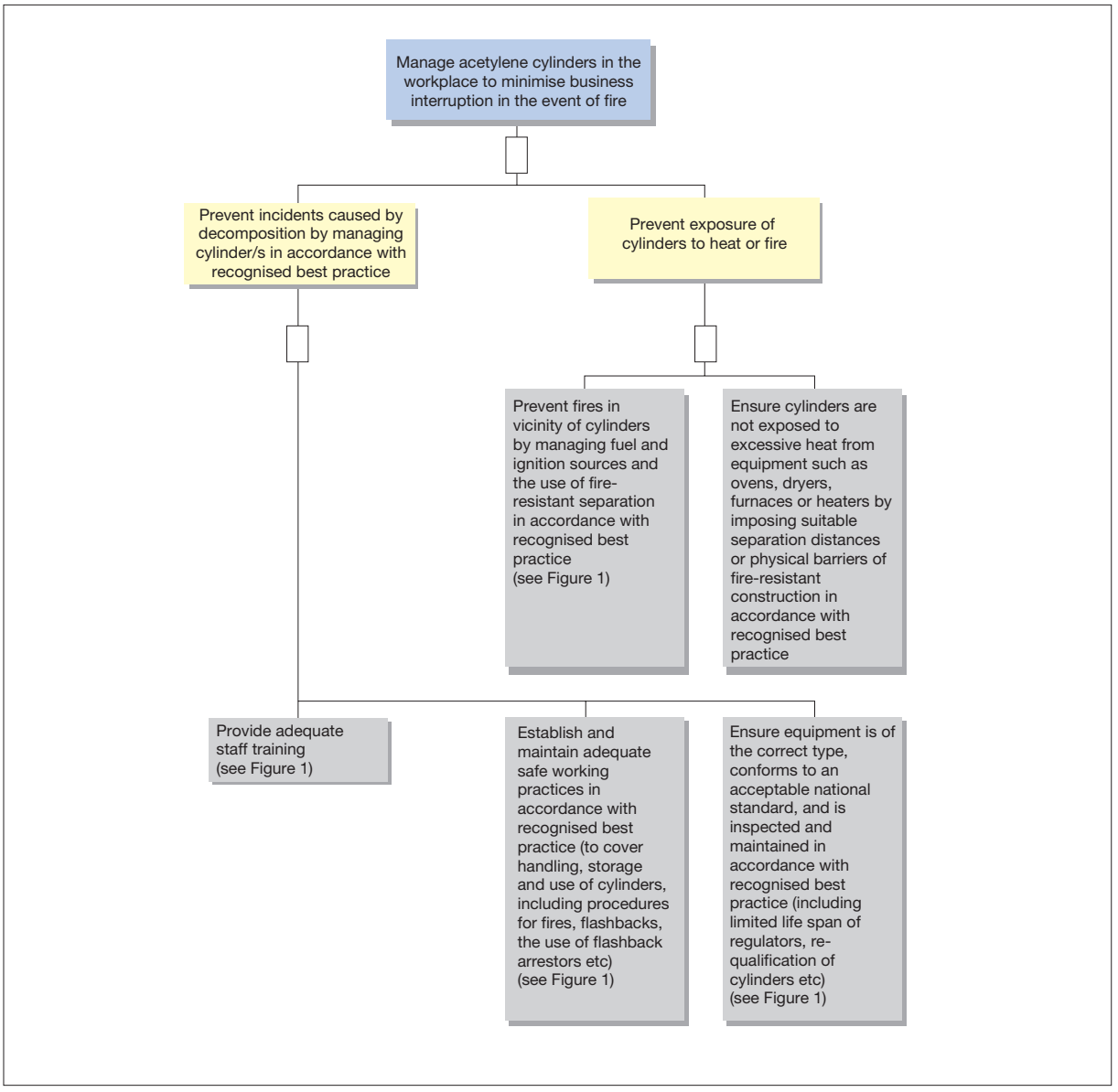

Figure 4: Risk reduction framework – manage acetylene component

5. Checklist

5.1	Risk assessment	Yes	No	N/A	Action required	Due date	Sign on completion
5.1.1	Have suitable and sufficient risk assessments been undertaken in compliance with the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland) and the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002?						
5.1.2	Is there a policy for these assessments to be reviewed periodically?						
5.1.3	Do the assessments consider elements of property protection and business interruption as well as life safety?						
5.2	**Elimination of acetylene cylinders**						
5.2.1	Can the need for hot work be eliminated entirely?						
5.2.2	If hot work has to be undertaken, has a study been made of the options available to allow acetylene cylinders to be removed from the workplace?						
5.2.3	Have staff been trained in the use of the alternative techniques?						
5.2.4	Have all reasonable measures been taken to minimise the use of alternative hot work techniques?						
5.3	**Managing acetylene cylinders**						
5.3.1	Have staff been trained and suitable safe working practices established for working with acetylene?						
5.3.2	Have measures been taken to ensure that acetylene cylinders are not exposed to heat sources such as ovens, dryers, furnaces etc?						
5.4	**Storing acetylene cylinders**						
5.4.1	Are cylinders stored under cover where they can be protected from frost and the direct rays of the sun?						
5.4.2	Where cylinders have to be stored in a building, have suitable criteria been considered when selecting the location of the store?						

		Yes	No	N/A	Action required	Due date	Sign on completion
5.4.3	Does the store have suitable ventilation?						
5.4.4	Are means for venting an explosion provided?						
5.4.5	Is any electrical equipment for use within the store suitable for use in atmospheres which may contain flammable concentrations of acetylene?						
5.4.6	Is the store only used for cylinder storage?						
5.4.7	Are oxygen and chlorine cylinders stored separately from acetylene cylinders?						
5.4.8	Are empty cylinders kept separate from full ones?						
5.4.9	Is the store indicated by suitable notices?						
5.4.10	Are the locations of the doors and the layouts of the stores such that cylinders may be removed easily in the event of a fire?						
5.4.11	Is the acetylene store kept locked?						
5.4.12	Are cylinders stored and used upright?						
5.4.13	Where cylinders are stored outside the building, have suitable criteria been considered when selecting the location of the store?						
5.4.14	Is the site where acetylene is stored properly fenced to prevent unauthorised entry?						
5.4.15	Is the area around the acetylene cylinder store kept free of dry vegetation and foliage?						
5.5	**Precautions when handling acetylene cylinders**						
5.5.1	Are protecting caps screwed down over the valves when cylinders are not in use?						
5.5.2	Are staff aware that cylinders should not be dropped or allowed to come into violent contact with one another or with any hard object?						

		Yes	No	N/A	Action required	Due date	Sign on completion
5.5.3	Is a reducing valve always used to maintain the outlet pressure?						
5.5.4	Are staff aware that valves or fittings should not be lubricated?						
5.5.5	Are cylinders and valves kept clean?						
5.5.6	When one cylinder is exchanged for another, are the valves closed before the connections are transferred?						
5.5.7	Is the gas used at pressures less than 1 bar?						
5.5.8	Are cylinders, lines and equipment electrically bonded and earthed?						
5.5.9	Is the air in the storage and working areas regularly sampled using a gas detector to check for leaks?						
5.5.10	Are cylinders kept away from acids and other corrosive substances?						
5.5.11	Are cylinders removed from working areas and returned to the store at the end of individual jobs or at the end of the working period?						

Signature	**Name**	**Date**

REFERENCES

1 *Guidance Note: Business Resilience – A Guide to Protecting Your Business and Its People,* Fire Protection Association for InFiReS, 2005.

2. Regulatory Reform (Fire Safety) Order 2005, SI 2005 No. 1541, The Stationery Office.

3. Fire (Scotland) Act 2005, 2005 asp 5, The Stationery Office.

4. Fire Safety (Scotland) Regulations 2006, Scottish SI 2006 No. 456, The Stationery Office.

5. Fire and Rescue Services (Northern Ireland) Order 2006, SI 2006 No. 1254 (N.I.9), The Stationery Office.

6. Dangerous Substances and Explosive Atmospheres Regulations 2002, SI 2002 No. 2776, The Stationery Office.

7. BS EN 1800: 2006: *Transportable gas cylinders. Acetylene cylinders. Basic requirements, definitions and type testing,* British Standards Institution.

8. BS EN 12863: 2002: *Transportable gas cylinders. Periodic inspection and maintenance of dissolved acetylene cylinders,* British Standards Institution.

9. *Fire Service Manual, Volume 2 Fire Service Operations, Acetylene Cylinder Incidents and Natural Gas Incidents,* The Stationery Office, 2003.

10. *BCGA Guidance Note GN15, Managing Gas Cylinders Involved in a Fire,* British Compressed Gases Association, 2004.

11. BS EN 60079: *Electrical apparatus for explosive gas atmospheres* (various parts), British Standards Institution.

12. Dangerous Substances (Notification and Marking of Sites) Regulations 1990, SI 1990 No. 304, The Stationery Office.

13. RC8: *Recommendations for the storage, use and handling of common industrial gases in cylinders including LPG,* Fire Protection Association for InFiReS, 2005.

14. *Safety in gas welding, cutting and similar processes,* INDG297, Health and Safety Executive, 1999.

15. *Take care with acetylene,* INDG327, Health and Safety Executive, 2000.

FURTHER READING

BS EN 1801: 1999: *Transportable gas cylinders. Filling conditions for single acetylene cylinders,* British Standards Institution.

NFPA 550: *Guide to the Fire Safety Concepts Tree,* NFPA, 2007.

Product Information, BOC Gases: www.boc-gases.com.

Safeguards: Welding and Cutting, SafeWork SA, Government of South Australia, 2000.

Technical Information, BOC Industrial: www.bocindustrial.co.uk.

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.

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, 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 and shock, even in the absence of air, and particularly when under pressure. Because of its instability, it is dissolved in acetone and dispersed in a porous filling when in cylinders.

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 vapour 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 (the fire and rescue service is likely to apply a hazard zone of 200m initially);
- inform your gas cylinder supply company;
- quickly move to a safe place any cylinders not directly involved or exposed and that have not become heated – but only if it is safe to do so and there is no undue risk; and
- 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.

Even after the fire has been extinguished, acetylene cylinders will need to be cooled for 24 hours. The hazard or exclusion zone established by the fire and rescue service is likely to remain during this period.

Once the 'all clear' has been given by the fire service, the cylinders can be removed by the gas supply company.

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 the area;
- 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 there is no undue risk;
- warn people in the area, particularly those downwind;
- call the fire and rescue service; and
- inform the supplier of the gas cylinder.

RC49

Recommendations for reducing business interruption Part 1: Acetylene cylinders involved in fires

FPA

InFiReS