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This circular is	For information	No response required	
This circular is	Not relevant to the National Framework		
Status	The information in this Circular is of high operational importance and should be read in conjunction with Fire Service Circular 32/2004 'Fire Service Manual Volume 2: Fire Service Operations, Acetylene Incidents and Natural Gas Incidents'		

Fire Service Guidance for Managing Acetylene Cylinder Incidents

Issued by:

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Addressed to:

**The Chair of the Fire and Rescue Authority
The Chief Executive of the County Council
The Clerk to the Fire and Rescue Authority
The Clerk to the Combined Fire and Rescue Authority
The Commissioner of the London Fire and Emergency Planning Authority
The Chief Fire Officer**

Please forward to:

**Training Officers
Hazardous Materials Officers
Fire Control Officers
Operations Officers
Operational Staff**

Summary

This guidance gives an update on the initiatives being undertaken that are aimed at reducing the disruption caused by acetylene cylinder incidents, and outlines current good practice for managing these incidents.

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1.0 Introduction

- 1.1 This Fire and Rescue Service Circular outlines recent developments aimed at reducing the disruption at incidents involving acetylene cylinders. This issue has been highlighted by many incidents across the country where the implementation of the 200m hazard zone for 24 hours resulted in a severe impact on local communities and the national infrastructure.
- 1.2 In November 2006 the Cylinders in Fire National Stakeholder Group was formed to understand and resolve the issues surrounding cylinders in fires and in particular acetylene cylinders. The Stakeholder Group includes representatives from the Fire and Rescue Service, Industry, Department for Transport, Health and Safety Executive, Highways Agency and the Chief Fire and Rescue Adviser. Detailed information regarding the work of this group can be found on CFOA Circular 2008/1014 and at [www.bcga.co.uk/preview/news/Cylinders in Fire-The National Stakeholder Group.pdf](http://www.bcga.co.uk/preview/news/Cylinders%20in%20Fire-The%20National%20Stakeholder%20Group.pdf).
- 1.3 The Stakeholder Group has made significant progress in a number of areas. London Fire Brigade and Manchester Fire and Rescue Service have reviewed and analysed their records of incidents involving gas cylinders. This in part has increased our understanding of incidents involving acetylene, and following a review of operational practice London Fire Brigade modified the way they dealt with cylinder incidents. This has resulted in a considerable reduction in the time 200m cordons are maintained, with a corresponding reduction in the impact to society. **London Fire Brigade's revised procedures should be viewed as current good practice for managing incidents involving cylinders in fires.**
- 1.4 The Competent Person Support Service from industry experts to the Fire and Rescue Service has been reviewed and standardised across all British Compressed Gas Association (BCGA) members. (Details of this service can be found in Fire Service Circular 32/2004, Fire Service Manual Volume 2: Fire Service Operations, Acetylene Incidents and Natural Gas Incidents)
- 1.5 This Fire and Rescue Service circular does not replace or change any procedure described in the Fire Service Manual or FSC 32/2004, rather it is designed to assist emergency service personnel in minimising the disruption at acetylene cylinder incidents in accordance with current Fire Service Manual guidance. The findings of the research being undertaken under the auspices of the National Stakeholder Group is expected to report in early 2009 and this may lead to a review of current procedures.

2.0 Current procedure

- 2.1 Fire Service Manual, Volume 2, Fire Service Operations and FSC 32/2004 details the current procedures for dealing with acetylene cylinders involved in a fire. These procedures are summarised below:

Hazards

- 2.2 All pressurised cylinders present significant hazards when involved in a fire. Acetylene along with other fuel gases such as butane, propane, propylene and hydrogen present particular risks because they are highly flammable materials stored in pressurised containers with the obvious risk of explosive detonation if involved in fires.
- 2.3 Acetylene differs from other flammable gases in one respect; it can decompose into its constituent components if exposed to extreme heat. This could result in catastrophic failure similar to other fuel gas cylinders **after** the fire has been extinguished.

Management of Incidents

- 2.4 For as long as any cylinder is exposed to direct heat in a fire there is a risk of catastrophic failure. The unique feature of acetylene, if it has been heat affected, is its ability to decompose after the fire has been extinguished.

2.5 Incident commanders should make every effort, as soon as is practicable to:-

- Identify the contents of any cylinder i.e. is it acetylene?
- If acetylene is confirmed, determine if the cylinder has been subjected to heating
- If the acetylene cylinder has been subjected to heating, assess if decomposition is likely to have been initiated?
- Remove any heat source impacting on the cylinder
- Commence cylinder cooling if required
- Set up Hazard Zone.

2.6 It is important to assess whether an acetylene cylinder has been heat damaged sufficiently for decomposition to be initiated. It requires heat in excess of 300°C to initiate decomposition. This is normally only achieved by direct impingement of flames onto a cylinder. Possible indicators that a cylinder has been heated include:

- Do the cylinder labels appear burnt?
- Are any of the plastic rings around the cylinder valve melted in any way?
- Is the cylinder paintwork burnt or blistered?

2.7 Heat impingement may leave an acetylene cylinder at risk if it is subsequently subjected to a physical shock.

Wetting Test

2.8 It is important to try to identify if an acetylene cylinder has undergone (or is undergoing) internal decomposition. The Wetting Test will give evidence of whether the outer shell is hot and should be used together with other indicators such as thermal image camera (TIC) and information when conducting a risk assessment. The test is also a useful indicator to show the progress of the cooling down operation.

The Wetting Test

- A confirmed (or suspected) acetylene cylinder that has been subjected to heating must be cooled for a minimum of one hour
- Water should then be turned off and the cylinder observed for signs of steaming or rapid drying of the cylinder
- A thermal image camera check should be carried out
- If no signs of continued heating are apparent and the cylinder shell is at ambient temperature the cylinder can be safely approached for further investigation. An assessment can now be made of the extent to which the cylinder was exposed to heat
- Cooling should not be reapplied at this stage but the cylinder should be left for approximately 15-30 minutes. If decomposition is taking place the increase in temperature will register on the cylinder shell

- If signs of a significant temperature increase are observed during this period water should be immediately reapplied for a further hour
- However, if after this period the cylinder temperature does not rise above ambient temperature it is deemed to have passed the wetting test.

Hazard Zone

- 2.9** When it is suspected that acetylene cylinder(s) are, or have been, involved in fire an *initial* Hazard Zone should be implemented, in liaison with the police. This zone should extend up to 200 metres from the cylinder(s).
- 2.10** The size of the initial Hazard Zone should be reduced following consideration of the protection provided by the surrounding environment and topography. Consideration should be given to the presence of any substantial buildings or materials that might offer shielding between the hazard and a public highway, railway or other thoroughfare.
- 2.11** If it is subsequently established that the cylinder(s) have not been exposed to heating then the hazard zone should be reduced or removed.
- 2.12** The size of the cordon should be re-assessed if circumstances change during the incident, for example, the provision of suitable shielding or a cylinder passes a Wetting Test and that there is no danger of reheating or physical impact to the cylinder.

Acetylene cylinders not affected by heat

- 2.13** Where cylinders are in the proximity of a fire but show no signs of direct heating, such as paint damage or melting plastic guards or neck rings, they are likely to be safe to move. However, before doing so the coolness of the cylinder walls may be checked by a Wetting Test and TIC.

Acetylene cylinders subjected to mechanical shock

- 2.14** It had previously been thought that mechanical shock to an acetylene cylinder that had not been involved in a fire situation could initiate decomposition. This is not now believed to be the case. Extensive research by the German Federal Institute for Materials Research and Testing (BAM), and a case study of damaged cylinders by Air Products, suggest that it is not possible to initiate decomposition in an undamaged, unheated cylinder through mechanical shock alone. This may not be the case if the cylinder has been exposed to heat capable of initiating decomposition. If the Incident Commander (IC) is in any doubt, the cylinder should be treated as an acetylene cylinder affected by heat (see below).

Acetylene cylinders affected by heat

- 2.15** The existing guidance indicates that heated acetylene cylinders cannot be considered completely safe until at least 24 hours after initial cooling has commenced, either via cooling water or by allowing the cylinder(s) to cool naturally. A sub-group of the National Stakeholder Group has commissioned BAM, based in Berlin, to research what cooling period is required before an acetylene cylinder may be declared safe. The outcome of this research is expected in 2009, at which point further guidance or a revision of operating procedures will be issued.
- 2.16** Key Actions for Incident Commander at acetylene cylinder incidents
- Implement an initial Hazard Zone of up to 200m
 - Carry out Dynamic Risk Assessment (DRA) of the size of the initial Hazard Zone
 - Establish cordons

- Apply water to any affected cylinder(s). Minimum crews wearing full Personal Protective Equipment (PPE) and Breathing Apparatus (BA) should be deployed to lash off branches, position ground monitors etc. Remotely operated vehicles (ROVs) could be used to assist with this task.
- Seek advice of BCGA Competent Person if required.
- Acetylene cylinders should be cooled for a minimum of one hour (All other cylinders will need considerably less time to cool). This time should commence following the removal of the heat source impacting on the cylinder.
- Carry out a Wetting Test and TIC check by minimum crews wearing full Personal Protective Equipment (PPE) and Breathing Apparatus (BA). If satisfactory, reduce Hazard Zone.
- Continue to cool cylinder as required and check temperature for 24 hours as necessary.
- After 24 hours hand over to occupier / cylinder owner or other agency
- Cylinder released to site owner, or gas supplier contacted to recover the cylinder
- Fire and Rescue Service incident closed
- Complete 'Fires of Special Interest' (FOSI) Competent Person Feedback Form as required and forward to CLG

Competent Person Support to Fire and Rescue Service

- 2.17** Competent Persons will provide expert support to the Fire and Rescue Services during a cylinder incident. This service is provided by the four acetylene suppliers in the UK: Air Liquide, Air Products, BOC and Energas.
- 2.18** BCGA has developed Competent Person training material to ensure consistency of response from all gas companies. The advice will include help in identifying the cylinder owner and its contents, advice for dealing with fuel gas related incidents, description of the wetting test and confirmation of procedures.
- 2.19** Telephone advice should be sufficient for the majority of incidents but physical attendance at an incident can be requested if it is deemed appropriate. However, it should be stressed that Competent Person support is provided on a best endeavours basis and it may not be possible for a Competent Person to attend. Where attendance is requested the Fire and Rescue Service should organise a blue light escort through any traffic or emergency cordons, if required.
- 2.20** If the cylinder owner cannot be identified a Competent Person will still give generic advice on dealing with cylinders in fires but they are not able to give specific advice on cylinders that do not belong to their company. If possible, try to identify the gas company involved, otherwise the Competent Person will be limited to offering generic advice. Once a cylinder has been positively identified the Competent Person will advise the Fire and Rescue Service to contact the appropriate gas company for further specific advice.
- 2.21** 'FOSI': As part of the quality assurance arrangements FRS are required to complete 'Feedback Form For Cylinder Incidents' (see Appendix A, FSC 32/2004). These forms should be collected by the FRS Mobilising Control and forwarded email to CLG on fosi@communities.gsi.gov.uk.

3.0 Other Activities

- 3.1 The BCGA has published several information leaflets aimed at the end user. These include: -
- 'Cylinders in Fires' leaflet that highlights storage, handling and transport requirements as well as the safe use of gas cylinders and what to do in the event of a fire (copy attached).
 - Technical Information Sheet No 15: 2008 'Model Risk Assessment for the Storage and Use of Oxyacetylene Cylinders' a tool to help smaller companies work through risk assessments where they might not be so familiar with the concept.
 - Guidance Note 13, DSEAR- Risk Assessment: 2008. These documents are available at www.bcga.co.uk (and click on 'cylinders in Fires').
- 3.2 Network Rail, the Highways Agency, and Transport for London working with London Fire Brigade have commissioned QinetiQ, the international defence and security technology company, to provide and operate specialised remotely operated vehicles (ROVs). These can be used to safely assess and deal with the cylinders, allowing incidents to be resolved more quickly. The ROVs, with their all-terrain capabilities, are able to enter environments that would be unsafe for firefighters. Their cameras can identify whether any acetylene cylinders are present and, using thermal imaging, can gauge whether the cylinders are sufficiently cool for the Brigade to safely approach and deal with them.
- 3.3 Following consultation with the National Stakeholder Group, gas companies have started labelling acetylene cylinders with retro-reflective tape and collars that will aid identification of cylinders and their owner.

Good Practice: Overview of London Fire Brigade's Review into incidents involving cylinders

- 3.4 In 2005/06 London Fire Brigade experienced several incidents involving cylinders that had a severe impact on local and national infrastructure. The main cause for this was the maintenance of the 200m cordon for the full 24hr period. However following a review of their procedures they instigated the methodology detailed below. This has led to a great reduction in disruption, in fact, LFB have not had an acetylene cylinder incident that necessitated a 200m / 24 hour cordon since 22 April 2007. This has reduced the average incident time to 2 hours 15 minutes, from the previous average of 19 hours. This improvement has been achieved within current national operational procedures.

London Fire Brigade Methodology

- A database of all cylinder incidents since 1st January 2004 has been created, including information on timelines, how cylinders behave in fire, actions taken by crews and mapping disruption to the public
- An investigation of every acetylene incident within this period has been undertaken reviewing operational tactics and decisions
- Timelines have been created for acetylene incidents within this period establishing when cylinders fail and how they react to cooling
- Hazardous Material and Environmental Protection Officers (HMEPO) are mobilised to all cylinder incidents. These officers have received specialist training from members of the BCGA on the following areas:-
 - Identifying acetylene cylinders
 - The properties of acetylene and cylinder construction

- The reaction of acetylene cylinders (including decomposition) when involved in fire.
- The BCGA Competent Person Procedure
- Managing the Hazard Zone after the cylinder has passed a wetting test (see below)
- ROV trial has been undertaken to assist crews in dealing with acetylene cylinder incidents.

Managing the Hazard Zone

This action has enabled LFB to be confident in the current national procedures, and provides extra support to Incident Commanders using Hazardous Materials and Environmental Protection Officers and Competent Person advice. Management of the hazard zone is based on the following tenets:

- Acetylene cylinders ultimately fail because the steel cylinder loses its tensile strength. Cooling the cylinder for one hour will restore the strength of the cylinder shell and inhibit/stop decomposition.
- Imposition of a 200m hazard zone is only required if the cylinder is in danger of failing.
- If the cylinder shell is at ambient temperature it is in no immediate danger of failing provided that the cylinder is not reheated or disturbed and that cooling continues
- Consequently the Hazard Zone only needs to be big enough to prevent the cylinder becoming reheated or being disturbed and to allow cooling to continue.
- The zone could therefore be reduced to as little as 5 to 10m.
- LFB have found the early reduction of the 200m Hazard Zone has been the most significant factor in reducing the disruption caused by acetylene cylinder incidents.

4.0 Additional Database and Research information

4.1 Current background information indicates that:-

- Acetylene cylinders have only failed whilst the fire is in progress or before substantial (1 hour) cooling has taken place.
- No acetylene cylinder has ever failed after it has passed a Wetting Test and not been reheated or moved.
- No acetylene cylinder has ever shown a sign of the shell reheating after it has passed a Wetting Test (and not been subjected to re-involvement in fire).
- No unheated acetylene cylinder has shown evidence of decomposition following mechanical shock.

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