



HANDLING GAS CONTAINER EMERGENCIES

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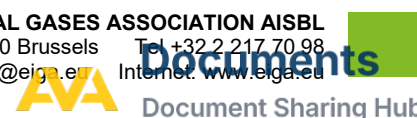


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Amendments to IGC Doc 80/14

4.1	Information about the Intervention in Chemical transport Emergencies (ICE)
4.3	Identification of members of Emergency Response Team
5.1	Paragraph is reworded and hazards from pressurised systems added
6.1	Practice of curing a leak with soft lead wire has been taken out of the text
6.2	Practice of curing a leak with self tapping screw has been taken out of the text
6.11.5	Picture has been added
7.1	Paragraph is restructured
7.2.2	Specific PPE for specific gases has been taken out of the text
7.2.3	Update of detection equipment
Fig 1	Letters added back to Fig 1 on 10 th June 2022

1 Introduction

This document describes the special requirements and techniques used in handling emergencies involving gas containers.

Owing to the high integrity of gas pressure containers, emergencies involving them are rare. However, when incidents do occur it is important that they are dealt with in a safe and professional manner. This document has been prepared as a practical guide to handling such emergencies.

2 Scope and purpose

2.1 Scope

This practical guide is limited to handling emergencies involving pressurised gas containers including cylinders, small cryogenic vessels (up to 450 litres), drums, bundles, MEGCs, and battery vehicles, (including tube trailers).

This practical guide is intended for the use of technically competent and trained practitioners only. Before attempting to tackle an emergency situation, the methods and techniques to be employed should be discussed and agreed with the customer and/or emergency services representatives.

The management issues associated with setting up and operating an Emergency Service are outside the scope of this practical guide.

2.2 Purpose

The purpose of this practical guide is:

- to identify potential emergency scenarios
- to provide guidance on initial advice that can be given to persons at the scene
- to set out the “tried and tested” techniques that can be employed to bring an emergency situation under control and to a safe conclusion
- to provide guidance on the equipment that may be required by personnel who deal with such emergencies

3 Definitions

3.1 Publications terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May and Need not

Indicate that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Cold-welding

Can occur where two similar materials which are in contact with each other apparently fuse together without the application of heat.

NOTE Such a phenomenon occasionally occurs between a cylinder valve outlet threaded connection and the outlet connector nut. Typically this is associated with stainless steel cylinder valves fitted with stainless steel outlet connector nuts that have either been cross-threaded or over-tightened or where the tolerances between the nut and valve outlet are insufficient for the threads to run smoothly. Wherever possible, connector nuts used on stainless steel valve outlets should be made from a different material (e.g. brass or Monel). Where this is not possible, it is recommended that the connector nut threads should be plated with a lubricating metal (e.g. silver), with adequate allowance made in the connector nut thread tolerance to allow for the thickness of the plating.

3.2.2 Cylinder recovery vessel

Pressure vessel which is designed to safely contain a cylinder and its content for transportation and storage, until it can be safely emptied.

NOTE A cylinder recovery vessel could be fitted with a gauge to indicate internal pressure and valves to enable purging. A cylinder recovery vessel is identified as a "salvage pressure receptacle" in the Regulations for the international transport of dangerous goods (UN Model regulations, ADR/RID, etc) [1,2]

3.2.3 Emergency

Unplanned situation that could give rise (or has given rise) to a hazard to people or the environment and or damage to equipment.

3.2.4 Gas

For the purposes of this document any product gaseous, dissolved or liquefied transported in gas containers.

3.2.5 Gas cabinet

A locally ventilated enclosure designed to contain a gas supply cylinder and, where appropriate, an associated purge supply gas cylinder. The term gas cabinet usually also includes the gas supply handling equipment such as purge manifolds and pressure reducing regulators. The gas cabinet can be quite complex in design, often being equipped with automatic microprocessor control. Gas cabinets are commonly used by the microelectronics industry.

3.2.6 Gas supplier's Emergency Response Team

A group of suitably equipped, technically competent and trained personnel with the purpose/function to bring an emergency to a safe conclusion by providing technical advice and or practical assistance. The emergency response team can be a third party contractor.

3.2.7 Gas supplier's Representative

A person who acts on behalf of the Gas supplier to provide safety & technical advice to persons at the scene of an emergency.

3.2.8 Gas user

Personnel from the customer / manufacturer working with the cylinder / gases

3.2.9 MEGC (Multiple elements gas containers)

a unit containing elements which are linked to each other by a manifold and mounted on a frame. The following elements are considered to be elements of a MEGC: cylinders, tubes, pressure drums and bundles of cylinders as well as tanks for the carriage of gases of Class 2 having a capacity of more than 450 litres.

3.2.10 Public emergency services

Public Services that may be involved or present at the scene of an emergency. These include fire brigade, police, and medical personnel (such as doctors, nurses & ambulance).

3.2.11 Pressure

In this publication, “bar” shall indicate gauge pressure unless otherwise noted – i.e., (bar, abs) for absolute pressure and (bar, dif) for differential pressure.

4 Emergency Service

4.1 Advice to emergency scene

To ensure that safety is not compromised, the Gas suppliers should make appropriate arrangements to enable sound technical advice to be made available (e.g. over the telephone) to persons at the scene of an emergency.

The nature and detail of the initial advice given may depend on a number of factors, including

- a) chemical formula and hazards of the gases involved
- b) types and numbers of gas containers
- c) location of the emergency
- d) knowledge and experience of persons at the scene

Within the framework of Responsible Care®, the European chemical industry makes efforts to transport goods safely. In the event of an incident, it will provide information, practical help and, if necessary and possible, appropriate equipment to the competent emergency authorities in order to minimise any adverse effects. ICE (Intervention in Chemical transport Emergencies) is the co-operative programme, set up by the European chemical industry to achieve this goal. In each European country, it seeks to create a framework for providing assistance in an effective way. Each national ICE scheme applies only to distribution incidents (i.e. those that occur outside manufacturing sites) and is formalised in a protocol between the national chemical industry federation and the national competent authorities. Refer to <https://www.ice-chem.org/>

4.2 Control of emergencies

Emergencies are controlled either by the Public Emergency services or by the site owner. Where Public Emergency Services are responsible for controlling the emergency, the Gas supplier's input should be limited to providing technical advice on the hazards and where necessary practical assistance in abating product release and making the containers safe.

4.3 Emergency response team

Where a Gas supplier has established an Emergency Response Team to assist bringing an emergency to a safe conclusion, the team members shall be suitably equipped, technically competent and experienced in required techniques. This team shall be able to make containers safe and, under some

circumstances, remove them to the Gas supplier's site, where the contents can be safely emptied and the causes investigated.

The ER team present at the incident/accident site should be easily identifiable to the public emergency services and site owners etc.

4.4 Emergency reports

It is recommended that a recording system is in place for all emergencies reported. This should cover:-

- location of incident and products / containers involved.
- the timetable of events
- the names and telephone numbers of all known persons involved
- details of any reported injuries or material damage
- details of initial advice given
- details of any follow-up actions taken (e.g. a report from the Gas supplier's Emergency Response Team on their visit to the scene of the emergency).
- details of any media involvement

5 Emergency scenarios

Emergency scenarios can be divided into four broad categories:

- external fire,
- gas leaks,
- transport emergencies and
- other emergency scenarios (see 5.4).

This section outlines many of the potential emergency scenarios that may be encountered and gives guidance on the initial advice that may be given to persons at the scene and subsequent follow-up actions that may be taken.

5.1 Fire in the vicinity of containers

The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) contains requirements referencing maximum pressures and temperature.[1] In no case the internal pressure at 65 °C shall exceed the test pressure. Above 65 °C, pressures increase and may ultimately reach the container deformation or burst pressure (generally, the rates of pressure increase are greater for liquefied gases than for compressed gases). At the same time, the mechanical properties of the container material may degrade (melting point for aluminium alloys, change of the crystalline structure of steel). There may be a risk of the cylinder rupturing or exploding. It should be noted that even if cylinders are not directly within the fire, there might be a risk of them becoming over-heated from the radiant heat emitted from a fire in the vicinity.

In addition to the potential hazards arising from cylinders, similar hazards may arise from pressurised systems that are not designed for high temperature operation.

5.1.1.1 Advice to persons at scene

It is recommended that the following advice is given to persons at the scene:

- a) There may be a risk of cylinders exploding or 'rocketing'.
- b) Cylinders should be sprayed with water from a safe distance to keep them cool. Care should be taken not to extinguish the flame of a leaking gas cylinder unless it is safe to do so.

- c) The identity of the contents of the cylinders should be sought, as certain gases may be thermally unstable (e.g. acetylene, ethylene oxide, 1,3 butadiene, organometallics, diborane, etc.), where heating may initiate an exothermic reaction which could eventually result in the cylinders exploding. Such reactions may not manifest themselves until long after the fire has been extinguished. Refer to EIGA Safety Information 02: "Handling of Gas Cylinders at and after Fire/Heat Exposure" for further recommendations
- d) After the fire has been extinguished and any cylinders involved have cooled down and have been deemed to be safe to approach, they should be appropriately labelled as having been involved in a fire and bonded to await further instructions from the Gas supplier. The EIGA SI 02, *Handling of Gas Cylinders during and after Exposure to Heat or Fire* includes recommendations for customers and Fire Brigades [3].

5.1.2 Follow-up actions

It is recommended that the Gas suppliers should make arrangements for suitably trained personnel to visit the site to inspect any cylinders involved in a fire to ensure that they are safe to be transported. Such an inspection could be particularly important if the cylinders are not empty and contain toxic or flammable gases or appear to be swollen.

In some cases, after assessment, it may be deemed most appropriate to either empty fire damaged cylinders before they are transported or to transport them in a cylinder recovery vessel.

5.2 Leaking container

Leakage from a container can arise from seven possible sources, as follows: (see figure 1)

- a) From the connection between the valve outlet and the Gas User's equipment. This may be due to damage to one or more of the valve outlet sealing components (e.g. the sealing faces of the connector/valve outlet/gasket) or the incorrect connection tightening torque. Experience has shown that Gas Users can mistakenly believe that a leak from the valve outlet connection is arising from the cylinder valve itself.
- b) From the valve outlet (valve seat pass-through leak). This may be due to the valve seat being damaged or valve operating mechanism being damaged or seized. The Gas User may experience this problem when initially removing the cylinder valve outlet cap-nut (in readiness to connect the cylinder for use) or when disconnecting the cylinder (after use), finding that the cylinder valve is leaking.
- c) From the valve gland. This may be due to a loose gland packing nut or diaphragm sealing nut. In these cases, it may be possible to rectify the leakage by tightening the gland nut. Other possible causes (rare) are, in the case of diaphragm-seal valves a fractured diaphragm and in the case of an O-ring seal valve, failure of the O-ring seal. Leaks of this nature cannot be cured by tightening the gland nut. Typically valve gland leaks can be overcome by closing the cylinder valve. Once the cylinder valve has been closed, the leak should cease once the pressure in the system has been released.
- d) From the joint between the valve and the cylinder (commonly known as 'neck-leak'). This may be due to
- the valve being tightened insufficiently into the cylinder
 - insufficient sealant on valve threads
 - damage to the valve thread
 - mechanical damage during handling
 - overheating of cylinder e.g. during fire
- e) From the cylinder body itself. This is very rare and extremely unlikely. Occasionally, cylinders of a welded construction have been known to develop a pin-hole leak at a welded seam. Certain cylinders

(such as drums) may be fitted with a flange into which the valve(s) are screwed. Flanges are fitted to this type of cylinder to facilitate the fitting of dip-tubes (for liquid or gas withdrawal). Occasionally, small leaks can develop from the joint between the flange and the container body.

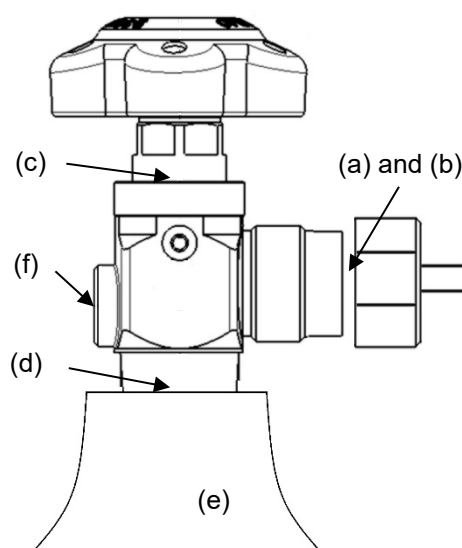
f) From a pressure relief device which may be fitted to some cylinder valves and very rarely in the bottom of Acetylene cylinders. Such a device is typically incorporated into a small plug which is screwed into the valve body and which is permanently exposed to the cylinder pressure (i.e. cannot be isolated by closing the cylinder valve). This pressure relief device may be referred to as a 'safety relief device' in some other parts of the world. Types of pressure relief device in use include one or more of the following types:

- 'fusible plug' type - this consists of a plug of metal which melts at a predetermined temperature and is intended to protect the cylinder from over-pressurisation in the event of a fire. Once the fusible plug has melted, the entire cylinder content will be discharged. Very small leaks from this type of device can arise from the joints between the fusible metal and the plug and between the plug and the valve body.
- 'bursting disc' type - this consists of a metallic disc designed to rupture at a predetermined pressure and is intended to protect the cylinder from over-pressurisation arising from any cause. Once the disc has ruptured, the entire cylinder content will be discharged. Very small leaks from this type of device can arise from the joints between the disc and the plug and between the plug and the cylinder valve body.
- 'spring-loaded' type - this consists of a spring-loaded relief valve, the spring being set to allow the valve to open at a predetermined pressure and thus protect the cylinder from over-pressurisation from any cause. Once any excess pressure has been released, the pressure relief device will close, preventing any further gas release. Very small leaks from this type of device can arise from the failure of the valve to re-seat properly after a gas release and from the joint between the plug and the cylinder valve body.

g) From the flange between the pressure drum or portable tank and its cover on which the valve(s) are threaded - this may be due to:

- the bolts being tightened insufficiently
- damage to the gasket
- mechanical damage during handling

NOTE Where the cylinder content is hygroscopic and corrosive to the valve body or cylinder, the leak rate may increase as the materials around the leak path corrode away.



- (a) Connection between the valve outlet and the user's equipment.
- (b) From the valve outlet (valve seat pass-through leak)
- (c) From the valve gland or packing.
- (d) From the joint between the valve and the cylinder (neck-leak).
- (e) From the cylinder body itself.
- (f) From a pressure relief device which may be fitted to some cylinder valves

Figure 1 - Container leak sources