Produced in collaboration with

UK Steel

GUIDANCE NOTE 34

THE SAFE USE OF GASES IN THE STEEL INDUSTRY

2018

British Compressed Gases Association

GUIDANCE NOTE 34

THE SAFE USE OF GASES IN THE STEEL INDUSTRY

BRITISH COMPRESSED GASES ASSOCIATION
Registered office: 4a Mallard Way, Pride Park, Derby, UK. DE24 8GX
Company Number: 71798, England

Website:
www.bcga.co.uk

ISSN 2398-936X

PREFACE

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

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

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

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

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

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

This document has been prepared by BCGA Technical Sub-Committee 6. It was approved for publication at BCGA Technical Committee 157. This document was first published on 25/04/2018. For comments on this document contact the Association via the website www.bcga.co.uk.

CONTENTS

* Throughout this publication the numbers in brackets refer to references in Section 16. Documents referenced are the edition current at the time of publication, unless otherwise stated.

TERMINOLOGY AND DEFINITIONS

Cylinder	A transportable pressure receptacle of a water capacity not exceeding 150 litres.
May	Indicates an option available to the user of this Guidance Note.
Pipeline	A pipe or system of pipes used for the conveyance of relevant fluid across the boundaries of premises, together with any apparatus for inducing or facilitating the flow of relevant fluid through, or through a part of, the pipe or system, and any valves, valve chambers, pumps, compressors and similar works which are annexed to, or incorporated in the course of, the pipe or system
Pipework	A pipe or system of pipes together with associated valves, pumps, compressors and other pressure containing components and includes a hose or bellows but does not include a pipeline or any protective devices.
Shall	Indicates a mandatory requirement for compliance with this Guidance Note and may also indicate a mandatory requirement within UK law.
Should	Indicates a preferred requirement but is not mandatory for compliance with this Guidance Note.
Pressure reducing station	A pipework system specifically designed to reduce pressure from a high input to a lower in-use. It will include a range of appropriate control and safety devices.

GUIDANCE NOTE 34

THE SAFE USE OF GASES IN THE STEEL INDUSTRY

1. INTRODUCTION

There are many uses for industrial gases in the steel industry. Oxygen is an important component in the steelmaking process and bulk quantities are either stored or delivered via a pipeline system. A smaller quantity of other bulk gases may also be stored on site, such as argon, nitrogen, natural gas and propane. These gases will be delivered to the point of use via pipelines and/or appropriate pipework. It is probable that there will also be available a range of welding and cutting gases with their associated equipment.

Provided they are stored, handled and used responsibly, knowledgably and correctly the use of gases in the steel industry are a valuable resource and are safe to use.

Operators shall ensure that they understand the hazards associated with the specific gases being used and take all necessary safety measures to properly control the risks to their staff and employees, and to anyone else who might be affected by the gas.

UK Steel

This code of practice is in line with advice from the British Compressed Gases Association (BCGA) and UK Steel. UK Steel, a division of EEF (the Manufacturers' Organisation), is the trade association for the UK steel industry. It represents all the country's steelmakers and a large number of downstream steel processors.

This document is intended for use in conjunction with current guidance and information produced by the Health and Safety Executive (HSE), other related bodies and trade associations.

2. SCOPE

This document covers the use of externally supplied gases at steel production sites. It provides advice on safe and appropriate storage, handling, use and gas quality, as well as appropriate ancillary equipment.

It includes the design and maintenance of pipelines, pipework and equipment.

Excluded from the scope of this Guidance Note are:

- Natural gas provided for domestic heating, cooking etc. purposes.
- LPG cylinders and cartridges, refer to documents provide by UKLPG.
- Compressed air systems, refer to documents provide by the British Compressed Air Society (BCAS).
- Works arising gases.

- Carbon dioxide and fire suppressant gases.

3. COMMON GASES IN THE STEEL INDUSTRY

The common gases externally supplied for use in the steel industry include:

- Oxygen – as gas and liquid;
- Nitrogen – as gas and liquid;
- Argon and argon mixtures;
- Calibration gases;
- Welding fuel gases. For example, acetylene, LPG;
- Welding shielding gases;
- Propane;
- Natural gas

4. HAZARDS FROM GASES

4.1 General hazards

Each gas will have its own particular set of hazards based on its physical and chemical properties. Always refer to the product Safety Date Sheet for specific information. The general hazards applicable to most are:

- Density, refer to Section 4.1.1.
- Asphyxia, refer to Section 4.1.2.
- Health effects, refer to Section 4.1.3.

There are additional hazards associated with a cryogenic gas, refer to Section 4.1.4.

For further information on managing the risks associated with gases, refer to BCGA GN 11 (40), *The management of risk when using gases in enclosed workplaces.*

4.1.1 Density

Knowing the density of the gases relative to air will suggest where the gas may preferentially tend to accumulate, for example, a gas with a density greater than air will tend to fall and collect in the lower areas of the workplace, such as pits, tunnels, drains, conduits etc. In addition, it should be remembered that the temperature of a gas will affect its density such that gases normally regarded as

being lighter than air may in fact be heavier than air when very cold, i.e. cold gases may initially accumulate in low lying areas.

4.1.2 Asphyxia

The normal concentration of oxygen in the air that we breathe is approximately 21 %. Oxygen is the only gas that supports life. The release of any gas will displace the existing atmosphere in an enclosed workplace, which in turn will (other than for released air and oxygen) reduce the volume of oxygen available to breathe. If the oxygen concentration in the workplace atmosphere decreases there is an increased risk of asphyxiation. Refer to Table 1.

O_2 concentration Volume %	Effects and symptoms
20.9	Normal level of oxygen in the atmosphere
19.5	Minimum safe level of oxygen
< 18	Potentially dangerous.
< 10	Risk of unconsciousness followed by brain damage or death due to asphyxia is greatly increased.
< 6	Immediate loss of consciousness occurs.
0	Inhalation of only 2 breaths causes immediate loss of consciousness and death within 2 minutes

Table 1: The effects of inhaling reduced concentrations of oxygen

4.1.3 Health effects

Health effects can occur where people are exposed to gases. The *Control of Substances Hazardous to Health* (COSHH) Regulations (8) require that exposure to any hazardous substance is managed. The HSE provide guidance on workplace exposure limits in HSE EH 40 (23), *Workplace exposure limits*. Not all gases are listed, however the effect of asphyxiation is covered within HSE EH 40 (23) as a special case.

Specific gases may have other health effects, as well as asphyxia, for example, cold burns, toxicity, corrosive, etc.

4.1.4 Cryogenics

Cryogenic gases may have the following additional hazards:

- Extreme cold – hazard to people, such as cold burns;
- Extreme cold – hazard to articles, such as embrittlement;

- Liquefaction of air - this can occur when air comes into contact with articles which are at a temperature below the boiling point of an air gas, for example, oxygen (-183 °C). This can occur when transferring liquid nitrogen (-196 °C) through uninsulated pipes which can result in the unexpected production of liquid oxygen, therefore increasing the fire risk;

- High liquid to gas expansion ratio;

- Poor visibility, with the formation of vapour clouds which will generally lay low to the ground.

4.2 Flammable gases

Flammable gases burn or explode when mixed with air or oxygen, and the mixture is then ignited. Flammable gases react or burn with other oxidising gases. The likelihood that a flammable gas will burn or ignite will depend on its flammability range. Some common examples of the flammability ranges of specific gases in air are:

- Acetylene, 2 to 85 %

- Hydrogen, 4 to 75 %

- Methane, 5 to 15 %

NOTE: The effects of oxygen enrichment may also need consideration, refer to Section 4.3.3.

Some common examples of ignition sources are:

- Welding;

- Hot work;

- Friction, sparks, etc.;

- Static electricity charge;

- Electrical, for example, connections, switching, overheating or faults;

- Smoking.

NOTE: Some flammable gases, for example, hydrogen, may ignite on release for a variety of reasons, examples include: due to the friction of the gas movement over a surface, adiabatic compression, self-generated static electrical charge, etc. Pyrophoric gases may ignite on contact with air (spontaneous combustion).

The primary hazard from a flammable gas is the risk of fire and explosion, in addition flammable gases have a secondary hazard of asphyxia and some may have narcotic effects.

4.3 Non-flammable, Non-toxic gases

Non-flammable, non-toxic gases includes gases which are generally referred to as inert, as they are not reactive, refer to Section 4.3.1. This division also includes gases which have oxidising properties, refer to Section 4.3.2.

4.3.1 Inert gases

Inert gases are non-oxidising, non-flammable and non-toxic but which may dilute or replace the oxygen normally present in the atmosphere. Typical inert gases include:

- Nitrogen;
- Argon;
- Helium.

The primary hazard from inert gases is asphyxia, refer to Section 4.1.2.

4.3.2 Oxidising gases

Oxidising gases will support the combustion process. Many substances which would otherwise not combust, are able to combust and burn fiercely in an atmosphere enriched with oxidising gases. Refer to Section 4.3.3. Substances may ignite with a lower ignition energy than that required for ignition in a non-oxidant enriched atmosphere, or they may ignite at concentrations below their normal Lower Explosive Limit (LEL). Typical oxidising gases include:

- Oxygen;
- Nitrous oxide.

NOTE: Oxygen can be produced in the workplace through biological action or chemical reactions.

The primary hazard from oxidising gases is the increased risk of combustion coupled with an increased intensity of combustion. Oxygen is a reactive gas and may cause a chemical reaction.

In oxygen enriched atmospheres, or where oxygen enrichment can occur, smoking shall be strictly forbidden.

Anyone who has been exposed to oxygen should not smoke or go near ignition sources until they have been properly ventilated. A minimum period of 15 minutes with movement of the arms and legs and coat unbuttoned is recommended.

4.3.3 Oxygen enrichment

Oxygen plays a vital part in combustion mechanisms. Oxygen is not in itself flammable, but increasing the oxygen content in an atmosphere will increase the combustion rate of materials and substances. The initiation, speed, intensity and extent of combustion will depend on:

- Oxygen concentration;

- Temperature;
- Pressure;
- Material type and quantity, as well as any local substances which could become involved in the combustion.

NOTE: Oil and greases and other hydrocarbons are particularly hazardous in the presence of oxygen as they can self-ignite and burn with explosive violence.

The normal concentration of oxygen in the air that we breathe is approximately 21 %. However, oxygen enrichment of the atmosphere, even by a few percent, considerably increases the risk of fire and also increases the rate of propagation and intensity of a fire or explosion. Concentrations of oxygen above 23.5 % should be avoided. Where it is unavoidable, specific precautions shall be implemented following a risk assessment. In oxygen enriched air, ignition sources which would normally be regarded as harmless can cause fires, and materials which do not burn in air, including fire resistant materials, may burn vigorously. Any fire will drive the evaporation process and may cause a sudden escalation of the fire.

An ignition in an oxygen pipe can create an extreme reaction where a rapid, very hot fire will develop, allowing the oxygen to react with the pipe material consuming it or melting it and material in its path. Pipe design should include safety features to prevent such a fire spreading along the pipe. Refer to Section 8.

For specific guidance on oxygen enrichment refer to:

- HSE INDG 459 (24), *Oxygen use in the workplace. Fire and explosion hazards*.
- European Industrial Gases Association (EIGA) Document 04 (26), *Fire hazards of oxygen and oxygen enriched atmospheres*.

5. REGULATIONS

Gases have a number of hazards. Gases are classified as dangerous goods under transport regulations and are identified as substances that are hazardous to health under the COSHH Regulations (8). Compliance with the *Health and Safety at Work etc. Act* (1) and its associated Regulations is mandatory.

The storage, handling and use of gases is subject to appropriate risk assessment, as required by *The Management of Health and Safety at Work Regulations* (5). Refer to Section 6.

Due to the potential for fire and explosion *The Dangerous Substances and Explosive Atmospheres Regulations* (DSEAR) (9) also requires an appropriate risk assessment to be carried out. Any equipment used in a hazardous area, as identified under DSEAR (9), will need to comply with the *Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations* (14).

Bulk quantities of gases will typically be distributed in a pipeline, for example, oxygen. All pipelines shall comply with the *Pipelines Safety Regulations* (2), refer to Section 8.

The design and construction of pressure equipment shall comply with the *Provision and Use of Work Equipment Regulations (PUWER)* (4) and (where the pressure is greater than 0.5 bar) has to comply with the *Pressure Equipment (Safety) Regulations* (13). Compliance may also be required with the *Simple Pressure Vessels (Safety) Regulations* (12).

Gases in pipework will be distributed under pressure. Such pipework will be classified as a pressure system. The *Pressure System Safety Regulations (PSSR)* (6) cover the safe design and use of pressure systems. Refer to Section 9.

All gases, apart from oxygen and air, if released to an inadequately ventilated space will produce local oxygen-deficient atmospheres, which will produce asphyxia if breathed. If excessive amounts of oxygen are released then the atmosphere will become enriched, increasing the likelihood of a fire. In any area that would be classified as a confined space then comply with the *Confined Space Regulations* (3).

In some circumstances, typically where there are large quantities of gases stored on site, compliance with the *Control of Major Accident Hazards Regulations (COMAH)* (11) will be required.

6. RISK ASSESSMENT

Gases are potentially hazardous products and their storage, handling and use is subject to appropriate risk assessment, as required by *The Management of Health and Safety at Work Regulations* (5). Due to the increased fire and explosion potential when flammable gases and/or oxygen are present a further risk assessment shall be carried out as required by *The Dangerous Substances and Explosive Atmospheres Regulations* (DSEAR) (9). DSEAR (9) applies even where no flammable gases are present, by virtue of the ability of compressed gas containers and systems to ‘explode’ through sudden release of mechanical (pressure) energy.

Information on risk assessment can be obtained from the HSE, who provide a wide range of guidance on carrying out risk assessments on their website: www.hse.gov.uk/risk

In any area which can be classified as a confined space, where there is the likelihood of the atmosphere changing, for example, in areas of poor ventilation, where a local oxygen deficient atmosphere or alternatively an oxygen enriched atmosphere is possible, then a specific risk assessment in compliance with the *Confined Space Regulations* (3) shall be carried out. Entry into such areas shall be prohibited unless appropriate safety control measures are adopted to protect those accessing or working in the area. Control measures may include ventilation arrangements and systems, gas detection systems and signage warning of the dangers.

An emergency rescue plan shall be prepared and in-place and appropriate emergency rescue equipment should be prepared and ready for immediate use by competent persons, where required.

For further information refer to HSE L101 (21), *Safe work in confined spaces. Approved code of practice*.

Where there may be a risk of a changing atmosphere within an enclosed space, guidance on risk assessment is available in BCGA GN 11 (40), *The management of risk when using gases in enclosed workplaces.*

For all activities involving gases, assess whether:

- For each individual gas product, comprehensive product information is held, including a current product Safety Data Sheet. COSHH Assessment(s) are to be completed for each product and actioned;

- The containers and storage vessels for gases are located in an appropriate place and, as necessary, are secured against falling and other foreseeable risks. Refer to Section 7;

- Appropriate safety control measures are in place, including the provision and use of personal protective equipment. Refer to Section 13;

- All personnel who will use, handle or be in proximity to gases and gases equipment receive suitable information, training and instruction. Refer to Section 14;

- Emergency procedures have been prepared, are available and have been communicated to relevant persons. First aid requirements for the different products are understood and in place. Refer to Section 15.

7. STORAGE

Where one or more gas cylinders are held, they shall be stored in accordance with BCGA CP 44 (38), *The storage of gas cylinders*.

Where cryogenic liquids are held, they shall be stored in accordance with BCGA CP 36 (36), *Cryogenic liquid storage at users' premises*.

All storage areas should meet the general principles of:

- Being located in an external area;

- Being secure;

- Having good natural ventilation;

- Having no potential sources of ignition or contain materials (which are not a necessary part of the store) which will allow a fire to start and/or provide fuel to allow a fire to continue.

The store location should take into account the need for delivery vehicles to deliver and collect cylinders and product, as well as controlled access, for example, for those undertaking maintenance, requiring cylinders on-site, etc.

Each store shall have appropriate safety, information and warning notices in clearly visible positions.

8. PIPELINES

The *Pipelines Safety Regulations* (2) require that a pipeline is designed, constructed and operated safely, and provide a means of securing pipeline integrity. The regulations do not take into account the effect on the environment, for example, from a leak, however through compliance with the regulations the risks to the environment are reduced. It is important that effects on the environment are considered at all stages in the life cycle of a pipeline. With oxygen such effects are minimal.

Product may be stored in large bulk storage tanks on site (refer to Section 7) and/or piped in from a local manufacturing plant. On-site pipelines and distribution systems then carry the product to the point of use. Oxygen is likely to be provided in the greatest quantities.

HSE have six key elements for the long term safety of pipelines:

- Initial safe design;
- Construction and commissioning to design standards;
- Operation within design parameters;
- Inspection and long - term maintenance;
- Integrity review and arrangements for managing change and decommissioning;
- Avoiding third party damage.

HSE provide general guidance on pipelines in HSE L82 (19), *A guide to the Pipelines Safety Regulations 1996*.

Where the product in the pipeline is classed as a dangerous fluid (refer to the *Pipelines Safety Regulations* (2), Schedule 2), such as oxygen, then additional requirements for Major Accident Hazard Pipelines (MAHP) are necessary, including:

- A notifications regime;
- A major accident prevention document;
- Arrangements for emergency plans.

HSE provide guidance on emergency plans within their document *Further guidance on emergency plans for major accident hazard pipelines. The Pipelines Safety Regulations 1996 (25).*

Where the gas is supplied by a third party either via a pipeline, or from a vessel located on site, then the point of demarcation between the third party and the user (customer) is to be clearly defined.

Also, the length of pipeline covered by the *Pipelines Safety Regulations* (2), is to be defined and the pipework covered by the PSSR (6) is to be defined. The demarcation point between the two sets of regulations is to be clearly identified.

EIGA provide extensive information on the design of pipelines and for oxygen systems in:

- EIGA Document 13 (27), *Oxygen pipeline and piping systems.*
- EIGA Document 33 (29), *Cleaning of equipment for oxygen service – Guideline.*
- EIGA Document 154 (31), *Safe location of oxygen and inert gas vents.*
- EIGA Document 200 (32), *Design, manufacture, installation, operation and maintenance of valves used in liquid oxygen and cold gaseous oxygen systems.*

There are also steel sector specific documents available. These should be followed at all times, taking account of the guidance in this document.

9. GAS DISTRIBUTION SYSTEMS

Gas distribution systems will be classified as pressure systems. At their design and installation stage they shall comply with the *Pressure Equipment (Safety) Regulations* (13) and when in use shall comply with the PSSR (6). The PSSR (6) requires periodic examination of a pressure system against and in accordance with a Written Scheme of Examination. In addition, the gas distribution system will require routine inspection and maintenance in compliance with PUWER (4).

Where gases are distributed via pipework refer to BCGA CP 4 (34), *Industrial gas cylinder manifolds and gas distribution pipework (excluding acetylene).*

For advice on managing gas distribution systems refer to BCGA CP 39 (37), *In-service requirements of pressure equipment (gas storage and distribution systems).*

HSE provide guidance:

- on managing work equipment, refer to HSE L22 (17), *Safe use of work equipment. Provision and Use of Work Equipment Regulations 1999. Approved Code of Practice and guidance.*
- on the PSSR (6), refer to HSE L122 (22), *Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice and guidance.*

10. PORTABLE GAS EQUIPMENT

For the safe use of portable welding equipment refer to BCGA CP 7 (35), *The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply).*

For other portable gas equipment refer to BCGA GN 7 (39), *The safe use of individual portable or mobile cylinder gas supply equipment*.

11. TRANSPORTING GAS CYLINDERS

Gases are classified as Class 2 dangerous goods. As such, anyone transporting gas cylinders shall comply with the *Carriage of Dangerous Goods and the Use of Transportable Equipment Regulations* (10). These regulations implement the *European Agreement Concerning the International Carriage of Dangerous Goods by Road* (ADR) (15), which provides a framework for dangerous goods carriage through compliance with standards for packaging and labelling of the products, and appropriate construction and operating standards for the vehicles and crew.

Everyone carrying gas containers (for example, gas cylinders) in a vehicle, in the course of their work, shall comply with the basic legal safety requirements detailed in ADR (15). A threshold level is set based on a quantity of transport units, if you exceed the threshold level you are required to comply fully with ADR (15).

The driver of the vehicle is legally responsible for the safety of the vehicle and any load being carried. The insurance policy for the vehicle shall include appropriate cover for the carriage of dangerous goods.

Advice on transporting gas cylinders is available in BCGA GN 27 (42), *Guidance for the carriage of gas cylinders on vehicles*.

12. RETURN / DISPOSAL OF CYLINDERS / EQUIPMENT

Only keep cylinders on-site where they contain product and are required for use. All cylinders which are empty, or are no longer required, should be returned to their owner at the earliest opportunity.

The vast majority of gas cylinders in circulation in the UK are the property of the gas suppliers. They are supplied to gas users under a rental agreement, which requires the user to pay rental on the cylinder until its return. The simplest and best way to deal with cylinders that are empty, or no longer required, is to identify this to the owner (usually the gas supplier) and request that they are collected. Even if the cylinders were not originally supplied to the premises where they are discovered or present, the owner will make arrangements to collect them. The details of the cylinder owner will be printed on the cylinder contents label.

Detailed advice on the recovery and disposal of cylinders is available on the BCGA website under '*Cylinder Recovery and Disposal'*.

Bulk cryogenic storage tanks, their associated pressure system and their immediate product output system will normally be provided on-site under a contract arrangement with a gas

supplier. When this equipment is no longer required arrange with your gas supplier for its removal.

Specialist disposal may be required for certain items, for example, pipes and hoses that have contained certain products, old vaporisers which may have asbestos spacers, etc.

Certain gas system components have only a limited in-use life and these shall be discarded in such a way as to prevent re-use, for example, some types of relief valves.

13. PERSONAL PROTECTIVE EQUIPMENT

The work activity risk assessment will determine the requirement for the use of hazard controls, including Personal Protective Equipment (PPE). PPE may only be considered as a control to achieve an acceptable level of residual risk after other levels of control have been addressed. Where PPE is required a PPE Assessment shall be carried out. PPE shall be provided as required by the *Personal Protective Equipment Regulations* (7). The PPE shall be selected for a particular task and location and shall be appropriate and chosen to effectively reduce the overall risk. Thus there are different PPE requirements for differing products, different tasks and possibly for different personnel. The requirements of the *Control of Substances Hazardous to Health Regulations* (8), any relevant equipment publications, manufacturers' information and the product Safety Data Sheet shall be taken into account.

HSE L25 (18), *Personal Protective Equipment at Work*, provides guidance on the *Personal Protective Equipment Regulations* (7). EIGA Document 136 (30), *Selection of personal protective equipment*, provides guidance for selecting and using PPE at work.

For personnel handling cryogenic products, subject to risk assessment, the typical minimum PPE requirements are likely to be identified as suitably rated gloves, eye and/or face protection and long-sleeved/legged clothing that protects against contact with cold products, including splashes. Personnel maintaining, operating or filling the storage system may require additional PPE such as anti-static safety footwear, hard hats and warm under clothes.

WARNING: Do not allow the skin to come into direct contact with cold or cryogenic liquids. Contact may cause severe cold burns.

Where there is the possibility of a flammable, asphyxiating or enriched oxygen atmosphere, the use of gas detection equipment shall be assessed as part of the risk assessment. For further information, refer to BCGA GN 11 (40).

It is not possible to cover all the safety aspects of handling cryogenic liquid in this Code of Practice. For further information refer to the British Cryoengineering Society, *Cryogenic Safety Manual* (44).

14. INFORMATION, INSTRUCTION AND TRAINING

All personnel shall be competent to fulfil all aspects of their role. It is recommended that all persons who will use, handle or be in proximity to gases and gases equipment shall receive suitable information, training and instruction regarding the hazards associated with the various gases and items likely to be encountered. The information, instruction and training, shall specifically cover:

- The actions to take in an emergency or in unusual circumstances;
- Measures to be taken to protect others from risk (including, where relevant, third parties);
- Operation and maintenance requirements, where relevant.

All staff should have the necessary competence to carry out the required range of tasks safely and shall receive appropriate information, instruction and training, including induction and continuation / refresher training as required. It is recommended that such a competence development programme is carried out under a formalised system where an acceptable level of competency has to be achieved. The competence development programme shall include a suite of supervision (support, assistance, coaching, etc.). Records shall be kept of the competence development provided.

The employer is responsible for ensuring that each individual is competent to carry out each task safely and correctly. The employer should declare and state that individuals are competent to conduct certain tasks or operations, along with any caveats or conditions attached to this declaration. The competence development programme shall make provision for periodic competence re-assessment.

General recommendations for the training of personnel are described in EIGA Document 23 (28), *Safety training of employees*. BCGA GN 23 (41), *Identifying gas safety training requirements in the workplace*, provides information on the topics that should be covered when considering gases safety training.

This will include providing appropriate information, instruction and training on:

- The gases being used, including their key properties and hazards;
- Correct storage requirements. Refer to Section 7;
- The storage containers and the associated pressure system(s);
- Ventilation requirements and any monitoring systems, including gas detection;
- Manual handling, including for gas cylinders and cryogenic equipment.

15. EMERGENCY ACTIONS

15.1 Emergency planning

A documented emergency plan shall be prepared by the user to cover foreseeable unplanned incidents involving the installation.

Possible incidents include:

- Uncontrolled cryogenic liquid spillage, for example, during product transfer;
- Significant vapour cloud release (not as a result of normal operations);
- Spillage/gas release following loss of mechanical integrity of the storage tank, pipeline or associated systems;
- Fire on the installation, or close to the installation;
- Failure of safety systems, or operation of safety systems;
- Violent impact from external sources, for example, vehicle collision;
- Situations caused by human factors.

The emergency plan should consider:

- The identification of the scales and consequences of potential major incidents, including malicious acts;
- The establishment of the technical and organisational response;
- The identification of the procedures, roles and resources, including the availability of IT equipment and associated software, required to achieve the response;
- The identification of the expertise, arrangements and capabilities required;
- How to co-ordinate and manage the response and resources to an incident, including the establishment of an emergency response team;
- The provision of appropriate training, written guidance and regular practice for an incident.

The emergency plan shall be developed involving, as appropriate, the Local Authority and the emergency services.

The emergency plan will be issued to the emergency response team and shall be readily available in a suitable, easily accessible format.

For general guidance on preparing an emergency plan refer to:

- HSE HSG 191 (16), *Emergency planning for major accidents*. *Control of Major Accident Hazards Regulations 1999*.

- EIGA Safety Information Human Factors 06 (33), *Organisation. Site emergency response.*

15.2 Emergency procedures

Emergency procedures shall be prepared by the user for the operators and responders.

Appropriate training shall be provided. Refer to Section 14.

The procedures shall be readily available to all personnel involved, regularly practised and checked periodically that they are up to date. The procedure shall consider:

- The properties and hazards of cryogenic liquids, these include:
    - Cryogenic burns from the liquid;
    - An oxygen deficient or enriched atmosphere in the vapour cloud;
    - Material embrittlement from cryogenic liquids;

NOTES:

1) Gases have different densities, some are lighter than air and will rise into roof spaces, whilst some are heavier than air and will accumulate in low lying areas. Refer to the individual product Safety Data Sheet. Cold gases may react differently to gases at ambient temperatures. Refer to Section 4.

2) Oxygen depletion and enrichment checks should be carried out in any area where the liquid gas or the vapour cloud may have entered or accumulated. Particularly in enclosed areas, which includes basements, pits and confined spaces.

- Appropriate safety precautions;
- The quantities involved;
- The local topography;
- The emergency equipment required and its availability, including PPE refer to Section 13;
- The provision of first aid facilities;
- An evacuation plan covering all personnel who are likely to be on site;

- The immediate and any follow-up action to make safe or prevent escalation of the incident, including any requirement for specific sequencing;

- Communications, both on-site and external;

- The co-ordination and management of the response and resources.

15.3 Emergency actions

The following are general emergency actions which should be implemented on all sites and incorporated into the site emergency plan.

The actions to be followed in the event of an incident are to be posted around the installation.

The following immediate actions shall be taken for all incidents:

- KEEP AWAY, Do not approach or attempt to move a cylinder(s) or operate a valve(s).

- Raise the alarm.

- Evacuate the immediate area. Keep people away.

- Contact the Fire & Rescue Service.

The following actions should then be taken:

- Contact the on-site emergency response team;

- Establish a hazard zone around the incident and prevent access;

- Follow pre-determined emergency procedures;

NOTE: Persons likely to be affected shall know the actions required to minimise the adverse effects of an incident, such as a spillage.

- Notify the gas supplier.

NOTE: The gas supplier will be able to provide advice, and, for example, will ensure tankers do not come onto site during the incident.

In addition:

- In case of leakage / spillage:

    - Isolate or repair leaks, if this can be done without risk;

    - Allow liquid to evaporate; where available divert towards an area designated as an evaporation area;

- Prevent contact with sources of ignition;

- Use diversions to prevent liquid entering sewers, pits, trenches, basements, pits, confined spaces etc.

- In case of fire:

  - Consider keeping the tank, pipeline and associated equipment cool by spraying it with water.

WARNING: When water is used to keep equipment cool careful control must be exercised. Water should not be sprayed near the vent stack outlet(s) due to the potential danger of plugging vents with ice, and therefore preventing the release of venting gas.

BCGA Leaflet 6 (43), *Cylinders in fires*, provides advice on managing gas cylinders involved in a fire.

- In case of injury through contact with cryogenic liquid:

  - Carry out immediate first aid treatment and seek medical assistance.

NOTES:

1. For information on cold burns resulting from contact with cryogenic liquid and appropriate first aid action, refer to Appendix 1.

2. HSE L74 (20), *First aid at work. The Health and Safety (First-Aid) Regulations 1981*, provides guidance for employers on providing first aid in the workplace

16. REFERENCES

	Document Number	Title
1		The Health and Safety at Work etc. Act 1974.
2	SI 1996 No. 825	The Pipeline Safety Regulations 1996.
3	SI 1997 No. 1713	The Confined Spaces Regulations 1997.
4	SI 1998 No. 2306	Provision and Use of Work Equipment Regulations 1998 (PUWER).
5	SI 1999 No. 3242	The Management of Health and Safety at Work Regulations 1999.
6	SI 2000 No. 128	Pressure Systems Safety Regulations 2000 (PSSR).
7	SI 2002 No. 1144	Personal Protective Equipment Regulations 2002.
8	SI 2002 No. 2677	Control of Substances Hazardous to Health Regulations 2002 (COSHH).
9	SI 2002 No. 2776	The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).
10	SI 2009 No. 1348	The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended).
11	SI 2015 No. 483	The Control of Major Accident Hazards Regulations 2015 (COMAH)
12	SI 2016 No. 1092	The Simple Pressure Vessels (Safety) Regulations 2016.
13	SI 2016 No. 1105	The Pressure Equipment (Safety) Regulations 2016.
14.	SI 2016 No. 1107	Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016.
15	ECE/TRANS/257	European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) (as amended).
16	HSE HSG 191	Emergency planning for major accidents. Control of Major Accident Hazards Regulations 1999.
17	HSE L22	Safe use of work equipment. Provision and Use of Work Equipment Regulations 1999. Approved Code of Practice and guidance.

	Document Number	Title
18	HSE L25	Personal Protective Equipment at Work. Personal Protective Equipment at work Regulations. Guidance on Regulations.
19	HSE L82	A guide to the Pipelines Safety Regulations 1996.
20	HSE L74	First aid at work. The Health and Safety (First-Aid) Regulations 1981.
21	HSE L101	Safe work in confined spaces. Approved Code of Practice.
22	HSE L122	Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice and guidance.
23	HSE EH 40	Workplace exposure limits.
24	HSE INDG 459	Oxygen use in the workplace. Fire and explosion hazards.
25	HSE	Further guidance on emergency plans for major accident hazard pipelines. The Pipelines Safety Regulations 1996.
26	EIGA Document 4	Fire hazards of oxygen and oxygen enriched atmospheres.
27	EIGA Document 13	Oxygen pipeline and piping systems.
28	EIGA Document 23	Safety training of employees.
29	EIGA Document 33	Cleaning of equipment for oxygen service – Guideline.
30	EIGA Document 136	Selection of personal protective equipment.
31	EIGA Document 154	Safe location of oxygen and inert gas vents.
32	EIGA Document 200	Design, manufacture, installation, operation and maintenance of valves used in liquid oxygen and cold gaseous oxygen systems.
33	EIGA Safety Information Human Factors 06	Organisation. Site emergency response.
34	BCGA Code of Practice 4	Industrial gas cylinder manifolds and gas distribution pipework (excluding acetylene).

Document Number		Title
35	BCGA Code of Practice 7	The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply).
36	BCGA Code of Practice 36	Cryogenic liquid storage at users' premises.
37	BCGA Code of Practice 39	In-service requirements of pressure equipment (gas storage and distribution systems).
38	BCGA Code of Practice 44	The storage of gas cylinders.
39	BCGA Guidance Note 7	The safe use of individual portable or mobile cylinder gas supply equipment.
40	BCGA Guidance Note 11	The management of risk when using gases in enclosed workplaces.
41	BCGA Guidance Note 23	Identifying gas safety training requirements in the workplace.
42	BCGA Guidance Note 27	Guidance for the carriage of gas cylinders on vehicles.
43	BCGA Leaflet 6	Cylinders in fires.
44	British Cryoengineering Society	Cryogenic Safety Manual. *Available through the British Cryogenics Council*

Further information can be obtained from:

UK Legislation	www.legislation.gov.uk
Health and Safety Executive (HSE)	www.hse.gov.uk
British Standards Institute (BSI)	www.bsigroup.co.uk
European Industrial Gases Association (EIGA)	www.eiga.eu
International Organization for Standardization (ISO)	www.iso.org
British Compressed Gases Association (BCGA)	www.bcga.co.uk
UK Steel	www.eef.org.uk/uk-steel
British Cryogenics Council	http://bcryo.org.uk
British Compressed Air Society (BCAS)	www.bcas.org.uk

"BURNS" DUE TO VERY COLD LIQUEFIED GASES

The temperature of liquefied gases varies. The boiling points, i.e. the temperatures at which the liquefied gas vaporises, are detailed in Table A-1.
s

Oxygen	-183 °C
Argon	-186 °C
Nitrogen	-196 °C

Table A-1: Liquefied gas temperatures

General effect on tissue

The effect of extreme cold on tissue is to destroy it, a similar end result to that of heat exposure, and in like fashion the amount of cold and the duration of contact is crucial. The destruction of tissue is not so immediately obvious as in the case of burns, since pain is absent in the frozen stage, and the tissue, although rigid, keeps its normal shape and is not obviously destroyed. Pain and destruction becomes more apparent as thawing occurs. Those who have had mild frostbite of fingers or toes will have some idea of the pain on re-warming.

Prevention of contact with very cold liquids is quite vital and those who work in this field must be aware of the hazard.

Skin effects

Liquid, vapour, or low-temperature gas can produce effects on the skin, which will vary in severity with temperature and the length of exposure. Naked or insufficiently protected parts of the body coming into contact with uninsulated pipes or vessels may stick fast by virtue of the freezing of moisture and flesh may be torn in removal. The wearing of wet clothing should be avoided.

Continued exposure of naked flesh to cold atmospheres can result in frostbite. There usually is sufficient warning by local pain whilst the freezing action is taking place. Re-warming with lukewarm water at 42 °C to 44 °C is generally sufficient safeguard against injury.

Effect of cold on lungs

Whilst transient and short exposure produces discomfort in breathing, prolonged inhalation of vapour or cold gas, whether respirable or not, can produce serious effects on the lungs.

FIRST AID TREATMENT OF COLD CONTACT BURNS

Flush the affected areas of skin with copious quantities of tepid water, but do not apply any form of direct heat, e.g. hot water, room heaters, etc. Move casualty to a warm place (about 22 °C; (295 K)). If medical attention is not immediately available, arrange for the casualty to be transported to hospital without delay.

While waiting for transport:

(i) Loosen any restrictive clothing.

(ii) Continue to flush the affected areas of skin with copious quantities of tepid water.

(iii) Protect frozen parts with bulky, dry, sterile dressings. Do not apply too tightly so as to cause restriction of blood circulation.

(iv) Keep the patient warm and at rest.

(v) Ensure ambulance crew or hospital is advised of details of accident and first aid treatment already administered.

(vi) Smoking and alcoholic beverages reduce the blood supply to the affected part and should be avoided.

NOTE: The above text has been reproduced with the permission of the British Cryoengineering Society from its '*Cryogenics Safety Manual*' (44).

British Compressed Gases Association

www.bcga.co.uk