GUIDANCE NOTE 13

DSEAR RISK ASSESSMENT GUIDANCE FOR COMPRESSED GASES

REVISION 1: 2021

British Compressed Gases Association

GUIDANCE NOTE 13

DSEAR RISK ASSESSMENT GUIDANCE FOR COMPRESSED GASES

REVISION 1: 2021

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 promote safe practice and to prioritise environmental protection in the supply, use, storage, transportation and handling 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. This document replaces BCGA GN 13, 2008. It was approved for publication at BCGA Technical Committee 163. This document was first published on 14/01/2021. 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 10. Documents referenced are the edition current at the time of publication, unless otherwise stated.

TERMINOLOGY AND DEFINITIONS

Compressed gases	For the purposes of this document, compressed gases include refrigerated and liquefied gases.
Continuous release	A fluid release which is continuous or is expected to occur frequently or for long periods. NOTE: Both 'frequently' and 'long' are terms which are intended to describe a very high likelihood of a potential release. In that respect, these terms do not necessarily need to be quantified.
Explosive limit, lower (LEL)	The concentration of flammable gas or vapour in air, below which the gas atmosphere is not explosive.
Explosive limit, upper (UEL)	The concentration of flammable gas or vapour in air, above which the gas atmosphere is not explosive.
Explosive atmosphere	A mixture of dangerous substances with air, under atmospheric conditions, in the form of gases, vapours, mist or dust in which, after ignition has occurred, combustion spreads to the entire unburned mixture.
Hazardous area	An area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment.
Ignition temperature	The lowest temperature of a heated surface at which, under specified conditions, the ignition of a flammable substance in the form of a gas or vapour mixture with air will occur.
May	Indicates an option available to the user of this Guidance Note.
Primary release	A fluid release that can be expected to occur periodically or occasionally during normal operation.
Secondary release	A fluid release which is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods.
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.
Site Operator	The person with overall responsibility for a specific site.

Temperature class	Equipment is classified by temperature class according to its maximum surface temperature.
Zone	A hazardous area classification based upon the frequency of the occurrence and duration of an explosive atmosphere. For gases, this will be sub-divided into Zone 0, Zone 1 and Zone 2.
Zone 0	A place in which an explosive atmosphere consisting of a mixture with air of flammable gas, vapour or mist is present continuously or for long periods or frequently.
Zone 1	A place in which an explosive atmosphere consisting of a mixture with air of flammable gas, vapour or mist is likely to occur in normal operation occasionally.
Zone 2	A place in which an explosive atmosphere consisting of a mixture with air of flammable gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
Zone of negligible extent	In some cases, a zone of negligible extent may arise and may be treated as non-hazardous. Such a zone implies that an explosion, if it takes place, will have negligible consequences. The zone negligible extent concept can be applied irrespective of any other adjustments for risk assessment to determine the equipment protection level.

GUIDANCE NOTE 13

DSEAR RISK ASSESSMENT GUIDANCE FOR COMPRESSED GASES

1. INTRODUCTION

Dangerous substances can put peoples' safety at risk from fire, explosion and corrosion of metal. The *Dangerous Substances and Explosive Atmospheres Regulations* (DSEAR) [4] are concerned with protection against these hazards and similar events arising from dangerous substances and potentially explosive atmospheres. All gases under pressure, regardless of their properties, are classified as dangerous substances and are in scope of *DSEAR* [4].

Gases that are under pressure (for example, gas in a cylinder) may present a risk of explosion if not correctly handled in the workplace. Substances that can corrode metals could cause structural damage reducing integrity of structures if not suitably contained.

The *DSEAR* [4] regulations apply where a dangerous substance is present or could be present, it puts duties on employers and the self-employed to protect people from these risks to their safety in the workplace, and to members of the public who may be put at risk by work activity. *DSEAR* [4] covers normal and abnormal operations, and requires that you have a plan in place to manage emergency situations.

DSEAR [4] does not apply during the carriage of dangerous goods as the transport Regulations mandate controls to ensure gas containers are safe for carriage. However, *DSEAR* [4] will apply at all places where dangerous goods are loaded, unloaded, or for the parking arrangements of a vehicle containing dangerous goods on a site.

The *Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations* (EPS) [7] apply to all equipment intended for use in explosive atmospheres, whether electrical or mechanical, as well as to protective systems.

NOTE: Compliance with *DSEAR* [4] and the *EPS Regulations* [7] does not constitute a comprehensive assessment of all workplace hazards as required under the *Management of Health and Safety at Work Regulations* [3] and additional specific risk assessments may be required, for example, for manual handling.

Premise owners and users of gases and related equipment should ensure they have adequate insurance to cover their activities and that they use their gases and look after their gas equipment in a safe and responsible way.

2. SCOPE

This document provides guidance on the application of the *DSEAR* [4] and related regulations for compressed gases. This document acts as a guide for the generation of *DSEAR* [4] risk assessments.

For further information on liquefied petroleum gas (LPG) storage, use and transportation, including as a vehicle fuel, refer to Liquid Gas UK documents.

3. LEGISLATION

The *Health and Safety at Work etc. Act* [1] sets out a wide-range of duties for employers to protect the health, safety and welfare at work of all their employees, as well as others on their premises and the general public.

DSEAR [4] requires employers to assess the risks of fires and explosions that may be caused by dangerous substances which are present in the workplace and to eliminate or control those risks. *DSEAR* [4] requires:

(i) **Risk assessment**. A suitable and sufficient risk assessment shall be completed where a dangerous substance is present in the workplace. Refer to Section 4.

The nature of the risk assessment will depend on the properties of the gas(es) present, the likelihood of a gas release and / or the potential for corrosion.

(ii) **Elimination / control**. Eliminate the hazard or reduce the risk from the dangerous substance so far as is reasonably practicable. As necessary, measures shall be put into place to minimise, control and / or segregate persons from the hazard.

(iii) **Hazardous area**. Classify areas where an explosive atmosphere may occur. The area where a hazardous substance is present shall be classified into a 'zone'. The type of zone will be dependent on the frequency and duration of an explosive atmosphere. For gases, this usually means a Zone 0, Zone 1 or Zone 2. The hazardous area will only apply for normal and abnormal operation and not for a catastrophic failure, consistent with BS EN 60079-10-1 [16], *Explosive atmospheres. Classification of areas. Explosive gas atmospheres*. Within a zone the use of compliant equipment is required, which shall be designed, operated and maintained for safe use in that specific zone. Other restrictions will also apply.

NOTE: This is not applicable to oxidising substances as they do not form an explosive atmosphere with air.

(iv) **Emergencies**. Arrangements to deal with accidents, incidents and emergencies. Procedures covering emergency arrangements, safety drills with effective warning and communication systems need to be in place.

(v) **Information, instruction & training**. Suitable information and instruction shall be provided to ensure all those personnel that may be affected by the dangerous substances are trained in the precautions associated with those substances.

(vi) **Identification**. Identification of hazardous contents of containers and pipes. All containers and pipes shall be suitably marked to identify the contents and nature of the dangerous substance.

(vii) **Co-ordination**. Where a workplace is shared, each employer has a duty to co-ordinate measures to implement the above regulations.

Where there are five or more employees, the employer shall record the significant findings of the risk assessment.

The Health and Safety Executive (HSE) provide guidance on their website: https://www.hse.gov.uk/fireandexplosion/dsear.htm

In the UK, *DSEAR* [4] implements the requirements of the *European ATEX Workplace Directive* [8].

The *EPS Regulations* [7] apply to all equipment intended for use in explosive atmospheres, whether electrical or mechanical, as well as to protective systems. The *EPS Regulations* [7] implement the requirements of the *European ATEX Equipment Directive* [9].

NOTE: ATEX is the name commonly given to the two European Directives for controlling explosive atmospheres. Compliance with *DSEAR* [4] and the *EPS Regulations* [7] is sufficient to achieve compliance with these *European ATEX Directives*. They are:

- *European Directive 99/92/EC* [8] (also known as *'ATEX 137*' or the *'ATEX Workplace Directive*') which sets minimum requirements for the safety protection of workers potentially at risk from explosive atmospheres.

  The *ATEX Workplace Directive* [8] requires an 'Explosion Protection Document' to be drawn up. Notably *DSEAR* [4] makes no mention of an Explosion Protection Document but the requirement to provide up-to-date information is very much a part of UK Regulations.

  The European Industrial Gases Association (EIGA) provide guidance, refer to EIGA 134 [21], *Potentially explosive atmospheres EU Directive 1999/92/EC*.

- *European Directive 2014/34/EU* [9] (also known as '*ATEX 153*' or the '*ATEX Equipment Directive*') which sets minimum requirements for equipment and protective systems intended for use in potentially explosive atmospheres.

4. RISK ASSESSMENT AND METHODOLOGY

A specific suitable and sufficient risk assessment is required under *DSEAR* [4] for all gases that are within the workplace under pressure. The extent of the *DSEAR* [4] risk assessment is dependent upon the flammability, oxidising, or corrosive properties of the gases and the risk of explosion, or the potential for structural damage, for example, if these gases are released to the atmosphere.

When gases under pressure are in the workplace and no flammable, oxidising or corrosive risks exists, then the *DSEAR* [4] risk assessment can record this and be completed. Employers need take no additional action to comply with *DSEAR* [4]. The requirements of the *Health and Safety at Work etc. Act* [1] and the *Management of Health and Safety at Work Regulations* [3], etc., mandate the need to carry out risk assessment and have arrangements in place for the general safe use of gases.

When flammable, oxidising or corrosive gasses are in the workplace the Employer is responsible for ensuring a comprehensive *DSEAR* [4] risk assessment is carried out and documented. A suitable and sufficient task orientated workplace risk assessment, including elements pertinent to *DSEAR* [4], shall be carried out for all activities, including maintenance.

NOTES:

1. Maintenance activities may require additional or different controls to those for normal operation. This may include the use of permit to work processes, documented procedures, carried out by competent people, etc.

2. Even with flammable, oxidising or corrosive gases, mitigation may still be evident to limit the detail or negate the requirement of a detailed *DSEAR* [4] risk assessment, refer to Section 5.

The risk assessment shall be completed and control measures implemented before:

- the system is commissioned or re-commissioned (with the dangerous substance);
- dangerous substances are introduced;
- the system is made operational;
- any related activities are undertaken, for example, maintenance.

DSEAR [4] does not apply during the carriage of dangerous goods as the transport Regulations mandate controls to ensure gas containers are safe for carriage. A *DSEAR* [4] risk assessment shall be undertaken, with appropriate control measures implemented, by the Site Operator, for all places where dangerous goods are loaded, unloaded, or for the parking arrangements of a vehicle containing dangerous goods on a site. Suitable reception facilities shall be provided.

A *DSEAR* [4] risk assessment shall only be carried out by competent persons, refer to Section 5.1.

The following headings can be used as guidance for a *DSEAR* [4] risk assessment:

(i) **Risk assessment**. Determine:

- all dangerous substances on site, specifically (for the purposes of this document) all gases that are within the workplace under pressure;
- the quantity held;
- their properties, especially their hazards and their relevance for *DSEAR* [4];
- where are they being stored;
- where are they being distributed;
- where are they used;
- their release points, for example, relief devices, vents, connections, etc.;
- potential leak paths;

- whether they interact with other hazards on site;
- the quality of the available ventilation;
- any local ignition sources, refer to Section 6;
- whether they interact with people on the site.

(ii) **Elimination / control**. If you cannot eliminate or substitute, then introduce suitable controls, options include:

- reduce the inventory (to the minimum requirement);
- reduce the pressure;
- provide additional ventilation (forced?);
- provide atmospheric monitoring equipment;
- provide isolation (from the source, for example, the use of emergency stop or slam-shut valves activated by a sensor);
- only allow necessary equipment (suitable for the zone in which it is sited) inside the hazardous area(s);
- provide physical barriers, enclosures, blast walls, etc., to prevent propagation;
- set up hazardous areas, implement zones, separation distances, etc. to prevent propagation;
- mandate a written safety control system, such as a permit to work system for, for example, hot work, etc.;
- where required, select personal protective equipment which is safe for use inside the hazardous area for the specific zone where it will be in use;
- implement standard operating procedures;
- implement emergency planning.

(iii) **Hazardous area**. Identify each hazardous area and classify it into the appropriate zone. Determine:

- the potential leak paths and leak rate, for example, hole size, condition and properties of the gas, etc.;
- available ventilation;

- the suitability of all equipment in the hazardous area, for example, in compliance with the *EPS Regulations* [7];

- other dangerous substances and their hazards in the location;

- other hazardous areas in the location;

- restrictions that apply, such as:

    - the use of certain clothing;

    - preventing ignition through managing the introduction of potential ignition sources, for example, portable equipment, mobile phones, portable testing equipment, some tools, smoking and naked lights, etc.;

    - control of access;

    - operations, maintenance activities, hot works, including permit to work;

    - minimising unnecessary storage of hazardous products or other items within or near a hazardous area.

- housekeeping.

(iv) **Emergencies.** Ensure there are plans and procedures to deal with incidents, accidents, and emergencies involving dangerous substances.

- put in place infrastructure to minimise propagation, for example, enclosures, blast walls, etc.;

- put in place controls to protect people, for example, separation distances which allow people to evacuate an area quickly;

- plan for emergencies:

    - provide emergency procedures / plan;

    - provide emergency response equipment.

(v) **Information, instruction & training**. Determine the information, instruction and training, including any supervision requirements, required for employees (or anyone else who may come into contact) to manage the hazard / risks. Consider the competence level required for the training of personnel to carry out:

- *DSEAR* [4] risk assessments;

- the activities that are included under *DSEAR* [4].

(vi) **Identification.** As well as providing safety signs and warning notices for the identification of dangerous substances, also consider specific requirements for the identification of hazardous area(s) and their individual zones, including the use of a warning sign to identify places where an explosive atmosphere may occur, the 'Ex' sign, refer to Figure 1.

Figure 1:
'Ex' warning sign

(vii) **Co-ordination**. Co-ordinate with neighbours. Ensure *DSEAR* [4] issues are disseminated and that are they understood by all parties. Take into consideration:

- sites with multiple occupants;
- 3rd party contractors on-site;
- operators of adjacent sites, particularly where other dangerous substances are in use;
- local emergency services.

On sites where there are multiple dangerous substances, whether gases or otherwise, consideration should be given to the properties and hazards of each as well as their collective impact, this shall be included in the risk assessment. The anticipated size of a release and the degree of ventilation available in each area will help to determine the control measures necessary.

Guidance is available in:

- HSE L138 [10], *Dangerous substances and explosive atmospheres. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance.*
- BS EN 60079 [16], *Explosive atmospheres*.
- BS EN ISO 80079 [19], *Explosive atmospheres*.

5. SPECIFIC ITEMS TO CONSIDER FOR POTENTIAL EXPLOSIVE ATMOSPHERES

Fundamental requirements include:

- competence of personnel undertaking risk assessment, refer to Section 5.1;
- the basis for gas release calculation, refer to Section 5.2;
- potential leak paths, refer to Section 5.3;
- the storage of gas cylinders and bundles, refer to Section 5.4;

- the storage of static storage tanks, refer to Section 5.5;
- the storage of non-static liquefied and cryogenic gas containers, refer to Section 5.6;
- the storage and use of transportable containers, refer to Section 5.7;
- the management of tankers, refer to Section 5.8;
- use of powered equipment to move gas containers, refer to Section 5.9;
- gas(es) in use, refer to Section 5.10;
- ventilation requirements, refer to Section 5.11;
- human factors, refer to Section 5.12.

5.1 Competence of personnel undertaking risk assessment

A *DSEAR* [4] risk assessment shall only be carried out by experienced persons who collectively have knowledge and understanding of:

- dangerous substances, to include gases and their properties;
- interactions (with other substances);
- normal process and non-routine processes;
- maintenance (may require additional assessment);
- persistence (likelihood of persistence of an explosive atmosphere);
- equipment;
- location;
- local environment;
- potential leak paths;
- potential ignition sources;
- control and mitigation measures;
- relevant legislation and literature;
- human factors;
- the risk assessment process.

BCGA define competence in BCGA Guidance Note (GN) 23 [31], *Gas safety. Information, instruction and training.*

5.2 The basis for gas release calculation for a DSEAR hazardous area

Any flammable gas release will create a hazard, the hazardous area and the type and extent of zone required will be dependent upon the characteristics of the gas, the release rate and the rate of dispersion.

To determine a *DSEAR* [4] hazardous area, based on typical leak scenarios within a pressure system, it has been custom and practice in the UK compressed gases industry to utilise a 0.1 mm equivalent diameter hole as the basis for leak calculations for secondary releases.

NOTE: Historically a 0.1 mm equivalent diameter hole aligned with Edition 3 of the Energy Institute, Model code of safe practice, Part 15 [34], *Area classification for installations handling flammable fluids*. Edition 4 of Energy Institute, *Model code of safe practice*, Part 15 [34], amended the hole size for pipework, increasing to 1 mm equivalent diameter. This may be justifiable for large bore pipe but is not representative when carrying out calculations on the small bore pipework which is typically used within the compressed gases industry. The compressed gases industry continues to use 0.1 mm equivalent diameter hole as the basis for leak calculation.

Other scenarios that may result in a more substantial release will require a specific assessment to determine the appropriate release rate. Sources of information include:

- Energy Institute, Model code of safe practice, Part 15 [34];
- BS EN 60079-10-1 [16];
- Cox, Lees and Ang [36], *Classification of hazardous locations*.

For a primary release or a continuous release, the hazardous area calculation shall be based on the expected flow of the gas. Where such a release is carried out intentionally, then this shall be carried out under a safe system of work procedure.

Historical data was used to calculate the following release rates for a 0.1 mm leak:

Acetylene:	15 bar dissolved acetylene cylinder	$2.27.e^{-5}$ kg/s
Hydrogen:	200 bar cylinder	$8.34.e^{-5}$ kg/s
LPG:	7.5 bar liquefied gas cylinder	$1.65.e^{-5}$ kg/s

For a LPG cylinder relief valve the flow rate is considered to be 4 m^3/min or 0.13 kg/s.

A gas release is considered to be horizontal (for example, cylinder valve seat not closed leak tight) or vertical (for example, leaks from the valve gland or the valve to cylinder neck joint) when conducting gas dispersion modelling.

Gas dispersion modelling using the release rates above estimate the extent of the hazardous area to be as follows:

Acetylene:	Horizontal release, 65 mm horizontally with a width of 4 mm.
	Vertical release, 62 mm vertical with a width of 4 mm.
Hydrogen:	Horizontal release, 640 mm horizontally with a width of 60 mm.
	Vertical release, 260 mm vertical with a width of 15 mm with a maximum horizontal hazardous area of 130 mm.
LPG:	Horizontal release, 15 mm horizontally with a negligible width.
	Vertical release, 45 mm vertical with a negligible width.

NOTE: Gas dispersion modelling was carried out using DNV GL PHAST ™. Other gas dispersion tools are available, including the HSE Quadvent software tool.

5.3 Potential leak paths

Typical leak path scenarios where a 0.1 mm equivalent diameter hole calculation may be used, include:

- on a gas cylinder, where experience has shown that, typically, a leak path will originate from the valve to cylinder neck joint, the valve gland or the valve outlet (where it doesn't close correctly after use);
- connections in small bore pipework systems;
- pigtails or coupling hoses, which connect the gas supply to the pipework system;
- flexible hose couplings, through wear and tear;
- punctures of flexible couplings on rotating machinery, for example, pumps, compressors, etc.;
- releases through / from operating devices, for example, sampling valves, trycocks, relief valves, vent valves, etc., which should normally close after use.

Transportable gas containers (cylinders, bundles, multiple element gas containers (MEGC), tubes, etc.) are designed, manufactured and filled in compliance with *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations* [5] to ensure they are safe for carriage, as such they are leak tight and are considered not to have a leak path other than the valve outlet. In addition, each gas container will have been filled in accordance with the supply company quality management system, this will include a post fill leak check. Further safety checks are carried out prior to transport.

Some transportable gas containers may have a pressure relief device installed, specifically (when they operate as a safety device) these will provide a release point. Where a pressure relief device is installed then additional controls may be necessary.

When a transportable gas container is in storage and not connected, then the likelihood of a leak path developing and the release of a gas creating a significant incident is considered to be very low, refer to Section 5.4.

Where a transportable gas container is in use, i.e. connected into a pressure system (to provide a gas source under pressure) then the potential leak paths of the entire system need to be identified. Once connected it shall be included in the site *DSEAR* [4] risk assessment to determine the requirement for a hazardous area.

Where a gas container designed and manufactured under the *Pressure Equipment (Safety) Regulations* [6] (including predecessor legislation) is connected into a pressure system it shall be included as a component of the wider pressure system.

Each pressure system will have potential leak paths. Any potential leak paths within the whole system shall be identified and the site *DSEAR* [4] risk assessment shall determine the requirement for a hazardous area across or around the complete pressure system.

Leaks from a gas container body due to corrosion, etc., are very rare and are not considered to be credible scenarios for risk assessment.

Leaks caused by the penetration of a gas container body, for example, by fork lift truck forks or other ancillary equipment, are not pertinent to *DSEAR* [4] classification.

5.4 Gas cylinders and bundles in stores

Gas stores shall be designed and managed in accordance with the relevant BCGA documents.

Gas cylinders shall be stored in compliance with BCGA CP 44 [28], *The storage of gas cylinders*.

There is a very low likelihood of a gas leak from a cylinder recently received from a reputable gas supplier, refer to Section 5.3. In these circumstances, any hazardous area is likely to be very small or will result in a zone of negligible extent, refer to Section 5.2.

Once a cylinder has been in use and has been returned back to a store, there is an increased risk of a leak. Potential leak sources in these circumstances may be:

- from a valve port, if not securely closed;
- from the connection between the valve and the cylinder neck, if mishandled;
- from a safety device if pressure is allowed to increase (for example, through solar exposure);
- on a bundle, from the interconnecting pipework, if mishandled;

- due to general careless and poor handling, impact and penetration damage; and

- through any connected equipment, (if the requirement below is not followed).

When a gas cylinder is returned to a store following use, the cylinder valve shall be securely closed. Any associated equipment shall either be removed or isolated. As an example, refer to BCGA CP 7 [22], *The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply)*, for managing oxy-fuel equipment.

Ultimately, any leak will be limited by the available gas in the cylinder.

Outdoor gas stores which are appropriately designed, constructed and managed, for example, they are not enclosed on more than one side and do not have a roof, generally do not require a hazardous area zone designation for the following reasons:

- natural ventilation will disperse any gas release;

- the 'open' nature prevents an accumulation of gas;

- any leak will only create a small flammable zone around the individual cylinder (refer to Section 5.2) which is of negligible extent;

- the probability of more than one cylinder leaking simultaneously is negligible;

- the extent of the released volume is limited to the volume of gas in the leaking cylinder.

However, certain factors may make it desirable to implement a hazardous area within specific gas stores, such as (individually and in combination):

- where free ventilation is uncertain;

- where cylinder inventory is not regularly refreshed, i.e. the same cylinders remain on site for extended periods;

- where there is credible scope for 'domino effect' impacts to or from nearby items, inventory, equipment, substances, etc.

5.5 Static storage tanks

Storage tanks for liquefied or cryogenic gases shall be designed, installed and subsequently managed in-service in compliance with BCGA documents. As appropriate, refer to:

- BCGA CP 26 [23], *Bulk liquid carbon dioxide storage at Users' premises*.

- BCGA CP 36 [26], *Cryogenic liquid storage at Users' premises*.

- BCGA CP 39 [27], *In-service requirements of pressure equipment (gas storage and gas distribution systems).*

- BCGA CP 46 [29], *The storage of cryogenic flammable fluids*.

The likelihood of a catastrophic failure of a storage tank is very low.

Potential leak sources may be:

- from a safety device (safety devices are fitted to all closed pressure vessels);

- through a valve;

- from pipework;

- from impact and penetration damage;

- during connection and disconnection, for example, when preparing to fill a container;

- when emptying or purging a tank;

- during the filling process.

5.6 Non-static liquefied and cryogenic gas containers in storage

Containers (including dewars, transportable tanks, etc.) for liquefied or cryogenic gases shall be designed, installed and subsequently managed in-service in compliance with BCGA documents. As appropriate, refer to:

- BCGA CP 30 [24], *The safe use of liquid nitrogen dewars.*

The likelihood of a catastrophic failure of a storage tank is very low.

Potential leak sources are the same as those detailed in Section 5.5, however different operating regimes may vary the operation of safety devices.

The risk of a leak may be increased due to handling, transport related vibration and local environmental conditions.

A non-static container may be located in a variety of different places. At each location consideration should be given to:

- available ventilation;

- orientation of relief devices;

- impact from and on nearby hazards, equipment, etc.;

- potential sources of ignition, including earthing and bonding, refer to Section 6;

- increased boil-off, caused by the movement of the container.

5.7 Transportable bulk units in storage or use

Transportable units (tube trailers (battery vehicles) and MEGC) for gases shall be designed, installed and subsequently managed in-service in compliance with *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations* [5] and BCGA documents. As appropriate, refer to:

- BCGA CP 33 [25], *The bulk storage of gaseous hydrogen at Users' premises.*

The likelihood of a catastrophic failure of such a transportable container is very low.

During carriage *DSEAR* [4] does not apply. When located in a storage area or when in-use then *DSEAR* [4] does apply.

Potential leak sources are the same as those detailed in Section 5.4. Consideration should be given to:

- the location during storage, which should be in an external place;

- the increased quantity of gas stored (compared to a gas cylinder or bundle);

- potential sources of ignition, including requirements for earthing and bonding, refer to Section 6.

5.8 Tankers

Tankers for the replenishment of gases shall be designed and operated in compliance with *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations* [5].

During carriage *DSEAR* [4] does not apply.

Where flammable or oxidising gases are to be replenished the Site Operator shall carry out a *DSEAR* [4] risk assessment for the area of the site where the loading / unloading is to take place. The assessment shall take place in the absence of the tanker. The Site Operator may ask the tanker operator for relevant information to assist in the *DSEAR* [4] risk assessment.

NOTE: A visiting tanker does not introduce a requirement for a *DSEAR* [4] risk assessment.

If loading / unloading in an existing hazardous area, then *DSEAR* [4] applies during the loading / unloading operations.

If loading / unloading in an area where there is not an existing hazardous area, then *DSEAR* [4] does not apply provided that the replenishment point is remote from the storage tank.

For further guidance refer to HSE L138 [10], (Section 71 to 74).

Potential leak sources are the same as those detailed in Section 5.5. Consideration should be given to potential sources of ignition, including the requirement for earthing and bonding, refer to Section 6.2.

5.9 Use of powered equipment to move gas containers

It is common for gas containers to be moved using powered equipment, for example, fork lift trucks, truck mounted cranes, powered pallet trucks, etc.

Powered equipment is a potential source of ignition.

If flammable or oxidising gases are moved by powered equipment outside of a hazardous area, then the powered equipment does not need to comply with the *EPS Regulations* [7]. Any potential leak path from a serviceable gas cylinder (which is handled and managed in line with BCGA guidance) will only create a zone of negligible extent, if any, which will not encroach on the powered equipment.

If powered equipment is used within a hazardous area, then it shall be suitable for use within each zone that it is used, in compliance with the *EPS Regulations* [7].

5.10 Gases in use

Gas containers that are in-use and the pressure systems / equipment they are connected to, are a potential source of leakage.

The Site Operator shall assess all equipment and activities for potential gas leak paths, refer to Section 5.2. Where this is likely, a *DSEAR* [4] risk assessment shall be carried out.

During operation activities, connecting, disconnecting and maintenance operations, potential leak sources include (but are not limited to):

- safety devices;
- vents;
- joints;
- connectors;
- equipment in use.

5.11 Ventilation

All places where gases are stored and in-use shall have adequate ventilation, refer to BCGA GN 11 [30], *The management of risk when using gases in enclosed workspaces.*

A well ventilated space will help prevent an accumulation of a flammable gas creating a mixture which is flammable (by reaching the lower flammability limit) or for an oxidant gas creating an enriched oxygen atmosphere.

Spaces with limited ventilation may require more onerous hazardous zoning and additional control and mitigation measures.

5.12 Human factors

Human factors: do not put others at risk!

Consider the human when carrying out a *DSEAR* [4] risk assessment, as the actions of operators can increase the risk of gas releases or ignitions, though intentional or unintentional actions. Refer to BCGA TIS 44 [33], *Human factors*.

6. SOURCES OF IGNITION

BS EN 1107 [13], *Explosive atmospheres. Explosion prevention and protection*, lists many sources of potential ignition, these include: static, hot surfaces, stray current, mechanically generated sparks, lightning, etc.

The HSE provide guidance on hazardous area classification and the control of ignition sources: https://www.hse.gov.uk/comah/sragtech/techmeasareaclas.htm

The various types of ignition sources include:

- heat energy, refer to Section 6.1;
- electrical energy, refer to Section 6.2;
- mechanical energy, refer to Section 6.3;
- chemical energy, refer to Section 6.4.

When operating machinery, in use this may be a leak source as well as an ignition source.

The correct selection of equipment, which is rated for use in a hazardous area, specific to the zone and specific to the gas type, will prevent a source of ignition occurring (from that equipment).

NOTE: Within the *EPS Regulations* [7] different gases may have different gas group and different temperature classifications, for example, hydrogen installations, which due to the low ignition energy of hydrogen, require equipment rated for ATEX gas group IIC hazardous areas.

Designers and operators shall be familiar with the properties of the gases they use.

6.1 Heat energy

Ignition sources for heat energy include friction, some substances, such as hydrogen, need very little energy to ignite.

Gases may generate adiabatic ignition; in some circumstances this can be exacerbated by particle impingement. Some substances may generate endothermic and exothermic conditions when compressed or expanded. This may generate sufficient energy for an ignition.

For some ignition sources and their controls for heat energy refer to Table 1.

Ignition Source	Where does it occur	Control refer to Section 7
Heating installations	Any space where there is a need for temperature management.	Appropriate equipment. Electrical engineering controls.
Operational equipment, motors, vehicles, generators, etc.	Heat generated from use, including exhaust emissions.	Separation. Appropriate equipment. Safe systems of work.
Smoking or naked flames	Heat generated from use.	Separation. Safe systems of work.
	Litter and rubbish on-site. Excess vegetation.	Control of Ancillary Service Providers, housekeeping, vermin and vegetation.
Hot work	Welding, brazing, grinding etc.	Separation. Safe systems of work.
Hot surfaces	Machinery, components	Separation. Safe systems of work. Material selection and compatibility.
Electrical components	Heat generated from use and fault conditions.	Electrical engineering controls.
Laser / intense radiation sources	Heat generated from use.	Separation. Safe systems of work.

Table 1: Heat energy as an ignition source category

6.2 Electrical energy

Electrical systems are a source of ignition. They may also be a source of (excess) heat. This can result from, for example, inadequate design, faulty equipment, etc.

Electrostatic discharge is a source of ignition as it can create potential differences, arcs and sparks.

An electrostatic charge(s) can arise from build-up where fluid flows through pipework, for example, as a result of friction. The conductive properties of the fluid and the pipework system affect the charging process. In some cases, it may be necessary to restrict flow rates to control static generation.

Gases as delivered by a Gas Supplier are usually to a high specification, which will have a zero or very low level of moisture or other contaminant content. However, once in use it is possible for contaminants to be introduced. This may affect the properties of the gas, including conductance.

Ignition Source	Where does it occur	**Control** refer to Section 7
Electrostatic charge(s)	Product transfer, due to the flow of fluid.	Electrical engineering controls.
	Across joints, flanges, etc.	Electrical engineering controls.
	Pipes and hoses. Conductivity of materials.	Appropriate equipment. Material selection and compatibility. Electrical engineering controls.
	Making / breaking connections.	Electrical engineering controls. Safe systems of work. Appropriate clothing.
	Personal clothing, including footwear.	Safe systems of work. Appropriate clothing.
	Maintenance.	Appropriate equipment. Portable and temporary-use equipment and tools. Isolation. Safe systems of work.
	Delivery vehicle (Tanker, battery vehicles, MEGC, etc.).	Electrical engineering controls.
	Liquid gas rapidly expanding into a gas (causing friction with atmospheric moisture).	Safe systems of work.
Lightning	Natural - weather	Electrical engineering controls.
Electrical fault	Natural – vermin.	Control of Ancillary Service Providers, housekeeping, vermin and vegetation.
Electricity (all items, including lighting, induction, loose connections, overload)	Incorrect selection, installation or maintenance of equipment.	Electrical engineering controls. Appropriate equipment. Competent personnel.
	Change of product.	Safe systems of work.

Table 2: Electrical energy as an ignition source category

Product transfer is a significant area where an electrostatic charge can build up. Particular safety focus shall be given to earthing during delivery and product transfer.

Integrity management of equipment (in particular their electrical components) is critical to ensure hazards remain managed throughout their life cycle. Neglect can affect many aspects of an installation. Examples include:

- corrosion of earthing and bonding connections rendering them ineffective;
- deterioration of insulation and conductors;
- poor or non-existent maintenance practices, for example, failure to conduct closed / open inspections of equipment, resistance checks, etc.;
- damage due to external factors;
- failure to maintain records, including an ageing assets register;
- failure to periodically review the safety and integrity regime.

Weather conditions, such as, lightning, may introduce an ignition source.

All electrical installations shall comply, as a minimum, with the controls detailed in Section 7.4.

For some ignition sources and their controls for electrical energy refer to Table 2.

6.3 Mechanical energy

For some ignition sources and their controls for mechanical energy refer to Table 3.

Ignition Source	**Where does it occur**	**Control** refer to Section 7
Impact, etc.	Maintenance and other mechanical work e.g. sparks from grinding and hammering.	Portable and temporary-use equipment and tools. Safe systems of work. Competent personnel.
	Abnormal event, external impact e.g. vehicle collision.	Separation.
Friction or overheating	Heat generated from movement of mechanical parts and from flow of fluids.	Separation. Appropriate equipment. Portable and temporary-use equipment and tools. Safe systems of work.
Compression: adiabatic, etc.	Heat generated from gas compression.	Appropriate equipment. Safe systems of work.

Table 3: Mechanical energy as an ignition source category

6.4 Chemical energy

For chemical energy some gases have very specific properties, such as pyrophoric gases, which can ignite spontaneously upon contact with air and other substances. Reference should be made to the safety data sheet.

Contact between oxygen and hydrocarbons can result in an ignition. Where oxygen is in use equipment and infrastructure shall not contain hydrocarbons, for example, joints should not contain grease or oil, the floor on liquid oxygen storage sites should not contain bitumen.

For some ignition sources and their controls for chemical energy refer to Table 4.

Ignition Source	**Where does it occur**	**Control** refer to Section 7
Reaction, including chemical incompatibility	Oxygen and hydrocarbon reaction, acetylene and acetylides, pyrophoric gases, uncontrolled reactions.	Separation. Appropriate equipment. Material selection and compatibility. Safe systems of work.

Table 4: Chemical energy as an ignition source category

7. CONTROL AND MITIGATION MEASURES

The *DSEAR* [4] risk assessment shall identify the hazardous area. It shall identify the size and persistency of the hazardous zone, for example, Zone 0, 1 or 2. Once hazardous areas are identified, *DSEAR* [4] and *EPS Regulations* [7] mandate that suitable control and mitigation measures are applied. This can be achieved through appropriate installation design, the use of compliant equipment, safe systems of work and competent personnel.

The various types of control and mitigation measures include:

- providing separation, refer to Section 7.1;
- providing appropriate equipment, refer to Section 7.2;
- material selection and compatibility, refer to Section 7.3;
- electrical engineering controls, refer to Section 7.4;
- providing isolation, refer to Section 7.5;
- managing portable and temporary-use equipment and tools, refer to Section 7.6;
- implementing safe systems of work, including standardised operating and emergency procedures, refer to Section 7.7;
- competent personnel, refer to Section 7.8;

- providing appropriate clothing, refer to Section 7.9;

- Management of ancillary service providers, housekeeping, vermin and vegetation, refer to Section 7.10.

7.1 Separation

Apply BCGA minimum recommended separation distances (refer to BCGA GN 41 [32], *Separation distances in the gases industry*), install physical barriers, provide appropriate safety signs and warning notices, etc.

Identify and install dedicated walkways for personnel. For these surfaces there may be specific electrical conductance criteria, such as to provide a resistance to earth of 10^8 Ω or less (unless limited by footwear).

Segregate incompatible dangerous substances.

Control access to the area. Reduce to a minimum of the number of people who may be exposed.

7.2 Appropriate equipment

Where required, equipment shall be designed for, be rated for, and maintained for a specific hazardous area in compliance with *DSEAR* [4] and the *EPS Regulations* [7]. This includes all equipment, whether static, mobile, part of the permanent installation or otherwise.

Use suitable and compatible heating equipment selected for use in, or close to, hazardous areas. Identify surface (hot) temperatures and the presence of naked flames, for example, boilers, ovens, etc. Apply separation requirements taking account of the conduction, convection and radiation of heat which may have an impact on items within a hazardous area. Where appropriate, provide and maintain adequate insulation.

Manage the flow rate. As a gas flows through a system of pipework it can generate friction which may lead to a build-up of static electricity and generate heat. Fluid velocities may need to be managed to minimise these effects, especially where solid particles may be entrained in the fluid, which may result in particle impingement. Low conductivity fluids are more of a concern for static build-up than high conductivity fluids.

7.3 Material compatibility and selection

Ensure compatibility with all gases that are present. The design, and any post-design changes, shall consider the interaction of all items of equipment with the gases that may be present. Unintended and uncontrolled reactions shall be avoided.

The design, and any post-design changes, shall ensure that appropriate materials are selected for all equipment and ancillary items. Considerations should include conductivity, electrical continuity, durability, compatibility, mechanical properties, construction, maintenance requirements, etc.

7.4 Electrical engineering controls

All electrical installations shall comply with *The Electricity at Work Regulations* [2]. BS 7671 [12], *Requirements for electrical installations. IET wiring regulations*, details the minimum standard to be applied.

Within a hazardous area all equipment and protective systems shall comply with the *EPS Regulations* [7].

Electrical equipment in a hazardous area shall comply with BS EN 60079 [16], *Explosive atmospheres*, including:

- Part 14, *Electrical installations design, selection and erection*;
- Part 25, *Intrinsically safe electrical systems*;
- Part 32, *Electrostatic hazards.*

Electrical systems shall include appropriate protection, suitable glands and barriers. Adequate insulation should be provided and maintained to ensure safety, for both thermal and electrical insulation.

Where protection from, for example, external weather conditions, is necessary, electrical equipment shall conform to BS EN 60529 [17], *Specification for degrees of protection provided by enclosures*, as a minimum protection class IP54.

To protect against electrostatic discharge, earthing and bonding shall be provided and maintained, for example, refer to BS 7430 [11], *Code of practice for protective earthing of electrical installations*. The HSE provide advice on earthing at:
https://www.hse.gov.uk/comah/sragtech/techmeasearthing.htm

Earthing can be classified in two ways, as system earthing or equipment earthing:

- system earthing is essential to the proper operation of the system;
- equipment earthing concerns the safety of personnel and plant. A key function of equipment earthing is to provide a controlled method to prevent the build-up of static electricity, thus reducing the risk of electrical discharge in potentially hazardous environments.

NOTE: A suitable earth conductor is required. Do not assume that an earth exists. Always test the earth.

A specific requirement for gas delivery tankers, tube trailers, etc. is that the vehicles and all receipt and delivery site equipment shall be designed and be compatible for earthing and bonding. Ancillary equipment, such as hoses, shall be included and electrical continuity shall be ensured to the required extent.

Generally, a resistance to earth of less than 10^6 Ω.m will ensure safe dissipation of static electricity in all situations. Refer to Energy Institute, Model code of safe practice, Part 21 [35], *Guidelines for the control of hazards arising from static electricity*.

Where protection against lightning may be required a lightning protection risk assessment should be carried out, with any control measures identified being implemented, refer to BS EN 62305 [18], *Protection against lightning*.

7.5 Isolation

Provide a means to isolate a complete, or part of a, system.

All isolations shall be done in a safe manner. This includes all circumstances, including routine and emergency. There may be a requirement to gradually close down a system, taking account of any hazards, for example, preventing pressure build-up in a part of the system.

The integrity of the isolation(s) shall be suitable to ensure safety and be periodically tested.

Isolation may be achieved using an automated system or by applying a manual procedure.

7.6 Portable and temporary-use equipment and tools

All portable and temporary-use equipment used in a hazardous area shall be selected, installed, used and maintained to comply with *DSEAR* [4] and the *EPS Regulations* [7].

Individual tools shall be selected and maintained specifically for use in a hazardous area, for example, the use of non-sparking tools.

There may be specific requirements for individual gases, associated substances and their compatibility with certain materials.

Assess the equipment that is carried on the person, for example, respiratory protective equipment (RPE), communication devices, items in pockets, items on tool belts, etc., to ensure they do not introduce additional hazards which negate the benefit of using intrinsically safe electrical equipment, flame resistance materials or that represent a hazard of itself.

7.7 Safe systems of work

Appropriate safe systems of work shall be developed, implemented and supervised, such as, standard operating procedures for low risk activities, with additional safety method statements for medium risk activities and permit to work systems for high risk activities. Operating procedures shall take account of *DSEAR* [4] and the *EPS Regulations* [7].

Standard operating procedures should cover topics such as, commissioning (including decommissioning), achieving electrical and mechanical isolation, maintenance instructions, supervision regime, etc. They shall be reviewed on a periodic basis.

Any proposed change shall follow a formal and documented management of change procedure prior to any implementation, for example, refer to EIGA 51 [20], *Management of change*. Changes in this context include:

- product and other hazardous substances;
- operational or process conditions;

- equipment and hardware;
- software;
- systems and processes;
- personnel resources, including competence.

Specific documented emergency operating procedures shall be developed for all foreseeable circumstances that may occur within a site. These shall include any specific requirements for an event occurring either in a hazardous area or other areas in proximity. This should include:

- fire containment, including specialist equipment;
- evacuation (to a safe muster point(s));
- first aid (with consideration of the effects from excessive heat);
- escalation management, including external assistance (from Emergency Services);
- mitigation management (isolation of equipment);
- testing of procedures and the carrying out of periodic drills including a review and update of procedures;
- competence and training of personnel, including of designated emergency team(s).

7.8 Competent personnel

The Site Operator is responsible for ensuring that the site is compliant with *DSEAR* [4] and the *EPS Regulations* [7], that all personnel involved are competent and that a suitable operating regime is in place (refer to Section 7.7). This includes:

- competent persons doing the *DSEAR* [4] risk assessment and carrying out subsequent reviews;
- competent designers and installers;
- competent operation and maintenance personnel;
- competent personnel managing maintenance procedures and systems.

7.9 Appropriate clothing

When working with hazardous substances personal protective clothing shall be chosen which is suitable for that use.

Wear flame resistant outer clothing when in the proximity of a *DSEAR* [4] hazardous area. Other clothing that is worn, particularly next to the skin, shall be assessed to ensure it does not introduce additional risks which negates the benefit of the flame resistance provided by the outer clothing or represents a hazard of itself.

Ensure that personal protective clothing is well fitting and correctly fastened.

Static electricity can build-up from clothing. The workplace risk assessment shall take account of the *DSEAR* [4] environment and assess the requirement for wearing anti-static clothing. Suitable clothing, which minimises the build-up of static electricity, shall be worn when within a designated hazardous zone.

Static build-up is a particular concern in dry atmospheres, refer to the Energy Institute, Model code of safe practice, Part 21 [35]. To help prevent static build-up:

- wear static dissipating footwear to help earth any charges, refer to BS EN ISO 20345 [14], *Personal protective equipment. Safety footwear*, and BS EN ISO 20347 [15], *Personal protective equipment. Occupational footwear*;

- consider the use of static dissipating gloves, especially when using hand tools;

- ensure that employees do not remove clothing in a hazardous area where a flammable atmosphere may be present; clothing that is heavily contaminated with flammable or oxidising product should be removed slowly and carefully in a non-hazardous place, ensuring that the body has first been adequately earthed;

- do not wear highly insulating clothing in a Zone 0 hazardous area.

7.10 Management of ancillary service providers, housekeeping, vegetation and vermin

Ancillary service providers, for example, cleaners, ground maintenance teams, etc., often work independently and use their own equipment. Where their personnel are required to enter a hazardous area or where their personnel bring their own equipment for use in or near a hazardous area, then they shall have received suitable information, instruction, training and, as appropriate, be under supervision to work safely within that hazardous area.

The use of chemicals by ancillary service providers, for example, cleaning products, weed killers, etc., should be assessed for any hazard they may introduce into a hazardous area prior to use with, as necessary, controls applied. Sodium chlorate and other oxidising agents which are used as weed killer, are a fire hazard and shall not be used within or near a hazardous area.

All portable and temporary-use equipment used in a hazardous area shall comply with Section 7.6. Care will need to be taken when operating equipment, such as grass strimmers, that sparks are not created during use.

To reduce the fire hazard to a minimum the area within and surrounding the hazardous area is to be kept clear of any excessive vegetation. Long grass, weeds and any overhanging branches are to be removed.

Vermin have been known to cause damage, for example, gnawing electrical cables. Where vermin are a problem suitable controls should be implemented. For further information, refer to the *British Pest Control Association* (BPCA).

Regularly carry out housekeeping. Keep the area clear of litter and other rubbish. Do not allow the area to be used for the storage of other dangerous substances or items. Ensure all safety features, including safety signs and warning notices, are in place and are fit for purpose.

8. SUSTAINABILITY OF SAFETY

There are many aspects to maintaining a safe system of work for *DSEAR* [4] activities. These include:

- documenting of risk assessments;
- periodic review of risk assessments;
- managed maintenance activities;
- management of equipment, including:
    - use of suitable components to remain *EPS Regulations* [7] compliant;
    - use of suitable electrical accessories, for example, glands, barriers, junction boxes, etc.;
    - calibration;
    - inspection (hazardous area grading);
    - alarm management.
- use of safety and warning signs, including markings, suitably sited, displaying the correct information and legible;
- competence of personnel;
- management of change, including engineering, management, workplace, equipment, etc. Refer to EIGA 51 [20];
- auditing and periodic process safety review;
- management and control of visitors and contractors;

- systematic evaluation and learning from incident and near misses (from self and others);

- a general safety culture.

9. SECURITY

All sites where gases are stored and used should have appropriate security arrangements in place.

Compliance with DSEAR [4] will create an area where the risk of a flammable incident is reduced.

10. REFERENCES

	Document Number	Title
1.		The Health and Safety at Work etc. Act 1974.
2.	SI 1989: No. 635	The Electricity at Work Regulations 1989.
3.	SI 1999: No. 3242	The Management of Health and Safety at Work Regulations 1999.
4.	SI 2002: No.2776	The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).
5.	SI 2009: No. 1348	The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended).
6.	SI 2016: No. 1105	Pressure Equipment (Safety) Regulations 2016.
7.	SI 2016: No. 1107	Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016 (EPS).
8.	European Directive 1999/92/EC	Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres. The Explosive Atmospheres Workplace Directive.
9.	European Directive 2014/34/EU	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres. The Explosive Atmospheres Equipment Directive.

10.	HSE L138	Dangerous substances and explosive atmospheres. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance.
11.	BS 7430	Code of practice for protective earthing of electrical installations.
12.	BS 7671	Requirements for electrical installations. IET wiring regulations.
13.	BS EN 1107	Explosive atmospheres. Explosion prevention and protection.
14.	BS EN ISO 20345	Personal protective equipment. Safety footwear.
15.	BS EN ISO 20347	Personal protective equipment. Occupational footwear.
16.	BS EN 60079	Explosive atmospheres. Part 10-1: Classification of areas. Explosive gas atmospheres. Part 14. Electrical installations design, selection and erection. Part 25. Intrinsically safe electrical systems. Part 32. Electrostatic hazards.
17.	BS EN 60529	Specification for degrees of protection provided by enclosures.
18.	BS EN 62305	Protection against lightning.
19.	BS EN ISO 80079	Explosive atmospheres.
20.	EIGA 51	Management of change.
21.	EIGA 134	Potentially explosive atmospheres EU Directive 1999/92/EC.
22.	BCGA Code of Practice 7	The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply).
23.	BCGA Code of Practice 26	Bulk liquid carbon dioxide storage at Users' premises.
24.	BCGA Code of Practice 30	The safe us of liquid nitrogen dewars.
25.	BCGA Code of Practice 33	The bulk storage of gaseous hydrogen at Users' premises.
26.	BCGA Code of Practice 36	Cryogenic liquid storage at Users' premises.
27.	BCGA Code of Practice 39	In-service requirements of pressure equipment (gas storage and gas distribution systems).

28.	BCGA Code of Practice 44	The storage of gas cylinders
29.	BCGA Code of Practice 46	The storage of cryogenic flammable fluids.
30.	BCGA Guidance Note 11	The management of risk when using gases in enclosed workspaces.
31.	BCGA Guidance Note 23	Gas safety. Information, instruction and training.
32.	BCGA Guidance Note 41	Separation distances in the gases industry.
33.	BCGA Technical Information Sheet 44	Human factors.
34.	Energy Institute Model code of safe practice. Part 15.	Area classification for installations handling flammable fluids.
35.	Energy Institute Model code of safe practice. Part 21.	Guidelines for the control of hazards arising from static electricity.
36.	Cox, Lees and Ang	Classification of hazardous locations.

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
British Compressed Gases Association (BCGA)	www.bcga.co.uk
British Pest Control Association (BPCA).	www.bpca.org.uk
Liquid Gas UK - The UK LPG trade association	www.liquidgasuk.org
Energy Institute	www.energyinst.org

British Compressed Gases Association

www.bcga.co.uk