GUIDANCE NOTE 9

THE APPLICATION OF THE CONFINED SPACES REGULATIONS TO BEVERAGE DISPENSE

REVISION 3: 2020

British Compressed Gases Association

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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 Technical BCGA Guidance Note 9, Revision 2: 2015. It was approved for publication at BCGA Committee 163. This document was first published on 22/10/2020. 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

Asphyxia	An extreme condition caused by a lack of oxygen. It may be accompanied by an excess of carbon dioxide in the blood (hypercapnia). Produced by interference with respiration or insufficient oxygen in the air. Asphyxia can cause coma or death.
Beverage	Any potable drink, mainly (but not necessarily exclusively) in liquid form.
Cellar	Liquid food store, with or without temperature or other environmental controls. A gas store may be included within the cellar.
Confined space	Any place, including room, chamber, tank, vat, silo, pit, trench, pipe, sewer, flue, well, or other similar space in which, by virtue of its enclosed nature, there arises a reasonably foreseeable specified risk. It has two defining features: 1. It is a place which is substantially, (though not always entirely) enclosed. 2. There will be a reasonably foreseeable risk of serious injury from hazardous substances or conditions within the space or nearby. Refer to the *Confined Spaces Regulations* [2].
Cylinder	A transportable pressure receptacle of a water capacity not exceeding 150 litres.
Keg	Pressure container for holding chilled and filtered beverage products.
May	Indicates an option available to the user of this Guidance Note.
Premises Operator	A party who operates a premises which involves drinks dispense, a cellar and / or a gas system. The Premises Operator maintains management responsible for health and safety at that specific premises. This may be a company or an individual, and usually will be the effective employer of those working on the premises. The 'responsible person', Premises Operator and the 'duty holder' are the same person or party. The role is fulfilled by the publican, user, manager (or pub operating company general manager), landlord or licensee. Where there is any overlapping of responsibilities then their roles, with regard to compliance with the requirements of this Guidance Note, shall be clearly defined in writing.
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.
Tolerable risk	In the context of this document a tolerable risk is one that can demonstrably be shown to be as low as is reasonably practicable, through risk assessment.

GUIDANCE NOTE 9

THE APPLICATION OF THE CONFINED SPACES REGULATIONS TO BEVERAGE DISPENSE

1. INTRODUCTION

Gases are used in beverage dispense to operate cellar equipment, to retain the carbon dioxide (CO_2) content in an alcoholic beverage, or to push product out of a container, i.e. a keg and through a downstream system. CO_2 is also used to carbonate water and other liquids for soft drinks dispense. The gases used are generally CO_2, nitrogen (N_2), and various mixtures of these. The gases will be used on separate systems, generally not connected to each other (however, refer to Section 3.4). Compressed air may be used for non-drinks-contact pneumatic power, for example, as an operating media for gas pumps, whilst other specialist gases may be kept for other specific purposes. Typically, gases are stored within or near the cellar.

With the exception of air, the gases used in beverage dispense, if released, may produce localised oxygen (O_2) deficient atmospheres, which may ultimately result in asphyxia of any persons within that atmosphere. In addition, CO_2 can become an intoxicant as concentrations increase.

The risk from these effects is increased in any location where there is inadequate ventilation, this may pose a risk to health. An enclosed space, for example a cellar, may meet the criteria of a confined space within the meaning of the *Confined Spaces Regulations* [2]. If so, these regulations require that employers carry out a suitable and sufficient risk assessment and, where necessary, implement appropriate controls to protect those accessing or working in the confined space. A safe system of work shall be developed for all activities required in the confined space. For the purposes of this document this responsibility is with the Premises Operator.

Gas suppliers can provide relevant safety data on the products that they supply which may assist the Premises Operator in assessing risks and in developing safe systems of work. Gas suppliers cannot and will not conduct or maintain a risk assessment of the cellar; only the Premises Operator can discharge that duty.

This document only refers to reasonably foreseeable, specified risks associated with common gas and gas dispense systems. The advice given does not apply to any other element of safety in the cellar, including other specified risks referred to in the *Confined Spaces Regulations* [2].

Further guidance on the safe use of beverage dispense gases is available in BCGA Guidance Note (GN) 30 [20], *The safe use of gases in the beverage dispense industry*.

Premises 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 installations in a safe and responsible way.

This Guidance Note has been prepared by the *British Compressed Gases Association* (BCGA) in consultation with the *British Beer & Pub Association* (BBPA) and the *Brewing, Food & Beverage Industry Suppliers Association* (BFBi) in order to provide guidance to users of gases in the beverage dispense industry.

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

2. SCOPE

Gas cylinders should be stored and managed in accordance with BCGA Code of Practice 44 [17], *The storage of gas cylinders*. Where it is necessary to store gas cylinders in an enclosed / confined space, then this document provides information and a methodology that can be used to assist in carrying out a confined spaces risk assessment.

This document covers:

- the process of conducting a risk assessment to determine if a cellar / storage area meets the requirement of being an enclosed / confined space;
- the establishment of a common standard for the application of the *Confined Spaces Regulations* [2] to beverage dispense applications;
- the preparation of a set of recommendations, giving accurate and consistent advice, on the use of beverage dispense gases in confined spaces (i.e. the cellar or storage area) in compliance with the regulations;
- the role of the suppliers of beverage dispense gases, with regard to the supply, storage and use of their products for beverage dispense applications.

3. KEY PROPERTIES OF GASES USED FOR BEVERAGE DISPENSE

With the exception of air, all the gases used in the beverage dispense industry, if released, may produce localised O_2 deficient atmospheres, which may ultimately result in asphyxia. The normal concentration of O_2 in air is approximately 21 %. Any variation from this is hazardous, refer to Section 3.2.

Additionally, in higher concentrations CO_2 can become an intoxicant, in which case there is the potential for CO_2 enrichment in a confined space, refer to Section 3.1.

In an enclosed / confined space there is an increased risk to health from exposure to a reduced O_2 atmosphere, or from the accumulation of high concentrations of CO_2. The *Confined Spaces Regulations* [2] require that employers carry out a risk assessment and implement appropriate controls to protect those accessing or working in the area. Refer to Section 4.

For information on the key properties of the common gases used in the beverage dispense industry:

- carbon dioxide, refer to Section 3.1;
- nitrogen, refer to Section 3.2;
- air, refer to Section 3.3;
- mixed gases, refer to Section 3.4.

3.1 Carbon dioxide

At normal temperature and pressure, CO_2 is classified as a non-toxic, non-flammable gas. CO_2 is a colourless, odourless gas which has a characteristic taste and pungency at higher concentrations. It does not support life or combustion.

CO_2 is approximately 1.5 times as heavy as air, with a density, at 1.013 bar absolute, 15 °C, of 1.87 kg/m³. Gas suppliers usually transport and store CO_2 in bulk as a liquefied gas, at a temperature of approximately –17 °C and a pressure of 20.7 bar.

CO_2 cannot exist as a liquid at atmospheric pressure. When the liquid under pressure is released to the atmosphere, a dense white cloud is formed, containing cold gas, solid CO_2 particles and condensed moisture from the air. The solid CO_2, at –78.4 °C, may settle on adjacent surfaces before subliming to produce more cold gas. As the gas is heavier than air, it will generally spread along the ground and accumulate in low lying areas such as cellars, floors, pits and trenches. CO_2 will dissolve in water to a limited extent to form a weak acid, but it is generally un-reactive.

CO_2 is present in atmospheric air at a level of approximately 411 parts per million (ppm). It is a normal part of human and animal metabolism and plays an important role in the control of several vital human bodily functions, however it is an intoxicant in higher concentrations. Increases in the local concentration of CO_2 will have an adverse effect on humans, refer to Table 1. The reactions and the timescales to cause the effects of CO_2 in a specific individual depend on the concentration and duration of exposure as well as individual factors, for example, age, state of health, physiological make-up, physical activity, lifestyle, etc.

In-line with the *Control of Substances Hazardous to Health (COSHH) Regulations* [5], HSE GN EH 40 [8], *Workplace Exposure Limits*, gives a workplace exposure limit for the concentration of CO_2 in air. Currently this is 0.5 % by volume (5000 ppm), calculated as an 8-hour time-weighted average. A short term workplace exposure limit of 1.5 % by volume (15000 ppm), calculated as a 15 minute time weighted average concentration, is also given. The HSE paper on the *Assessment of the major hazard potential of carbon dioxide (CO_2)* [12] identifies that at low levels CO_2 is mildly toxic to humans. Above concentrations of about 7 % in air (i.e. > 70 000 ppm), humans are particularly sensitive to further increases.

The latest edition of HSE GN EH 40 [8] should be checked before assessing specific risks. Use these limits as the basis for calculating an acceptable level of risk.

It is important to note that the effects of CO_2 on humans may be entirely independent of the effects of O_2 deficiency. The O_2 content in the atmosphere is therefore not an effective indication of the hazards from CO_2. For example, in a confined space, such

as a cellar, a potentially fatal CO_2 concentration of 14 % can theoretically exist with a normal O_2 content.

NOTE: Filter respirators give no protection in atmospheres containing dangerous concentrations of CO_2.

Where atmospheric monitoring equipment is in-use, Premises Operators shall be clear on what hazard they believe they are controlling. For most cellar installations, two monitors should be considered; one to monitor O_2 levels (and hence, O_2 deficiency) and one to monitor CO_2 enrichment.

CO_2 Concentration Volume %	**Typical effects and symptoms**
0.04	Normal level of CO_2 in the atmosphere
0.5	Minimum safe level of CO_2. Maximum allowed exposure over an 8 hour period *
1 – 1.5	Slight and unnoticeable increase in breathing rate. 1.5 = maximum allowed exposure in a 15 minute period *
3	Breathing becomes laboured, rate increases. Hearing ability reduced, headache experienced with increase in blood pressure and pulse rate.
4 - 5	Breathing laboured at a greater rate. Symptoms as above, with signs of intoxication becoming more evident with longer exposure and a slight choking feeling.
5 - 10	Characteristic pungent odour noticeable. Breathing very laboured, leading to physical exhaustion. Headache, visual disturbance, ringing in the ears, confusion probably leading to loss of consciousness within minutes.
10 - 100	In concentrations above 10 %, unconsciousness will occur in under one minute and unless prompt action is taken, further exposure to these high levels will eventually result in death.

* Refer to HSE GN EH 40 [8]

Table 1: Typical effects of inhaling carbon dioxide

NOTE: Independent gas sensors are necessary to monitor for O_2 depletion and for CO_2 enrichment. O_2 depletion monitors do not provide protection for monitoring atmospheres where CO_2 may be present and CO_2 monitors may not provide indication of O_2 deficiency (for example, where N_2 is present). Refer to Section 4.1.

For further information on the physiological effects of CO_2, refer to the *European Industrial Gases Association* (EIGA) Safety Information Sheet 24 [16], *Carbon Dioxide Physiological Hazards*.

3.2 Nitrogen

N_2 is classified as a non-toxic, non-flammable gas which is chemically non-reactive. It is odourless and does not support life. It is slightly lighter than air, depending upon the temperature.

A leak of N_2 anywhere, but especially into a confined space increases the levels of N_2 present and it may cause an O_2 deficient atmosphere, which could lead to asphyxia if people are nearby. Asphyxia due to O_2 deficiency is often rapid with no prior warning to the victim. The effects of inhaling reduced concentrations of O_2 are given in Table 2.

O_2 monitoring equipment should be considered where there is a risk to people of a change from normal O_2 levels. This will generally be alongside CO_2 monitoring. Refer to Section 4.1.

NOTE: Working in an area where the concentration of O_2 is below the normal level may be dangerous for some individuals, for example, those with medical conditions affecting their breathing or lung function.

O_2 Concentration Volume %	**Typical effects and symptoms**
20.9	Normal levels of O_2 in the atmosphere.
19.5	Minimum required level of O_2 (as recommended by HSE).
< 18	Potentially dangerous. Reduced intellectual and physical performance.
< 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 of an inert gas (which contains no O_2, such as N_2) causes immediate loss of consciousness and death within 2 minutes.

Table 2: Typical effects of inhaling reduced concentrations of oxygen

3.3 Air

Air is classified as a non-toxic, non-flammable gas, but it does support combustion. If pressurised, it may vigorously support and help to spread combustion. It is odourless and colourless. Air does support life.

3.4 Mixed gases – CO_2 and N_2

Gas suppliers provide cylinders with combinations of CO_2 and N_2 pre-mixed together. There are also separator systems available where the gases may be mixed together in a cellar, for example, where N_2 is sourced via an Air Separation Unit (which will exhaust an enriched O_2 air stream). These gases shall be treated for safety management purposes as if they exhibit the properties of all the component gases, unless their hazard classification demonstrates otherwise. Refer to Section 3.1 and 3.2.

4. THE CONFINED SPACES REGULATIONS

An enclosed space meets the criteria of a confined space within the meaning of the *Confined Spaces Regulations* [2], especially so if a reduced O_2 atmosphere and / or an accumulation of high levels of CO_2 could foreseeably be present.

The *Confined Spaces Regulations* [2] require that employers carry out a risk assessment and, if entry into a confined space is unavoidable and there is a risk to health and safety, put in place appropriate controls to protect those accessing or working in the space, i.e. create a safe system of work and ensure appropriate emergency arrangements are in place before entering the space.

Only authorised personnel, may enter a confined space in line with the safe systems of work, refer to Section 7.

For further information, refer to:

- HSE webpages on working in confined spaces: https://www.hse.gov.uk/toolbox/confined.htm
- HSE L101 [7], *Safe work in confined spaces. Approved code of practice*.
- HSE INDG 258 [11], *Safe work in confined spaces*.

Beverage dispense gases that are released to an environment with insufficient ventilation will produce local O_2 -deficient atmospheres, and / or an atmosphere enriched with CO_2, refer to Section 3. Where there is a reduction in the O_2 concentration or an increase in the CO_2 concentration then this difference in the concentration from normal shall be investigated and the cause resolved before exposing anyone to danger and before resuming normal work.

In all areas where gases are stored, handled and used, or an area where a gas has the potential to be released / leak, appropriate controls are necessary, for example, ventilation, atmospheric monitoring equipment (refer to Section 4.1), etc.

Gas powered or assisted pumps, especially where they are operated by N_2, CO_2 or mixtures of these gases, shall be vented such that they discharge in a safe place in the open air, i.e. outside the building. In confined spaces, an appropriate safe system of work shall be applied, which may include the provision of ventilation systems, atmospheric monitoring systems, information to employees, automatic monitoring and alarm systems. Appropriate safety signs and warning notices shall be installed, refer to Figure 1.

BCGA GN 11 [18], *The management of risk when using gases in enclosed workplaces*, provides comprehensive advice on managing reduced O_2 atmospheres in the workplace. BBPA provide additional guidance in their technical guidance leaflet, *Carbon dioxide in cellars* [21].

Smoking shall not be allowed near confined spaces (or in any area where gases are stored).

Appropriate safety signs and warning notices shall be displayed in-line with the premises' safe system of work and *The Health and Safety (Safety Signs and Signals) Regulations* [1]. Examples are shown in Figure 1.

No smoking | No unauthorised access | Potential asphyxiating atmosphere | Gas cylinder store

Figure 1: Examples of safety signs and warning notices

Where the safe system of work allows personnel to enter the cellar it is recommended that, alongside other controls, the cellar access door is secured in the open position, where it is safe to do so. This may assist with ventilation and may expedite emergency egress. However, consideration should be given to the efficiency of mechanical ventilation systems and natural air-flow routes (as these may be designed for optimum performance with the cellar door in the closed position). Additionally, with an open door, the Premises Operator may need to ensure controls are in place for general safety risks, for example, of tripping, falls, pressure release, etc.

Where the safe system of work permits lone working then this activity shall be subject to a specific risk assessment with appropriate controls put in place. Appropriate arrangements shall be in place for emergencies. This includes providing assistance and managing the rescue of persons in the event of an emergency. Lone working may require specific arrangements and additional communication facilities, instruction, training, supervision, personal protective equipment, atmospheric monitoring equipment (such as personal gas monitors) etc. HSE INDG 73 [9], *Working alone. Health and safety guidance on the risks of lone working*, provides additional guidance.

Where a cellar is a confined space, the Premises Operators shall have local emergency procedures in place. Such procedures shall include:

- notifying the emergency services in the event of an incident;
- increasing ventilation into the area (where practical);
- preventing further (unauthorised and uncontrolled) access to the space;

- determination of how persons may be safely recovered from a confined space without exposing others to risk, for example, if they are involved in an incident.

Recovery (rescue) attempts shall only be made in accordance with a pre-planned confined spaces emergency rescue procedure, by competent persons using appropriate equipment. Appropriate equipment may include, for example, air supplied breathing apparatus, (if necessary) atmospheric monitoring equipment which can give pre-warning of non-respirable atmospheres, etc., refer to Section 7 and Section 8.

WARNING: Unplanned rescue attempts into confined spaces have resulted in multiple deaths, as the rescuers themselves are often overcome by the non-respirable atmosphere.

Gas supply companies provide safety information, for example, safety data sheets, for their products and can offer advice on key aspects of the *Confined Spaces Regulations* [2] in respect of beverage dispense gases. However, the responsibility for compliance with the *Confined Spaces Regulations* [2] rests with the Premises Operator. The Premises Operator shall have a safe system of work in place, which shall cover the activities of all personnel who may wish to access the confined space, including for example, suppliers, third-party or contract technicians, cleaners, non-employees, etc.

4.1 Atmospheric monitoring equipment

The requirement for atmospheric monitoring (gas detection) equipment shall be determined by a risk assessment, refer to Section 5, in particular, where the risk is determined to be medium or high risk, refer to Section 6. For further information on the use of atmospheric monitoring equipment refer to BCGA GN 11 [18].

The risk assessment shall take into account the type of gas(es) that may be present (as well as in-use) and the locations from where the gas(es) may originate and accumulate (taking into consideration the properties of each individual gas).

Specifically, the risk assessment shall determine if atmospheric monitoring equipment is required and, if so, each gas it shall detect. An independent gas sensor is required to monitor CO_2 and an independent gas sensor is required to monitor O_2. Other gases may themselves require an independent sensor. Where there is a potential risk for the accumulation of CO_2, then this shall be monitored using a CO_2 detector, not an O_2 detector.

The atmospheric monitoring equipment shall:

- be installed by a competent body / person;
- be set up and operated in accordance with the manufacturer's instructions;
- be used to test the workplace atmosphere before entry and during occupancy;
- incorporate a system of warning alarms, both audible and visual. These shall activate both inside the area and (for fixed monitors) in appropriate external locations;

- be subject to a formal planned maintenance and test schedule that includes functional testing, calibration of detectors, alarm and interlock checks, the routine replacement of components, etc. Appropriate maintenance arrangements shall be put in place, for example, through a third party maintenance contact.

For fixed monitor systems, monitor displays, safety signs and warning notices shall be sited at each entry point so that they are clearly visible to personnel before entering the area. As appropriate, additional monitor displays, safety signs and warning notices shall be sited inside the area.

Permanent fixed equipment is generally preferable to portable personal equipment. If the safety of a person entering the cellar / confined space is totally reliant on one or more portable personal gas detectors for protection, this requires specific arrangements within the safe system of work. This shall include for pre-entry checks, that the operator is competent and that the monitor is maintained, tested and used in accordance with the safe system of work and the manufacturer's operating instructions.

Persons (including those not directly employed by the Premises Operator) who may wish to enter confined spaces (including cellars), for example, for delivery or collection of containers and / or gas cylinders, may be equipped with portable personal atmosphere monitors, issued by their employers. Great care shall be exercised in the use of portable monitors – it is no good warning someone of a non-respirable atmosphere when they have already entered it; PRE-WARNING is required, to prevent entry! All persons shall be protected from risk, for example, by complying with the Premises Operator's confined spaces entry requirements. All parties shall co-operate with each other in the interests of Health and Safety.

The user shall be competent in all respects, including in the operation of the monitor(s), for example, if the instrument(s) has a significant response time when exposed to a sudden change in the concentration of the gas.

All persons who enter a confined space where atmospheric monitoring equipment is in use shall do so in accordance with a safe system of work. This shall include sufficient information, instruction and training on the correct operation and response of or to the equipment.

NOTE: Suppliers of atmospheric monitoring equipment can provide advice on suitable equipment and the use and appropriate location of the detector / monitor.

5. ASSESSMENT OF RISK

The Management of Health and Safety at Work Regulations [3], as well as other legislation, require employers to conduct risk assessments to ensure the health and safety of all those who may be exposed to hazards due to the employer's activities. The *Confined Spaces Regulations* [2] require a specific risk assessment before entry of personnel into a confined space, refer to Section 4.

All areas of the premises, where gases are stored, distributed and used shall be included in a risk assessment, in addition, where this involves a confined space then a specific confined

spaces risk assessment shall be carried out. The risk assessment(s) shall identify the hazards present, assess the risks and determine what controls should be implemented. The risk assessment shall take account of:

- all tasks, for example, the change-over of a gas cylinder;
- the working environment, including foreseeable changes to that environment, for example, from leaks;
- the materials, equipment and tools;
- the competency of those present, for example, those carrying out the task(s);
- arrangements for emergencies, including rescue.

Factors which may affect the overall assessment include:

- the size of the area under assessment;
- the location, for example, whether below ground or above ground;
- ventilation, including that created by specific installed systems, its reliability, etc., for example, a forced air circulation system;
- if the space may create hazards nearby, for example, if it opens directly to an area that could be occupied by people.

For further information on carrying out a risk assessment involving gases, refer to Section 5.1.

Guidance is available from:

- HSE INDG 163 [10], *Risk assessment. A brief guide to controlling risks in the workplace*.
- The British Soft Drinks Association (BSDA) leaflet, *Safe use of dispense equipment in retail and other non-licensed premises. Advice to users* [22].
- BBPA technical guidance document on *Carbon dioxide in cellars* [21].

All assessments shall be recorded and records maintained and updated as necessary. The assessments shall be reviewed periodically.

5.1 Procedure for the calculation of risk involving gases

Specifically, where gas cylinders and / or containers are stored and / or in-use in a cellar / confined space, the assessment calculation shall be based on a full cylinder or container of gas being released into a space following an incident.

NOTE: Cylinders are inspected for their serviceability, including for leakage, as part of their filling process. More than one cylinder developing a leak at the same time is a highly unlikely event (however, refer to Section 5.1, NOTE 2).

If a pressure system and its associated pipework is permanent and continuous, without any mechanical joints and with no risk of mechanical damage, it may generally be discounted in the assessment for the purposes of a leaking gas. However, if there are locations where the pressure system(s) includes components that may allow a gas to be released, for example, connectors, unions, safety relief devices, vent pipe exhausts, etc., then these shall be included in the assessment.

BCGA GN 11 [18] can be used to calculate the potential depletion of O_2 in a confined space.

The following calculation can be used to calculate the value of the concentration of CO_2 in air, which could result from the escape of the CO_2 contents into a confined space. No allowance is made in the calculation for air changes, either natural or via a forced ventilation system. Modifications to the confined space that affect the free air volume and flow shall be allowed for by re-assessing the situation.

The chart given in Appendix 1 can be used to assist with this calculation.

Appendix 3 gives a flowchart guide to the process of risk reduction.

$$\textit{Concentration of } CO_2 \textit{ in air} = \left(\frac{V_{gas}}{V_{air}} \right) \times 100$$

Where:

V_{gas} = Largest volume of CO_2 contained in a single cylinder or container (m^3)

Establish the largest volume of CO_2 within in a single cylinder or other container. This is done by identifying all the CO_2 gas cylinders / containers within the confined space (area) under assessment and, using the appropriate gas company data (for examples, refer to Appendix 2), determining which single cylinder or container has the largest volume of CO_2, (refer to Notes below).

V_{air} = Free air volume (m^3)

Calculate the free air space in the confined space under assessment. For a regularly-shaped space measure the height, width and length, then multiply together to determine the total volume of the space (m^3). From this volume deduct the volumes of any objects within the confined space, such as kegs, barrels, coolers, etc. These objects reduce the volume of free air in the confined space. Allowance shall be made for maximum stocks during peak trading periods since these extra stocks will further reduce the free air volume within the confined space.

Table 3 provides the estimated volumes of typical objects that may be located in a cellar. As necessary, each individual item should be measured.

Object	Equivalent air volume
11 gallon keg	0.05 m^3
22 gallon keg	0.10 m^3
36 gallon barrel	0.16 m^3
10 litre bag in boxes	0.015 m^3 (64 boxes = 1 m^3)
Cellar cooler	0.2 m^3
Remote line cooler	0.175 m^3
Full crates (for beer bottles)	0.008 m^3 (120 crates = 1 m^3)
Full cardboard box wraps or cases	0.025 m^3 (40 = 1m^3)

Table 3: Estimated volume of typical objects located in a cellar

NOTES:

1. The largest CO_2 volume could be in a mixed gas cylinder or a container, for example, a portable cryogenic container.

2. If more than one cylinder is connected and opened to the same ring main system or manifold then the total of the cylinder volumes so connected shall be calculated and used in the assessment.

3. If more than one gas supply system is used within the same confined space the supply with the largest value of V_{gas} shall be used. This assumes that regular leak checks are conducted on the systems, at least after every cylinder change.

4. Appendix 2 gives the volumes for cylinders from some of the major gas suppliers. If another supplier is involved, contact them for data for your cylinders.

Risk type	Description
Tolerable risk (so far as is reasonably practicable)	CO_2 concentration in the air less than 0.5%.
Medium risk	CO_2 concentration in the air between 0.5% and 1.5%.
High risk	CO_2 concentration in the air above 1.5%.

Table 4: Risk categories

When the calculation is completed use the calculated value to categorise the risk as tolerable, medium or high according to Table 4.

The result obtained provides a useful general guide to the risk that is likely to be encountered, however there are other potential hazards that may need to be taken into consideration, these include:

- the efficiency of the ventilation system employed, or the natural air pathways. Mechanical ventilation systems can be more effective than natural ventilation. Stored items (kegs, boxes, etc.) can disrupt ventilation flows;

- how well the different gases mix together. For example, CO_2 is a dense gas that will tend to accumulate at low levels, therefore there is generally likely to be a greater concentration of CO_2 closer to the floor;

- the air quality, which can differ if the location contains remote or low-lying compartments. Take into consideration the possible effects of the dimensions and layout of the space;

- equipment, such as gas driven pumps, which vent into the space;

NOTE: Such equipment, especially when operated by N_2, CO_2 or mixtures of these gases, should have been installed such that they discharge, via a vent system, to a safe place in the open air, i.e. outside the building.

- specific tasks which may take place in the confined space and which may affect air circulation, fresh air renewal or O_2 consumption, including the use of cleaning agents and solvents;

- gases and liquids may leak or may have leaked into the space from adjacent plant, installations, services, processes or landfill sites, especially where the space is below ground level;

- gases and vapours from natural (some emitting from the ground) or external sources that may be present in the local atmosphere, for example, CO_2, radon (Rn), methane (CH_4), etc.;

- where very cold products are in use, for example, liquid nitrogen, displacement of the air as a consequence of pipe freezing;

- a gradual depletion of the O_2 level as those present in the confined space breathe and where ventilation systems or the provision of replacement air is inadequate.

Take appropriate action to mitigate the risk, refer to Section 6.

6. ACTIONS RESULTING FROM ASSESSMENT

Actions shall be taken dependent on the level of risk identified.

For a tolerable risk refer to Section 6.1.

For a medium risk refer to Section 6.2.

For a high risk refer to Section 6.3.

WARNING: In the event of a gas leak do not enter the area until it is safe to do so.

6.1 Tolerable risk

For a tolerable risk carry out the following actions:

- Record the assessment. Plan further risk reduction control measures to reduce the risk so far as is reasonably practicable, with actions and dates. Update the risk assessment with actions that are completed;

- Manage access to confined spaces. Only authorised persons who operate in line with a safe system of work, for example, have received appropriate instruction, information, training and are appropriately equipped and supervised, shall be allowed entry into confined spaces;

- Create a schedule for regular tests and maintenance, for example, gas leak checks, with special emphasis on cylinder and keg changes. Always leak check after disturbing a gas connection;

NOTE: Carry out a leak test using an approved leak detection fluid. For information on leak detection fluids refer to EIGA 78 [14], *Leak detection fluids cylinder packages*.

- Review and monitor gas cylinder stocks. Maintain stocks consistent with business needs and ensure effective stock rotation. Do not overstock and do not have unnecessary items within a confined space, this especially includes non-beverage gas cylinders (for example, propane, butane, etc.);

- Follow equipment maintenance schedules and keep records of any work carried out;

- Ensure that all gas equipment conforms to appropriate legislation, standards and industry best practice requirements, for example, BCGA GN 30 [20], BBPA, BFBi, BSDA, etc.;

- Display appropriate safety signs and warning notices at the entrance to and inside confined spaces, to support the implementation of and advertise the safe system of work;

- Carry out regular housekeeping;

- Develop and implement emergency procedures for the confined space, ensuring all staff have appropriate competence, refer to Section 7;

- Review any assessment at appropriate intervals, or when there is any change.

6.2 Medium risk

For a medium risk, comply with the requirements of Section 6.1 (for a tolerable risk) and carry out the following actions:

- Limit and control entry, for example, through a Permit to Work system;

- Assess the need for additional ventilation, for example, the use of low level air bricks for ground level or elevated spaces, mechanical ventilation systems in the case of subterranean spaces (specialist advice will be required), etc. Where appropriate, consider the use of heating, to assist air flow and ventilation;

- Assess the need to install a permanent atmospheric monitoring (gas detection) system (which is specific for the gases held on the premises);

- Where practical, remove cylinders, containers and other items from the confined space, in order to better manage the risk. Consider siting some or all of the cylinders outside of the confined space to facilitate free venting and the isolation of the supply in case of a gas leak;

- Consider reducing the size and / or number of cylinders being used.

6.3 High risk

For a high risk, comply with the requirements of Section 6.2 (for a medium risk) and carry out the following action:

- Prohibit entry to the confined space until risks are appropriately managed.

NOTE: The installation of mechanical ventilation systems within some buildings may not be sufficient to remove the risk and may prove problematic when complying with other legislation, for example, fire regulations, local planning consent, etc. Ventilation systems should be carefully considered and assessed, they can be expensive, and whilst gas cylinders can instantly release their contents, no ventilation system can instantly remove the leaked gases from a confined space.

7. COMPETENCE AND TRAINING

Before entry into a confined space each person shall be familiar with the safe system of work at that premises. The safe system of work shall specify the required conditions for entry, along with the required information, instruction, training and supervision, including details of hazards associated with cylinders, containers and systems and gases, and / or any other gases which might enter the confined space, as well as other hazards which may be encountered. Confined space entrants shall be aware of the relevant emergency procedures.

The employer shall ensure that any person entering a confined space is competent to do so. It is recommended that a programme is carried out by the Premises Operator, under a formalised system, where an acceptable level of competency is achieved. Records shall be kept of the information, instruction and training provided and the of the competence achieved by each individual. The programme shall make provision for periodic refreshing of competence.

Recommendations for the training of personnel are described in EIGA 23 [13], *Safety training of employees*. BCGA GN 23 [19], *Gas safety. Information, instruction and training*, provides information on the general topics which should be covered when considering gases safety training. Specific training and competence requirements relating to the storage and use of beverage dispense gases are covered in BCGA GN 30 [20].

Specifically for confined spaces, persons who may foreseeably be involved in any emergency rescue shall be trained and competent for that purpose, refer to HSE L101 [7].

Where atmospheric monitoring equipment is installed or provided, then specific information, instruction and training in the use of that equipment shall be provided, as appropriate, for each person who may foreseeably have need to enter the confined space, refer to Section 4.1.

8. PERSONAL PROTECTIVE EQUIPMENT

A work activity risk assessment shall be conducted to determine the requirement for the use of hazard controls, including, where necessary, for *personal protective equipment* (PPE).

PPE may only be considered as a control to achieve an acceptable level of residual risk after higher levels of control have been addressed but found not to reduce the risk to a level as low as is reasonably practical, for example, elimination, substitution, etc.

Where PPE is required a PPE Assessment shall be carried out by a competent person. PPE requirements shall be satisfied in line with the *Personal Protective Equipment Regulations* [4].

The PPE shall be selected for a particular task and location and shall be appropriate and chosen to effectively manage any residual risk. Thus there are different PPE requirements for differing products, for different tasks, for different situations and for different personnel.

Consider the requirements of the *Control of Substances Hazardous to Health Regulations* [5], in relation to assessing risks, along with any relevant equipment publications, manufacturers' information and the product(s) Safety Data Sheet.

HSE L25 [6], *Personal Protective Equipment at Work,* provides guidance on the *Personal Protective Equipment Regulations* [4]. EIGA 136 [15], *Selection of personal protective equipment*, provides guidance for selecting and using PPE at work.

For confined spaces there may be a specific need to provide breathing apparatus to enable safe entry into a confined space to conduct an emergency rescue. Refer to Section 4 (for Premises Operator local emergency procedures) and Section 7.

9. SECURITY

Access to gas cylinder storage areas, including cellars, shall be for authorised persons only.

All gas cylinders should be stored in a secure location, including used and empty cylinders. When a gas cylinder is no longer required it should be returned to the gas supplier at the earliest opportunity.

Refer to BCGA for further advice.

10. REFERENCES

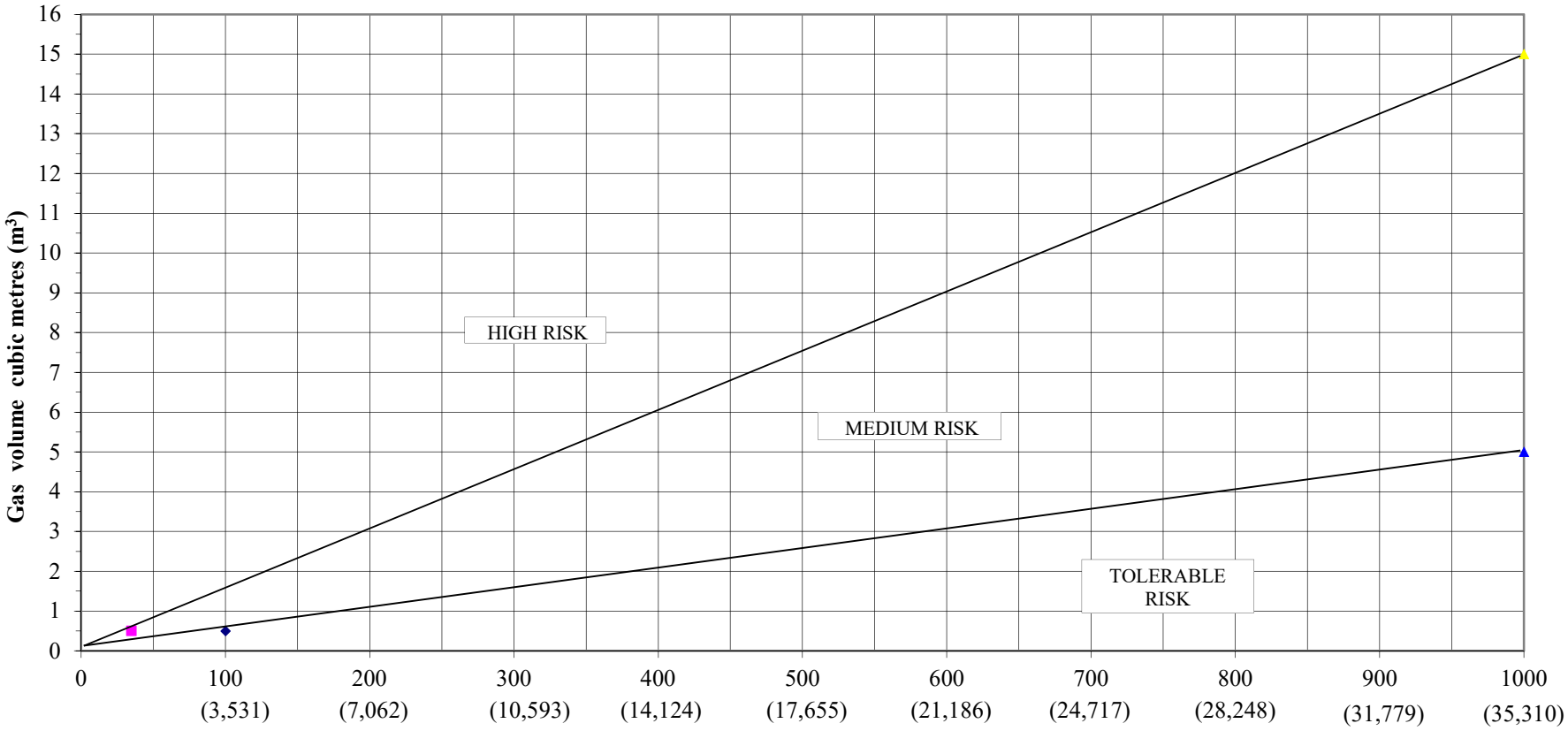
	Document Number	Title
1.	SI 1996: No 341	The Health and Safety (Safety Signs and Signals) Regulations 1996
2.	SI 1997: No 1713	Confined Spaces Regulations 1997
3.	SI 1999: No 3242	The Management of Health and Safety at Work Regulations 1999.
4.	SI 2002: No 1144	Personal Protective Equipment Regulations 2002.
5.	SI 2002: No 2677	Control of Substances Hazardous to Health Regulations 2002 (COSHH).
6.	HSE L25	Personal Protective Equipment at Work.
7.	HSE L101	Safe work in confined spaces. Approved code of practice.
8.	HSE Guidance Note EH 40	Workplace exposure limits.
9.	HSE INDG 73	Working alone. Health and safety guidance on the risks of lone working.
10.	HSE INDG 163	Risk assessment. A brief guide to controlling risks in the workplace.
11.	HSE INDG 258	Safe work in confined spaces.
12.	HSE	Assessment of the major hazard potential of carbon dioxide (CO_2). A paper by Dr. Peter Harper.
13.	EIGA 23	Safety training of employees.
14.	EIGA 78	Leak detection fluids cylinder packages.
15.	EIGA 136	Selection of personal protective equipment.
16.	EIGA Safety Information Sheet 24	Carbon dioxide physiological hazards.
17.	BCGA Code of Practice 44	The storage of gas cylinders
18.	BCGA Guidance Note 11	The management of risk when using gases in enclosed workplaces.
19.	BCGA Guidance Note 23	Gas safety. Information, instruction and training.

20.	BCGA Guidance Note 30	The safe use of gases in the beverage dispense industry.
21.	BBPA Technial Guidance Leaflet	Carbon dioxide in cellars.
22.	BSDA Leaflet	Safe use of dispense equipment in retail and other non-licensed premises. Advice to users.

Further information can be obtained from:

UK Legislation	www.legislation.gov.uk
Health and Safety Executive (HSE)	www.hse.gov.uk
European Industrial Gases Association (EIGA)	www.eiga.eu
British Compressed Gases Association (BCGA)	www.bcga.co.uk
The British Beer & Pub Association (BBPA)	www.beerandpub.com
Brewing, Food and Beverage Industry Suppliers Association (BFBi)	www.bfbi.org.uk
The British Soft Drinks Association (BSDA)	www.britishsoftdrinks.com

CARBON DIOXIDE - ROOM VOLUME ASSESSMENT CHART



Room volume cubic meters (m^3) (Figures in brackets are in cubic feet (ft^3))

GAS COMPANIES – EXAMPLES OF GAS CONTAINER PROPRIETARY INFORMATION

	Cylinder Type (Refer to label)	Max filled pressure (bar(g))	Cylinder size (cm)		Approx. cylinder weight (kg)	Carbon Dioxide (m^3)	Nitrogen (m^3)
			Diameter	Height			
Suregas	E	50	14	50	7	1.7	
Suregas	B	50	14	83	14	3.4	
Suregas	B	50	14	94	14	3.4	
Suregas	SB	50	16.6	62.8	14	3.4	
Suregas	SB	50	17.6	69	14	3.4	
Suregas	R	50	20.3	87	30	7.4	
Suregas	K	50	23	149.5	65	18.2	
	LC200 HP	23	50.8	158.8	132	107	
Suremix 30	V	220	14	94	16	0.74	1.74
	S	220	20.3	87	30	1.35	3.16
	N	220	23	149.5	65	3.52	8.22
Suremix 50	V	200	14	94	16	1.35	1.35
	S	200	20.3	87	30	2.55	2.55
	N	200	23	149.5	65	6.45	6.45
Suremix 60	V	180	14	94	16	1.68	1.12
	S	180	20.3	87	30	3.06	2.04
	N	180	23	149.5	65	7.86	5.25

NOTE: Nominal fill weights, pressures and volumes are stated at 15 °C and 1013 mbar.

Table A2-1: BOC SURESERVE - Gas cylinder reference chart

Cylinder Size	Max. Filled Pressure (bar(g))	Carbon Dioxide (m^3)	Nitrogen (m^3)
3.15 kg	50	1.68	Nil
6.35 kg	50	3.39	Nil
12.7 kg	50	6.78	Nil
22.6 kg	50	12.07	Nil
30/70 mixed gas 10 litres	200	0.68	1.59
50/50 mixed gas 10 litres	200	1.39	1.39
60/40 mixed gas 10 litres	180	1.76	1.17
30/70 mixed gas 47/50 litres	200	3.40	7.95
Air Separator Nitrogen Receiver	10	Nil	1.0

NOTE: Nominal fill weights, pressures and volumes are stated at 15 °C and 1013 mbar.

Table A2-2: AIR LIQUIDE - Gas cylinder reference chart

Cylinder Type	Product Name	Max. Filled Pressure (bar(g))	Carbon Dioxide (m^3)	Nitrogen (m^3)
L or K	Topgas CO_2	50	18.14	Nil
MD 30	Topgas CO_2	50	11.5	Nil
PT 10	Topgas CO_2	50	3.8	Nil
L or K	Topgas 30	200	3.23	7.54
MD 30	Topgas 30	200	2.05	4.78
PT 10	Topgas 30	200	0.68	1.59
L or K	Topgas 50	160	5.39	5.39
MD 30	Topgas 50	160	3.43	3.43
PT 10	Topgas 50	160	1.14	1.14
L or K	Topgas 60	160	7.62	5.08
MD 30	Topgas 60	160	4.84	3.23
PT 10	Topgas 60	160	1.61	1.07

NOTE: Nominal fill weights, pressures and volumes are stated at 15 °C and 1013 mbar.

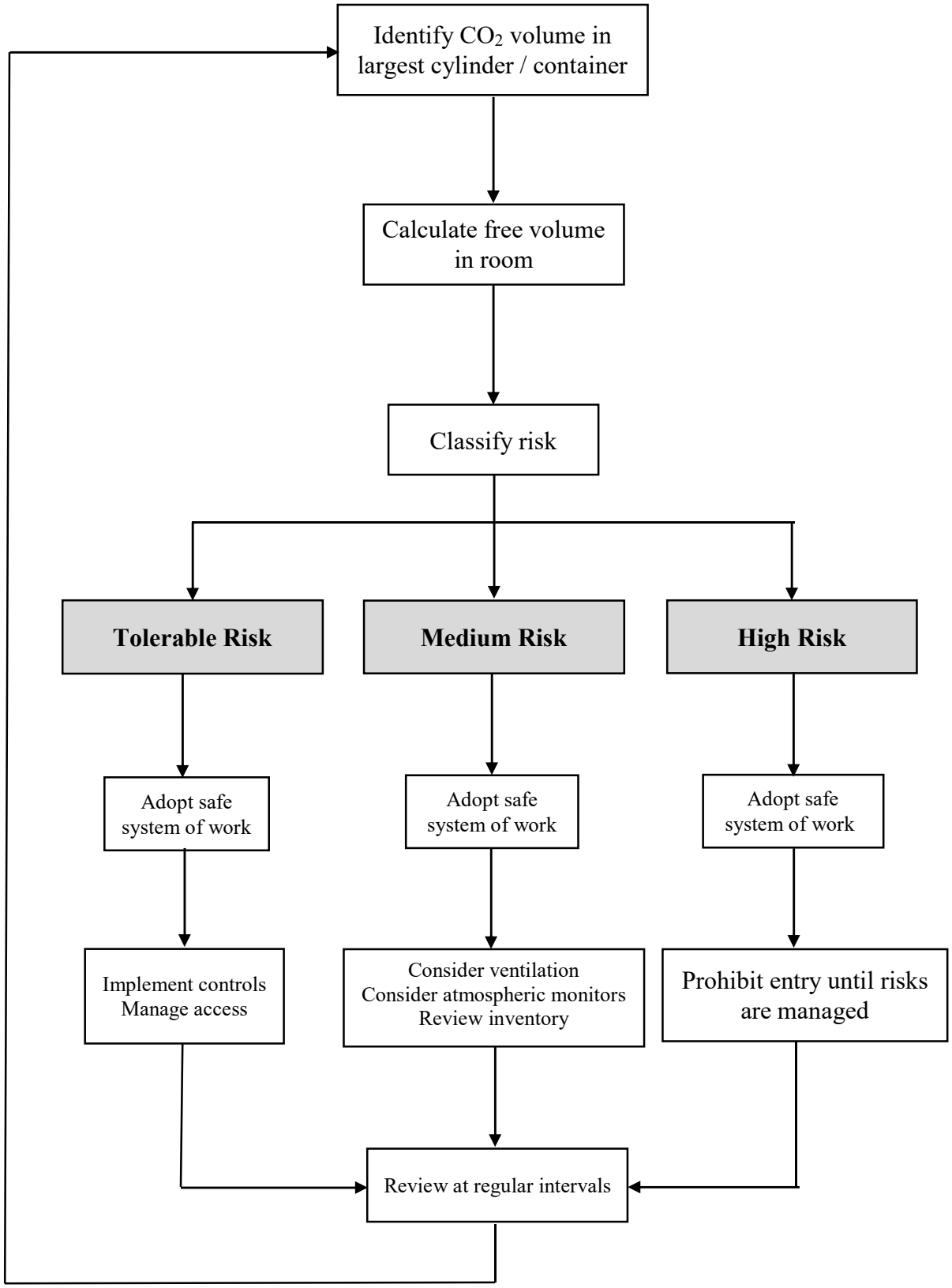
Table A2-3: AIR PRODUCTS - Gas cylinder reference chart

Cylinder Designation	Carbon Dioxide (m^3)	Nitrogen (m^3)
240 litre liquid nitrogen tank	-	157
Prism 30:70 receiver	0.12	0.27
Prism 50:50 receiver	0.19	0.19
10 litre 30:70 mixed gas	0.69	1.6
10 litre 50:50 mixed gas	1.35	1.35
10 litre 60:40 mixed gas	1.68	1.12
3.1 kg CO_2	1.67	-
6.35 kg CO_2	3.42	-
15.0 kg CO_2	8.07	-
50.6 kg CO_2	27.22	-
CarboStore 180 CO_2 tank	113.2	-
CarboStore 270 CO_2 tank	150	-

NOTE: Nominal fill weights, pressures and volumes are stated at 15 °C and 1013 mbar.

Table A2-4: AIR PRODUCTS CRYOEASE SERVICES - Gas cylinder reference chart

GUIDE TO CELLAR GAS RISK REDUCTION



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