

Australian Standard™

**Installation and use of inert gases for
beverage dispensing**



This Australian Standard was prepared by Committee ME-002, Gas Cylinders. It was approved on behalf of the Council of Standards Australia on 26 September 2005.

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The following are represented on Committee ME-002:

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Australasian Institute of Engineer Surveyors
Australia New Zealand Industrial Gas Association
Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Liquefied Petroleum Gas Association
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STANDARDS AUSTRALIA
—
RECONFIRMATION
OF
AS 5034—2005
Installation and use of inert gases for beverage dispensing
—

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Technical Committee ME-002 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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NOTES

Australian Standard™

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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee ME-002, Gas Cylinders. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian, rather than an Australian/New Zealand Standard.

In the preparation of this Standard, significant input from the Beverage Dispensing Industry was made through direct participation in Working Group ME-002-05-03, Inert Gases.

The Committee recognized there was a need to give specific guidance to the designers, installers, users, maintainers, inspectors, hirers and owners of pressurized beverage equipment beyond the general principles of Risk Assessment required in the handling of Dangerous Goods.

The objective of this Standard is to ensure the safety of owners, hirers and users when operating compressed inert gas systems and equipment for beverage dispensing.

Users of this Standard are reminded that it has no legal authority in its own right, but acquires legal standing where adopted by government or other authority having jurisdiction, or if specified as part of a commercial contract.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

NOTE THAT FULL COMPLIANCE WITH THIS STANDARD MAY NOT NECESSARILY FULFIL ALL LEGAL OBLIGATIONS.

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STANDARDS AUSTRALIA

Australian Standard

Installation and use of inert gases for beverage dispensing

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION**1.1.1 Scope**

This Standard specifies the requirements for the design, location and installation, testing, commissioning, safe use and maintenance of the compressed inert gas or refrigerated liquid equipment and reticulated and portable systems necessary to dispense beverages.

NOTE: This Standard does not supersede any 'duty of care' which may be prescribed on owners and users by regulation.

1.1.2 Application

In recognition of this Standard, existing equipment should be assessed for risk, and control measures should be implemented.

Current installed equipment should be updated to conform to this Standard. Compliance improvements should be made within a time frame that takes into consideration the cost of upgrading and the associated risk levels. Where compliance improvements are not associated with significant safety issues it is recommended that they should be implemented as follows:

- (a) Non-naturally ventilated areas, by end of 2007.
- (b) Gas operated pumps requiring exhausting to outside areas, by end of 2007.
- (c) All other areas requiring compliance improvements, by end of 2011.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

| | |
|--------|--|
| 1210 | Pressure vessels |
| 1271 | Safety valves, other valves, liquid level gauges and other fittings for boilers and unfired pressure vessels |
| 1319 | Safety signs for the occupational environment |
| 1349 | Bourdon tube pressure and vacuum gauges |
| 1894 | The storage and handling of non-flammable cryogenic and refrigerated liquids |
| 2030 | The verification filling, inspection, testing and maintenance of cylinders for storage and transport of compressed gases |
| 2030.1 | Part 1: Cylinders for compressed gases other than acetylene |
| 2030.4 | Part 4: Welded cylinders—Insulated |
| 2441 | Installation of fire hose reels |
| 2473 | Valves for compressed gas cylinders (threaded outlet) |

AS

| | |
|--------|---|
| 2832 | Cathodic protection of metals |
| 2832.1 | Part 1: Pipes and cables |
| 2971 | Serially produced pressure vessels |
| 3892 | Pressure equipment—Installation |
| 4041 | Pressure piping |
| 4267 | Pressure regulators for use with industrial compressed gas cylinders |
| 4332 | The storage and handling of gases in cylinders |
| 4484 | Gas cylinders for industrial, scientific, medical and refrigerant use—Labelling and colour coding |
| 4706 | Pressure gauges for regulators used with compressed gas cylinders |
| 4839 | The safe use of portable and mobile oxy-fuel gas systems for welding, cutting, heating and allied processes |
| 4840 | Low pressure regulators for use in industrial compressed gas reticulation systems |

AS/NZS

| | |
|----------|--|
| 1221 | Fire hose reels |
| 1270 | Acoustics—Hearing protectors |
| 1337 | Eye protectors for industrial applications |
| 1596 | The storage and handling of LP Gas |
| 1680 | Interior lighting |
| 1680.2.4 | Part 2.4: Industrial tasks and processes |
| 1715 | Selection, use and maintenance of respiratory protective devices |
| 1716 | Respiratory protective devices |
| 2161 | Occupational protective gloves (series) |
| 2210 | Occupational protective footwear |
| 2210.1 | Part 1: Guide to selection, care and use |
| 2210.2 | Part 2: Requirements and test methods |
| 2430 | Classification of hazardous areas (series) |
| ACTDG | (Australian Committee for the Transport of Dangerous Goods) |
| ADG Code | Australian Dangerous Good Code |
| NOHSC | National Occupational Health and Safety Commission |
| 1003 | Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment |
| 1010 | National Standard for Plant |
| 3009 | Guidance Note for Placarding Stores for Dangerous Goods and Specified Hazardous Substances |

1.3 DEFINITIONS

For the purposes of this Standard, the definitions given in AS 2030.1 and those below apply.

1.3.1 Asphyxia

The condition that arises when the blood is deprived of an adequate supply of oxygen; loss of consciousness and death can result from the brain being starved of oxygen.

1.3.2 Asphyxiant

A gas or vapour which, when present in sufficient concentration, excludes oxygen and leads to asphyxia. Death may be almost immediate if all oxygen is excluded.

1.3.3 Bottled wine dispensing

A dispensing application for wine where an inert gas at low pressure is used to transfer the wine from its bottle to the dispensing valve.

1.3.4 Cellar

A general storage area for beer, ready to drink kegs and other materials.

1.3.5 Compressed air supply back up

An alternative to compressed air supply, usually carbon dioxide under regulated pressure.

1.3.6 Cool room

A refrigerated, enclosed room used to chill beer and ready to drink kegs. Also known as a cold room.

1.3.7 FCB (frozen carbonated beverage)

A dispensing application for soft drinks which mixes and freezes a syrup and water containing carbon dioxide dissolved under pressure.

1.3.8 Gas mixer

Equipment supplied with two or more inert gases and intended to deliver a mixed gas in a desired ratio.

1.3.9 High pressure

Pressure in excess of 2400 kPa used for supply systems, e.g. gas cylinder pressures and those in certain storage tanks.

1.3.10 Inert gas

A non-toxic, non-flammable gas in Class 2.2 in the ADG Code, without any subsidiary risk. This definition is deemed to include carbon dioxide, nitrogen, argon and air.

1.3.11 Low pressure

In this Standard, regulated pressures not exceeding 2400 kPa used for distribution systems.

1.3.12 Multiple cylinder supply

An inert gas supply system consisting of two or more compressed gas cylinders or a bundle of cylinders connected together and control equipment intended to supply a distribution system according to this Standard.

1.3.13 On site gas generation

An inert gas supply system consisting of nitrogen generators, gas mixers, and control equipment intended to supply a distribution system according to this Standard.

1.3.14 Post-mix

A dispensing application for beverages which mixes at the dispensing valve a syrup with water containing carbon dioxide dissolved under pressure and where the carbon dioxide also provides the pressure to transfer the water to the dispensing valves.

1.3.15 Pressurized beverage storage vessel

A dispensing application where the beverage is held in a keg pressurized with an inert gas or gas mixture to maintain carbonation, and where the inert gas or gas mixture also provides the pressure to transfer the beverage to the dispensing valves. The beverage may be beer or other ready to drink beverage in kegs.

1.3.16 Ready to drink (pre-mix)

A dispensing application for beverages which mixes in a tank a syrup with water containing carbon dioxide dissolved under pressure before piping it by action of the carbon dioxide pressure to the dispensing valve.

1.3.17 Refrigerated liquid CO₂ supply

An inert gas supply system consisting of a refrigerated liquid CO₂ storage tank, vaporizer and control equipment intended to supply CO₂ gas to a distribution system according to this Standard.

NOTE: In this Standard, cryogenic storage vessels are included in this definition.

1.3.18 Regulator board

Part of a distribution system consisting of two or more pressure regulators with high pressure supply and where each regulator supplies its own regulated low pressure pipe system.

1.3.19 Shall

Indicates that a statement is mandatory.

1.3.20 Should

Indicates a recommendation.

1.3.21 Single cylinder supply

An inert gas supply system consisting of a single compressed gas cylinder and control equipment intended to supply a distribution system according to this Standard.

SECTION 2 COMPRESSED INERT GAS SYSTEM DESIGN

2.1 GENERAL AND BACKGROUND

Accidents have occurred in the dispensing of beverages due to lack of understanding of the potential damage high pressure inert gases can cause. High pressure cylinders in the supply systems for beverage dispensing can apply pressures up to 24 000 kPa. Without well designed, installed, managed and maintained pressure regulation systems and pressure relief devices, and use in accordance with safe practices, such systems could be dangerous or difficult to operate safely.

NOTE: The gas supply industry refers to the pressure in a gas cylinder under 'settled' conditions at a temperature of 15°C. However, the pressure in a full compressed gas cylinder or in a partially full liquefied gas cylinder can be higher if it is exposed to higher ambient temperatures or directly to the sun for several hours. A nitrogen cylinder filled to a maximum pressure of 20 000 kPa at 15°C may exert about 24 000 kPa at 50°C and this is used as the maximum working pressure (MWP). For carbon dioxide, a liquefied gas, this effect is higher, and although at 15°C the pressure in the cylinder is about 5000 kPa, a MWP of 21 000 kPa needs to be used. See Clause 2.3.1.2.

Due to all gas systems being under pressure, it is possible that the system and equipment connections may develop leaks, causing a build up of inert gases in cellars and low level areas with the real possibility of asphyxia leading to collapse and death of personnel working in these areas.

For the purposes of this Standard, compressed inert gas systems have been divided into supply systems (Clause 2.3), distributions systems (Clause 2.4) and dispensing applications (Clause 2.5), according to Table 2.1.

TABLE 2.1
INERT GAS SYSTEMS FOR BEVERAGE DISPENSING

| Supply systems (Operation at gas cylinder or storage tank pressure, see Clauses 2.3.1.2 and 2.3.2.2) | Distribution systems (Operation at regulated pressure not exceeding 2400 kPa, see Clause 2.4.1.2) | Dispensing applications (Operation at regulated pressure not exceeding 800 kPa for post-mix or 400 kPa for beer dispensing, see Clause 2.5.1.2) |
|---|---|---|
| Cylinders (single and multiple) | Regulator boards | Post mix |
| Refrigerated liquid CO ₂ supply | Safety devices | FCB (frozen carbonated beverages) |
| On-site gas generation and mixing | Piping | Ready to drink (pre-mix) |
| Compressed air | | Bottled wine dispensing |
| | | Draught beer and ready to drink kegs |

NOTE: Separation between systems is at the respective pressure reduction points.

2.2 REQUIREMENTS COMMON TO ALL INERT GAS SYSTEMS

2.2.1 Materials for inert gas systems

2.2.1.1 Material specification

Materials used in cylinder supply systems shall be compatible with the supply gas at the maximum developed pressure and temperature of the cylinder contents.

2.2.1.2 Piping

All piping shall be copper or copper alloys, stainless steel or other materials that have been proven suitable for service with the supply gas at the maximum working pressure.

Distribution piping for inert gas systems shall be selected from the following:

- (a) Stainless steel (cleaned and degreased).
- (b) Copper and copper alloys (refrigeration grade).
- (c) Food grade polymers (UV stabilized where appropriate, e.g. in sun-affected areas).

NOTE: Materials should be clean for food service.

2.2.1.3 Non-metallic materials

All non-metallic materials used in the construction of inert gas and inert gas mixture supply systems shall be chosen with extreme care due the effect these inert gases, especially carbon dioxide at high pressure, have on certain materials, such as leaching of plasticizers and explosive decompression.

2.2.1.4 Jointing materials

All jointing material used shall be suitable for use with the supply gas at the maximum working pressure, e.g. oil-free PTFE tape. Joints may be silver-soldered for high pressure service, or silver-soldered or brazed for low pressure service. Consideration should be given to the use of fluxless brazing or a post-installation cleaning operation.

2.2.2 Operating temperature

The operating temperature range for all materials and equipment used in the system shall be -20°C to 50°C .

NOTE: Where Refrigerated Liquid CO_2 prior to vaporization is involved, a minimum temperature of -80°C should be assumed.

2.2.3 Pressure relief devices

2.2.3.1 General

A pressure relief device shall be provided for the low pressure side of all supply systems to protect connected equipment.

NOTE: The position of the pressure relief device depends on the particular application.

Pressure relief devices for the high pressure side of the cylinder supply system are optional.

NOTE: Pressure regulators may be fitted with pressure relief devices to protect them against minor component failures. Such devices should not be considered pressure relief devices for the protection of downstream equipment, including the equipment to which they are attached.

2.2.3.2 Design

Pressure relief devices shall be designed, manufactured and installed in order to minimize tampering, maladjustment or the fitting of inferior replacement parts. Pressure relief devices shall comply with AS 1271.

Pressure relief devices shall not start to open below 1.1 times the maximum working pressure (MWP) of the piping system to which they are connected and shall be fully open at 1.25 times the MWP.

Pressure relief devices shall be sized so that they are capable of venting excess gas in order to ensure that the pressure of the piping system to which they are connected does not exceed 1.25 times the MWP for the maximum flow in failed condition at maximum supply pressure of the pressure regulator feeding the piping system.

NOTE: The maximum flow in failed condition of the pressure regulator should be obtained from the manufacturer.

Where pressure relief devices are located in non-naturally ventilated areas, consideration shall be given to their discharge to an outside safe area. If vent piping is used, it shall be sized in a way that will not decrease the rated capacity of the pressure relief devices.

2.2.3.3 *Pressure relief devices for beer and keg systems*

For the protection of the beverage dispensing system each pressurized beverage storage vessel shall be provided with a pressure relief device fitted in the piping system and adjacent to the pressure regulator (see Clause 2.5.2.5).

The pressure relief device shall not start to open below 1.1 times the MWP of the piping system supplying the beer and keg system, which for the purpose of this Standard is 400 kPa or 0.8 times the design pressure of the beverage storage vessel, whichever is the lesser, and shall be fully open at a pressure not exceeding 1.1 times the design pressure of the beverage storage vessel (see Table 2.2).

TABLE 2.2
PRESSURE RELIEF DEVICE SETTINGS

| Pressures as percentage of the beverage storage vessel design pressure | |
|--|------|
| Maximum full discharge of the pressure relief device | 110% |
| Design pressure of the beverage storage vessel | 100% |
| Minimum opening pressure of the pressure relief device | 88% |
| Maximum working pressure of the piping system | 80% |

The capacity of the pressure relief device shall be such that at the maximum inlet pressure of the supply system and for the maximum flow in failed condition of the pressure regulator supplying the piping system, the pressure in the beverage storage vessel shall not exceed 1.1 times its design pressure as required in AS 2971.

NOTE: The maximum flow in failed condition of the pressure regulator should be obtained from the manufacturer.

The pressure relief device shall be capable of preventing overpressure to the beverage storage vessel taking into account the possible freezing and consequent clogging which can occur in the piping system during the operation of a beverage dispensing system.

2.2.3.4 *Installation, testing and certification*

The manufacturer or supplier shall provide a proof certificate of the performance of the pressure relief device to the owner.

The installation of pressure relief devices shall be in accordance with AS 3892 or manufacturer's recommendations. Each pressure relief device shall be given a unique identification and its location within the inert gas system shall be recorded.

New or serviced pressure relief devices shall be assessed by a competent person prior to installation and assembly in the piping system to ensure that the device integrity has not changed during transport or storage.

2.2.4 **Pressure regulators**

Pressure regulators shall comply with AS 4267 for connection to gas cylinders or with AS 4840 for connection to regulated pressure supply not exceeding 2400 kPa.

High pressure regulators supplying a low pressure regulator shall not deliver a pressure in excess of 2400 kPa.

Regulators supplying a distribution system or gas line without further pressure reduction stages shall NOT be capable of being adjusted to deliver a pressure in excess of 400 kPa (beer and keg systems, see Clauses 2.2.3.3 and 2.5.1.2) or 800 kPa (post-mix systems, see Clause 2.5.1.2).

Low pressure outlet connections from the high pressure supply and inlet connections to piping shall be such that the direct connection of high pressure gas to low pressure piping systems cannot occur.

NOTE: Connections which can be made or unmade in the normal operation of the system should be those from AS 2473 for the respective gas at cylinder pressure and from AS 4840 for the respective gas at lower pressure.

2.2.5 Pressure gauges

Bourdon tube gauges shall comply with either AS 1349 or AS 4706.

2.2.6 Installation and labelling

Manufactured sub-systems and components of the inert gas system shall be delivered from their manufacturer or supplier cleaned, sealed and intended for use with the supply gas.

All inert gas systems shall be installed according to the requirements of Section 5 and commissioned prior to first use or following any modification or change made to them.

Labels shall be affixed on or near the different parts of the inert gas system which are in accordance with NOHSC 1010.

2.2.7 Operation and maintenance

Supply systems shall be operated and maintained in accordance with Section 6.

2.3 SUPPLY SYSTEMS

2.3.1 Cylinder supply, single and multiple

2.3.1.1 General

Cylinder supply systems may be single- or multi-cylinder, single or double bank, with automatic, semi-automatic, or manual changeover, may be fitted with single or multiple primary regulating devices and be connected to cylinders directly or by means of flexible connectors.

The outlet pressure of a cylinder supply system to the distribution system shall be regulated. The pressure regulating devices may be built into the supply system or the supply system may be fitted with a high pressure outlet which complies with AS 2473 for direct fitment of separate pressure regulators. However, once the supply system is installed and commissioned, all pressure regulators attached to such an outlet becomes an integral part of the supply system.

Systems shall comply generally with Figures 2.1 or 2.2 as appropriate.

2.3.1.2 Maximum working pressure (MWP)

The maximum working pressure (MWP) of the cylinder supply system shall be not less than

2.3.1.4 *Connections*

Any cylinder connection which can be made or unmade in the normal operation of the supply system shall comply with AS 2473 for the respective gas or gas mixture.

2.3.1.5 *Non-return devices*

Where more than one cylinder is to be connected, a non-return device shall be fitted to each flexible connector attachment point on the supply system to minimize loss of supply in case of a flexible connector failure or rapid backflow to an inadvertently connected empty cylinder (see Figure 2.2). This non-return device is optional for single cylinder supply. The maximum return flow allowed at the maximum inlet pressure is 0.5 L/min.

NOTE: A non-return device should be fitted to the outlet of the primary regulating devices of some dispensing applications to prevent the possible backflow of syrups or beer (see Figures 2.7, 2.8, 2.9, 2.10, 2.12 and 2.13).

2.3.1.6 *Isolation valves*

For multiple cylinder supply, there shall be a manual isolation valve between each cylinder bank and the primary pressure regulating device or devices (see Figure 2.2). For single cylinder supply, if the cylinder is connected to the primary regulating device via a flexible lead there should be a manual isolation valve between the flexible lead and the primary regulating device (see Figure 2.1).

2.3.1.7 *High pressure flexible connectors*

High pressure flexible connectors shall not exceed 2 m in length for cylinder supply and 3 m for bundle/pack supply. They shall be fitted with protection against whipping in case of rupture, e.g. safety cables.

NOTE: Consideration should be made of fitting inlet filters to high pressure flexible leads to minimize carrying particles and contamination towards pressure regulator seat mechanisms. A maximum opening of 63 µm for such filters has been found acceptable.

2.3.1.8 *Supply system dimensions*

For single cylinder supply, the pipe length between any cylinder and the supply system isolation valve if fitted, or the primary regulator if no isolation valve is fitted, inclusive of the flexible connector, shall not exceed 5 m.

For multiple cylinder supply, the pipe length between any cylinder and the supply system isolation valve, inclusive of the flexible connector, shall not exceed 5 m.

2.3.1.9 *Pressure regulation*

All supply systems shall provide either a means for pressure regulation or an outlet connection designed for fitment of a pressure regulator.

The outlet of the primary pressure regulator and inlet connections to piping shall be such that the direct connection of high pressure gas to low pressure piping cannot occur.

2.3.1.10 *Testing*

The assembled supply system shall be tested pneumatically at a pressure between 85% and 100% of the MWP of the supply system using oil-free inert gas or oil-free air. There shall be no discernible leakage when using a suitable leak-detection solution.

Any connection made or unmade prior to the use of a new supply system shall be tested in accordance with this Clause.

2.3.2 Refrigerated liquid carbon dioxide supply

2.3.2.1 General

A refrigerated liquid carbon dioxide supply system shall deliver a regulated pressure to the distribution system.

Systems should comply generally with Figure 2.3.

2.3.2.2 Maximum working pressure

The maximum working pressure (MWP) of all equipment connected to the refrigerated liquid storage system shall be not less than the rated pressure of the pressure relief device fitted to the system.

2.3.2.3 Isolation valve

There shall be a manual isolation valve between the refrigerated liquid carbon dioxide system and either the primary pressure regulating device, if one is fitted, or the distribution system.

NOTE: The use of an automatic low-temperature shutoff valve or a maximum flow restriction system downstream of the vaporizer is recommended to prevent damage to downstream equipment. A risk assessment should determine whether it is required.

2.3.2.4 Pressure regulation

If the outlet pressure from the supply system can exceed 2400 kPa a pressure regulator not capable of being adjusted to deliver an outlet pressure exceeding 2400 kPa shall be fitted to the outlet of the supply system. The outlet of the pressure regulator and inlet connections to piping shall be such that the direct connection of high pressure gas to low pressure piping cannot occur.

If the outlet pressure from the supply system is controlled within the system not to exceed 2400 kPa, and the distribution system incorporates a downstream pressure reduction stage, the supply system may be connected directly to the distribution system without the need for an intermediate high pressure regulator.

If the supply system is connected to a distribution system without further pressure reduction stages it shall NOT be capable of being adjusted to deliver a pressure in excess of 400 kPa (beer and keg systems, see Clauses 2.2.3.3 and 2.5.1.2) or 800 kPa (post-mix systems, see Clause 2.5.1.2).

2.3.2.5 Pressure relief device

A pressure relief device shall be incorporated in the supply system to ensure the outlet pressure does not exceed the pressure according to Clause 2.3.2.4.

Pressure relief devices shall be vented according to Clause 5.1.3.7.

2.3.2.6 Testing

The assembled supply system shall be tested pneumatically at the MWP of the assembled supply system using oil-free inert gas or oil-free air. There shall be no discernible leakage when using a suitable leak-detection solution.

2.3.3 On site gas generation and mixing

Systems should comply generally with Figure 2.4.

Cylinder supply, if used, shall comply with Clause 2.3.1. Refrigerated liquid CO₂ supply, if used, shall comply with Clause 2.3.2.

The outlet pressure of the gas mixer shall comply with Clause 2.3.2.4.

2.3.4 Compressed air

Systems should comply generally with Figure 2.5 and be installed according to the instructions of the manufacturer or supplier.

In systems with backup from a carbon dioxide supply, a three way valve shall be used to connect the backup supply to avoid feeding carbon dioxide to the air receiver or air into the carbon dioxide supply system. The exhaust from any beverage dispensing pump which may be driven by carbon dioxide shall be vented to a safe, naturally well ventilated location.

2.4 DISTRIBUTION SYSTEMS

2.4.1 Regulator boards

2.4.1.1 *General design*

Regulator boards may have high inlet pressure supply or low inlet pressure supply and shall comply generally with Figure 2.6. If high inlet pressure supply is used, it shall comply with Clause 2.3.1.

All inlet and outlet connections in the regulator board shall be such that direct connection of high pressure gas to low pressure piping or gas lines cannot occur.

NOTE: Connections which can be made or unmade in the normal operation of the system should be those from AS 2473 for the respective gas at cylinder pressure and from AS 4840 for the respective gas at lower pressure

2.4.1.2 *Pressure regulation*

High inlet pressure regulators supplying a low inlet pressure regulator shall not deliver a pressure in excess of 2400 kPa.

Regulators supplying a piping system without further pressure reduction stages shall NOT be capable of being adjusted to deliver a pressure in excess of 400 kPa (beer and keg systems, see Clause 2.2.3.3) or 800 kPa (post-mix systems).

2.4.1.3 *Interconnection piping*

All pressure piping in the board shall comply with AS 4041, e.g. pipes and pipe fitting should be rated for the maximum working pressure and certified by the manufacturer. Special consideration should be given to leak testing when high pressure compression fittings are used.

2.4.2 Distribution piping

2.4.2.1 *Design*

Pipe diameters shall be chosen so as to keep the pressure drop as low as practicable in order not to restrict the maximum flow from the system.

2.4.2.2 *Maximum working pressure*

If the piping system supplies a second pressure reduction stage, its maximum working pressure (MWP) shall be 2400 kPa.

If the piping system supplies beverage dispensing equipment directly without a second pressure reduction stage, its maximum working pressure (MWP) shall be 400 kPa (beer and keg systems, see Clause 2.2.3.3) or 800 kPa (post-mix systems).

2.4.2.3 *Inlet connection*

The inlet connection to the piping system, where it is intended to be connected to the supply system or control arrangement, shall be such that connection of high pressure gas to low pressure gas cannot occur.

NOTE: Connections which can be made or unmade in the normal operation of the system should be those from AS 2473 for the respective gas at cylinder pressure gas and from AS 4840 for the respective gas at lower pressure.

2.4.2.4 *Isolation valves*

Isolation valves shall be fitted at the beginning of a main line or a principal branch, shall be positioned to enable ease of operation and shall be identified as to its use.

NOTE: All valves installed should be of a type suitable for use with the supply gas.

2.4.2.5 *Labelling*

The piping systems shall be identified (see Clause 3.2.6.4).

2.5 DISPENSING APPLICATIONS

2.5.1 Requirements common to all dispensing applications

2.5.1.1 *Design*

Each dispensing application connection point to the distribution system shall be provided with a manual isolation valve suitable for service with the supply gas at the pipeline maximum working pressure.

If the distribution system supplies gas at pressures greater than 400 kPa (beer and keg systems, see Clause 2.2.3.3) or 800 kPa (post-mix systems), the connection to the distribution system shall incorporate a pressure regulator.

If the distribution system supplies gas at pressures less than 400 kPa (beer and keg systems, see Clause 2.2.3.3) or 800 kPa (post-mix systems), the dispensing application connection to the distribution system should comply with AS 4840.

2.5.1.2 *Pressure regulation*

Pressure regulators shall NOT be capable of being adjusted to deliver a pressure in excess of 400 kPa (beer and keg systems, see Clause 2.2.3.3) or 800 kPa (post-mix systems).

If a low inlet pressure regulator is not intended to be readily detachable, its inlet connection may be other than that specified in AS 4840 but in no case shall it be a high pressure connection or those specified in AS 2473 for the supply gas, i.e. not to Types 10, 30, 50 or 60.

2.5.1.3 *Pressure relief devices*

If a dispensing application unit is connected to pressurized beverage storage vessels, each vessel shall be protected by a pressure relief device appropriate to the vessel design pressure (see Clause 2.2.3.3).

2.5.2 Particular requirements for dispensing applications

2.5.2.1 *Post mix (mixed at the point of dispensing)*

Post mix applications should comply generally with Figures 2.7 and 2.8 as appropriate.

The CO₂ supply to the carbonator shall be fitted with at least one non-return device, either inline or built into the carbonator.

The exhaust from any pump where carbon dioxide may be used as the supply gas shall be vented to a safe location.

2.5.2.2 *FCB (frozen carbonated beverage) applications*

FCB applications should comply generally with Figure 2.9 and where appropriate, with Clause 2.5.2.1.

2.5.2.3 *Ready to drink (pre-mix)*

Ready to drink applications should comply generally with Figure 2.10.

The CO₂ supply to the pre-mix tank shall be fitted with a non-return device and an isolation valve.

The pre-mix tank shall be supplied with its own pressure relief device.

The exhaust from any pump where carbon dioxide may be used as the supply gas shall be vented to a safe location.

2.5.2.4 *Bottled wine dispensing*

Bottled wine dispensing applications should comply generally with Figure 2.11.

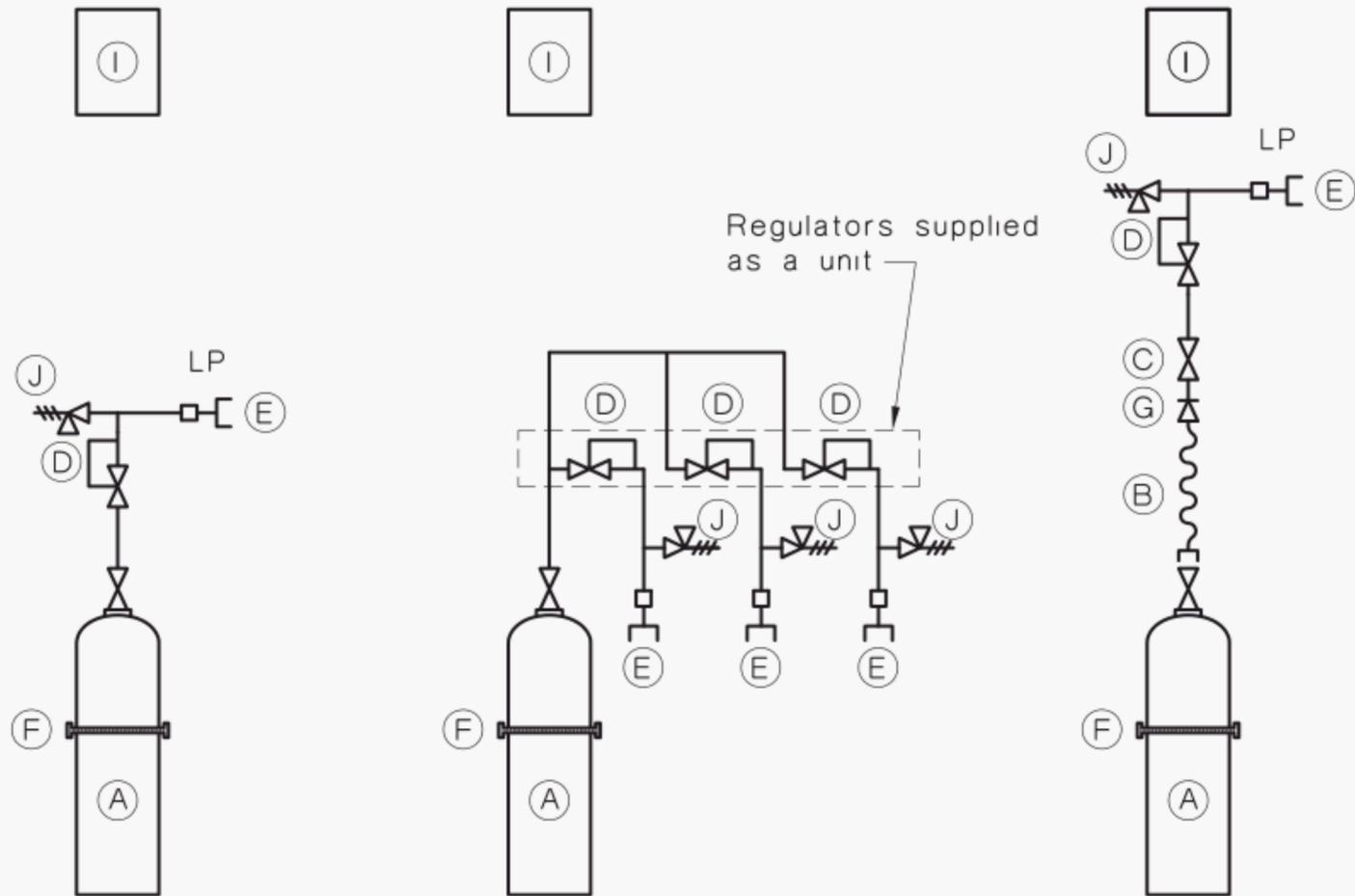
A pressure relief device set no higher than 10 kPa shall be fitted to the piping system supplying the wine bottles.

2.5.2.5 *Draught beer and ready to drink kegs*

Draught beer and ready to drink kegs should comply generally with Figures 2.12 and 2.13 as appropriate.

The outlet of the pressure regulator shall be fitted with a pressure relief device (see Clause 2.5.1.3) and a non-return valve. An isolation valve shall be fitted to the supply to each keg or set of kegs, either at the inlet of the pressure regulator or between the non-return valve and the keg coupling.

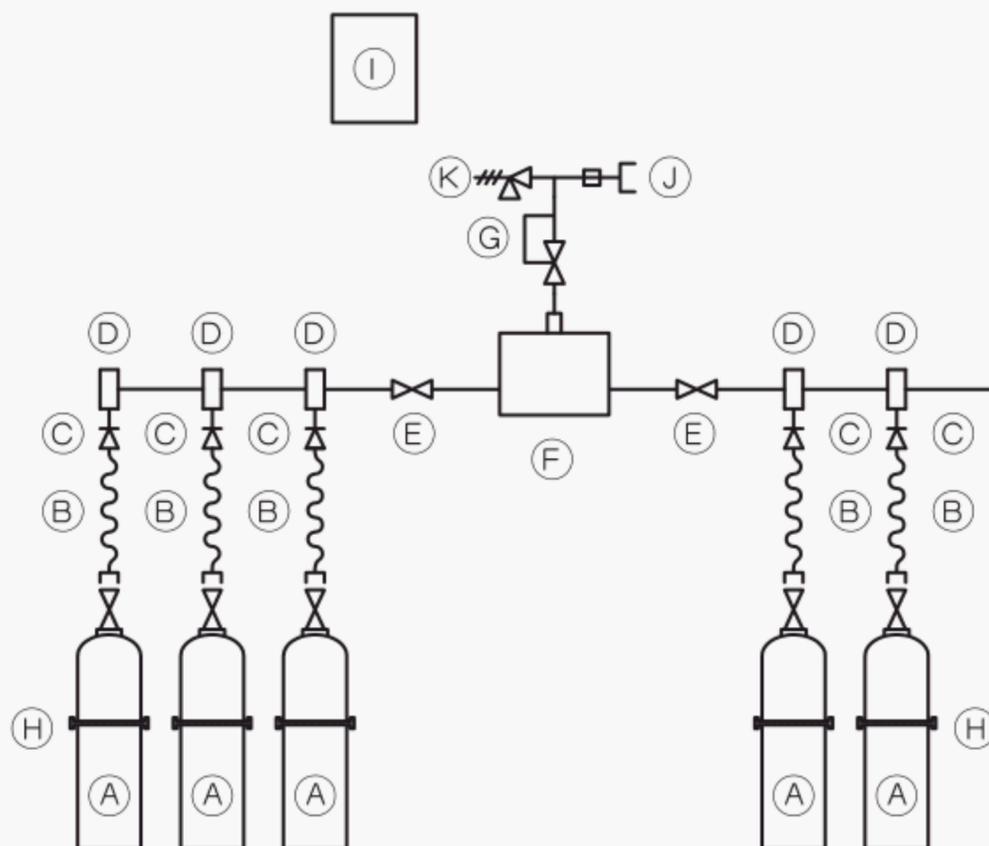
If the pressure regulator supplies multiple kegs, the lines to each keg shall be fitted with additional isolation valves.



LEGEND

- A = High pressure gas cylinder c/w cylinder valve with AS 2473 outlet connection
- B = High pressure flexible lead max length 2m
- C = High pressure inlet valve (optional)
- D = Single or multiple high pressure regulator(s), c/w inlet connection to AS 2473, max outlet pressure 2400 kPa, high pressure contents gauge and low pressure gas delivery gauge
- E = Outlet connection from regulator
- F = Cylinder restraint installed approx 2/3 of the height of cylinder (recommended)
- G = Non-return valve (optional)
- I = Operating instructions
- J = Pressure relief valve (See Clause 2.2.3.1)

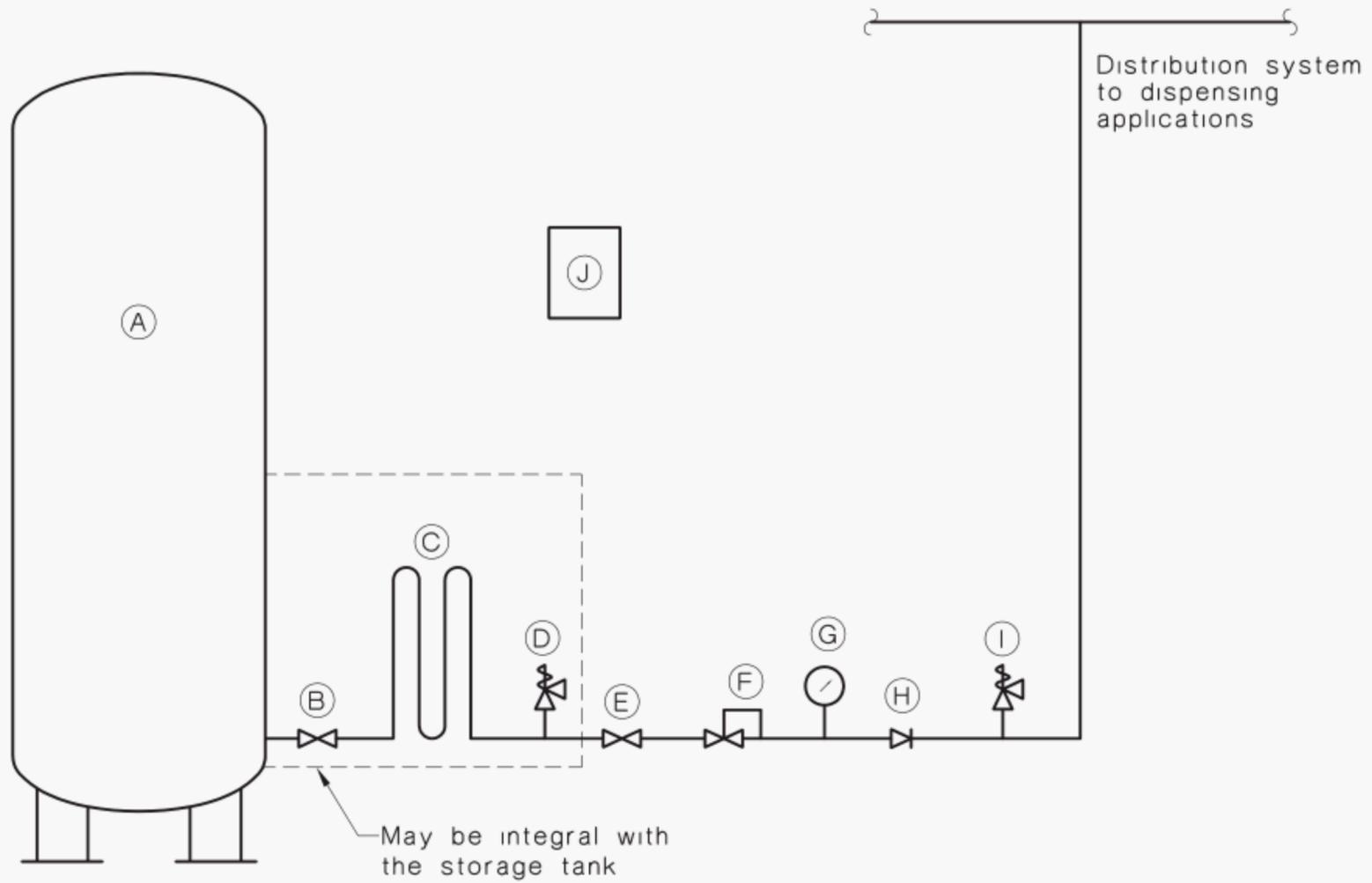
FIGURE 2.1 SINGLE CYLINDER SUPPLY



LEGEND:

- A = High pressure gas cylinder c/w cylinder valve with AS 2473 outlet connection
- B = High pressure flexible lead max. length 2 m for cylinders or 3 m for bundles/packs
- C = Non-return valve
- D = High pressure mounting block
- E = Isolation valve
- F = Regulator mounting block
- G = Single or multiple high pressure regulator(s) c/w inlet connection to AS 2473, max. outlet pressure 2400 kPa high pressure contents gauge, low pressure gas delivery gauge and fitted with pressure relief valve. (Control arrangement for cylinder bank switching permitted)
- H = Cylinder restraint installed approx. 2/3 of the height of cylinder (recommended)
- I = Operating instructions
- J = Outlet connection from regulator to the dispensing applications
- K = Pressure relief valve

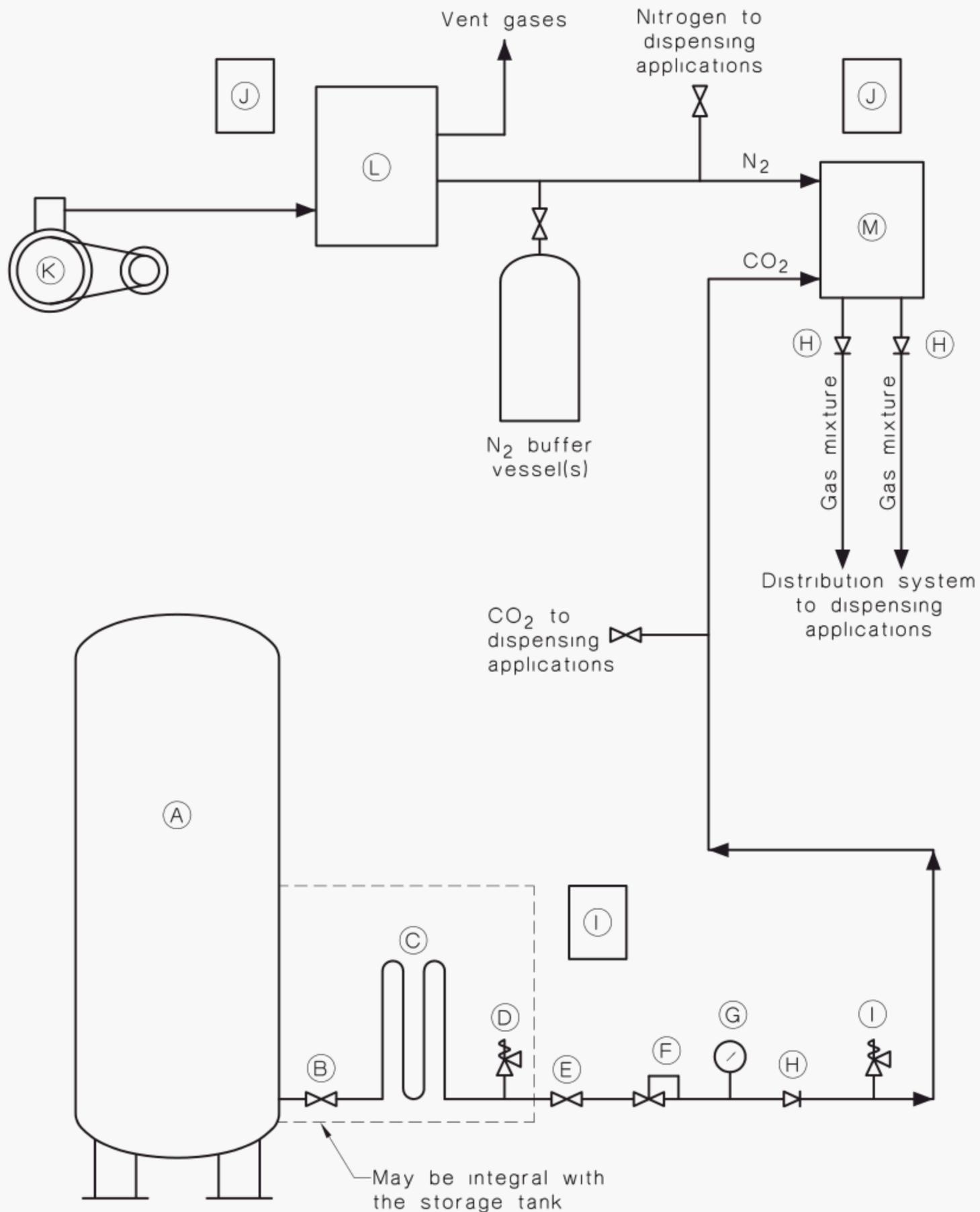
FIGURE 2.2 MULTIPLE CYLINDER OR BUNDLE/PACK SUPPLY



LEGEND

- A = Refrigerated liquid CO₂ storage tank
- B = Liquid isolation valve
- C = Liquid vaporiser
- D = Line safety relief valve (thermal)
- E = Pipeline isolation valve
- F = Gas pipeline regulator, max outlet pressure 2400 kPa (See Clause 2.3.2.4)
- G = Pipeline pressure gauge (can be fitted to regulator)
- H = Non-return valve
- I = Line safety relief valve
- J = Operating instructions

FIGURE 2.3 REFRIGERATED CO₂ SUPPLY



LEGEND

- A = Refrigerated liquid CO₂ storage tank
- B = Liquid isolation valve
- C = Liquid vapouriser
- D = Line safety relief valve
- E = Pipeline isolation valve
- F = Gas pipeline regulator, max outlet pressure 2400 kPa (See Clause 2.3.2.4)
- G = Pipeline pressure gauge (can be fitted to regulator)
- H = Non-return valve
- I = Line safety relief valve
- J = Operating instructions
- K = Air compressor
- L = Molecular sieve, PSA plant or membrane technology
- M = Gas mixer

FIGURE 2.4 ON SITE GAS GENERATION WITH REFRIGERATED LIQUID CO₂ TANK AND MIXERS

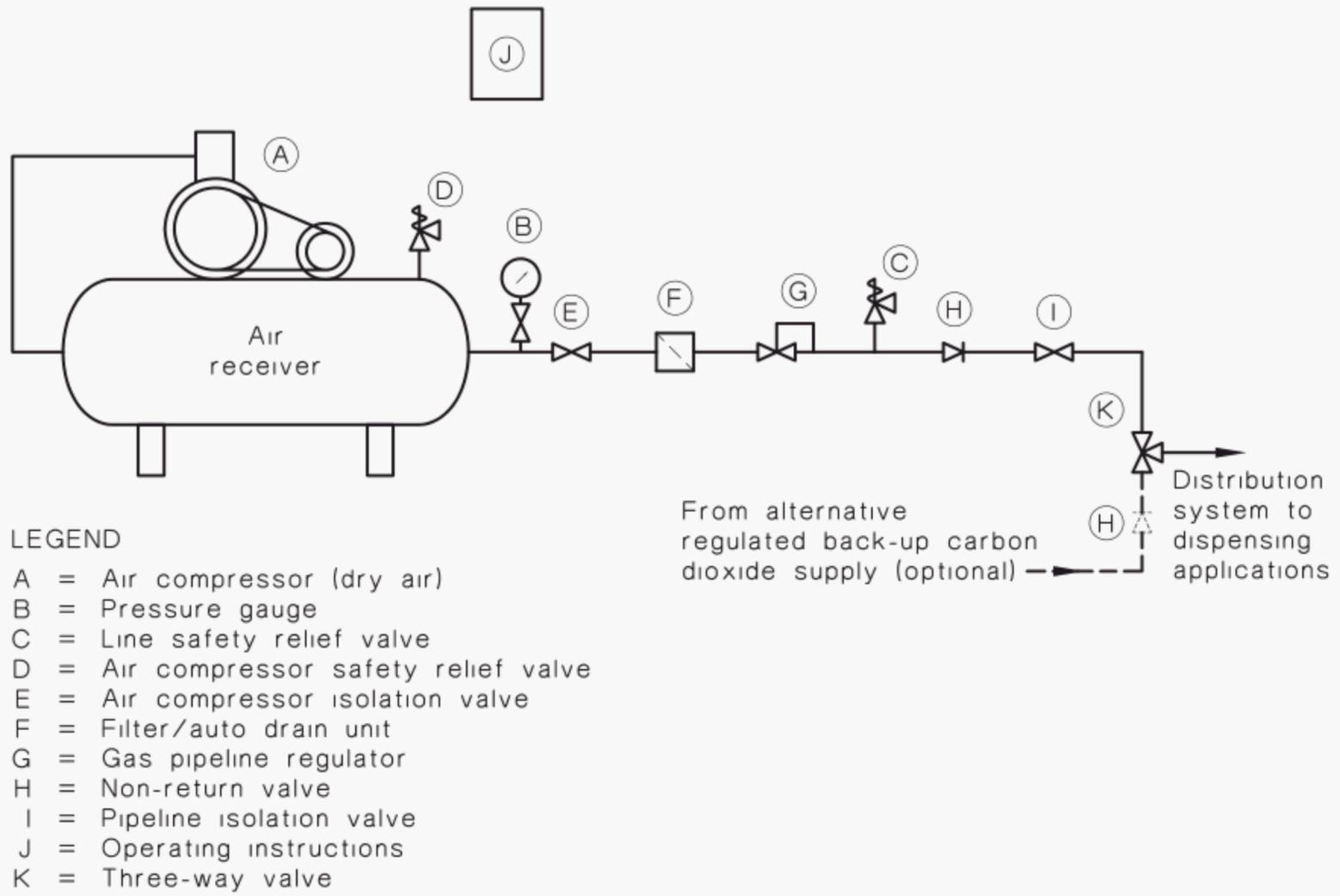
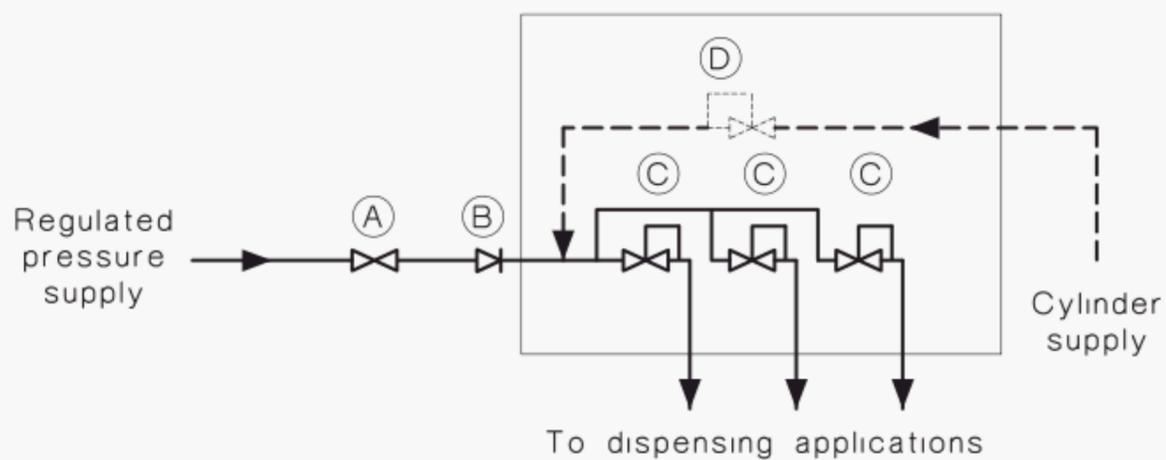


FIGURE 2.5 COMPRESSED AIR SUPPLY



- LEGEND
- A = Isolation valve
 - B = Non-return valve
 - C = Low inlet pressure regulators
 - D = Optional high pressure regulator from cylinder supply (see Figure 2 1)

FIGURE 2.6 REGULATOR BOARD

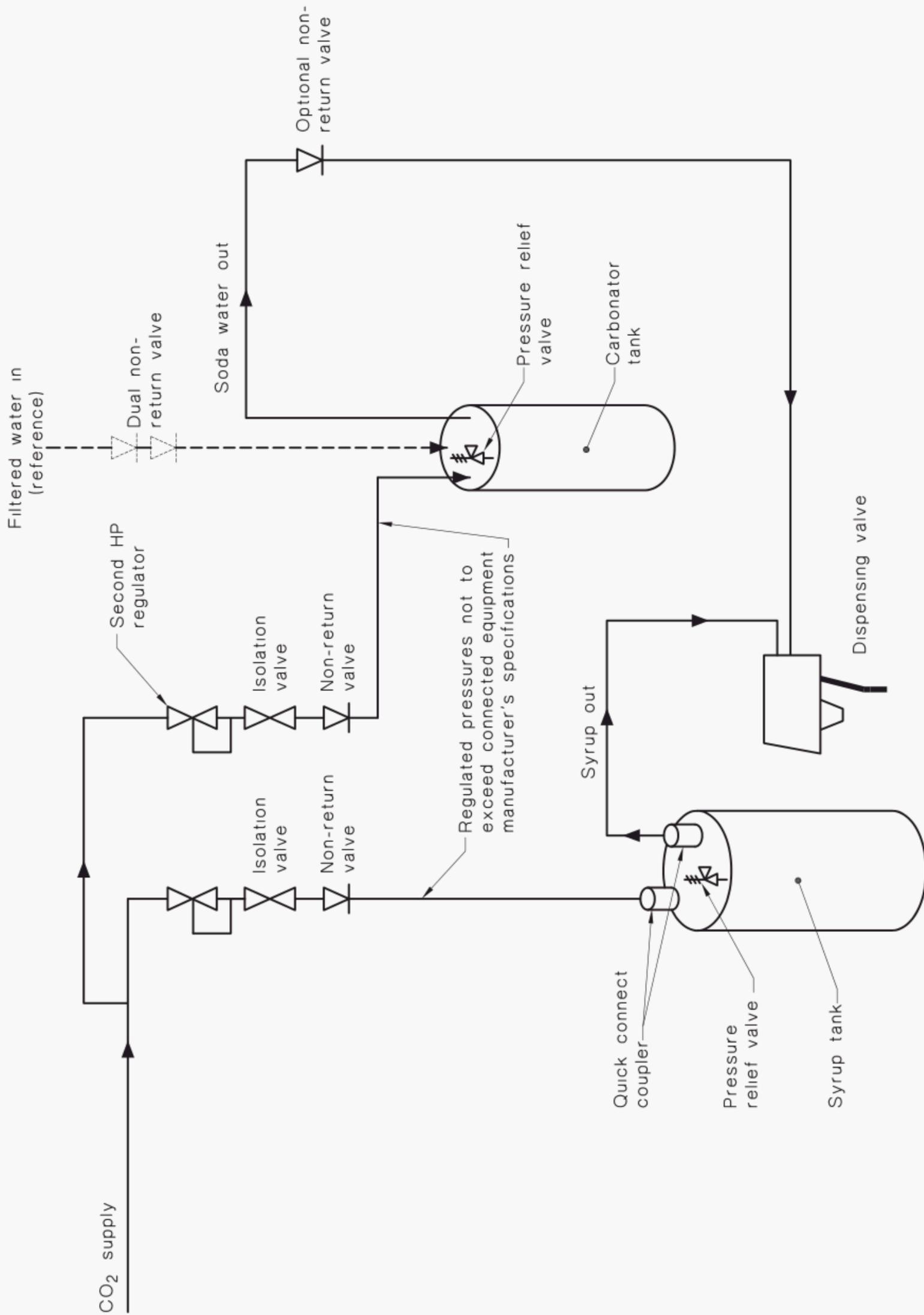


FIGURE 2.7 POSTMIX SYSTEM USING SYRUP TANKS

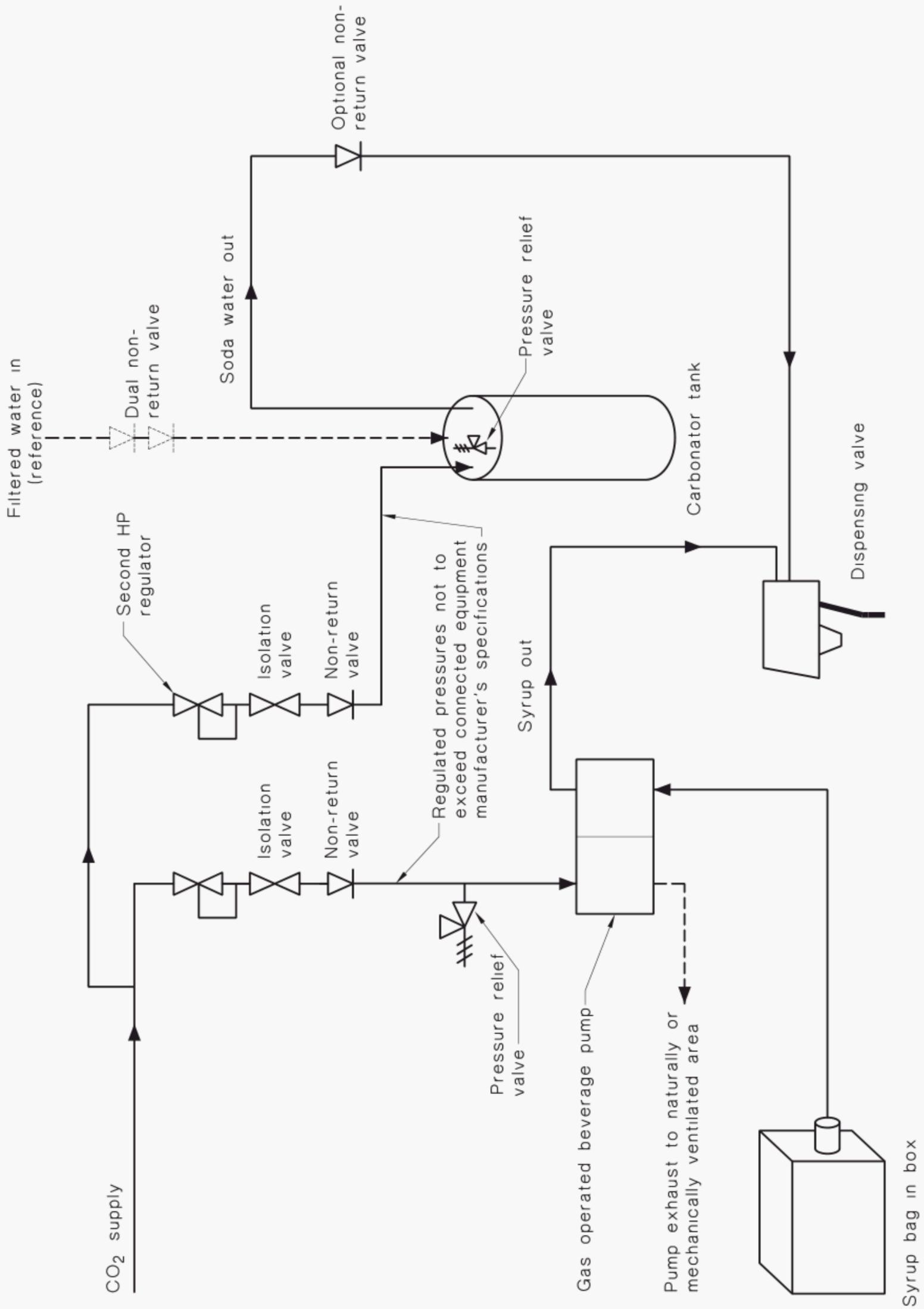


FIGURE 2.8 POSTMIX SYSTEM USING SYRUP BAG IN BOX AND GAS OPERATED BEVERAGE PUMP

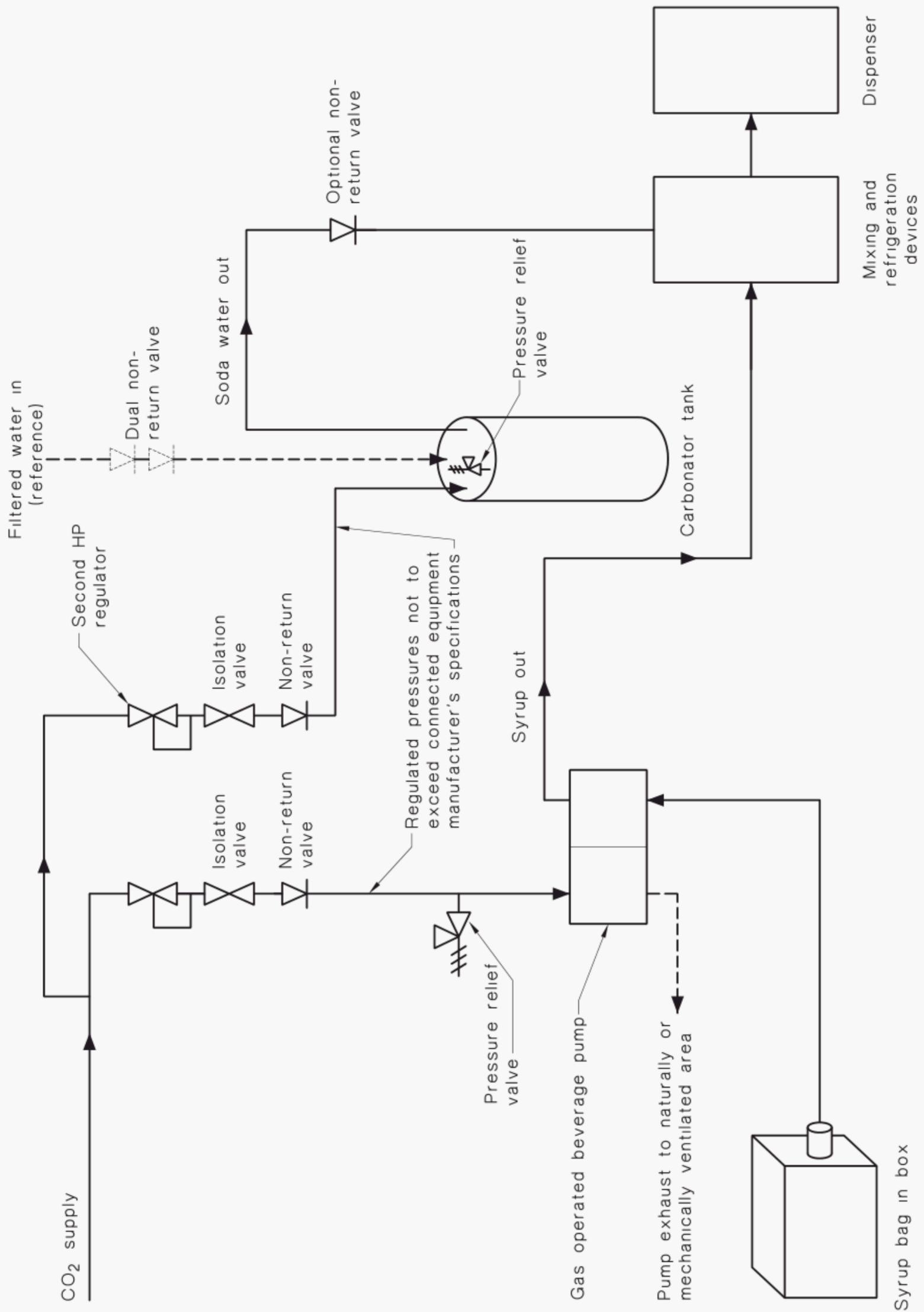


FIGURE 2.9 FROZEN CARBONATED BEVERAGE SYSTEM USING SYRUP BAG IN BOX AND GAS OPERATED BEVERAGE PUMP

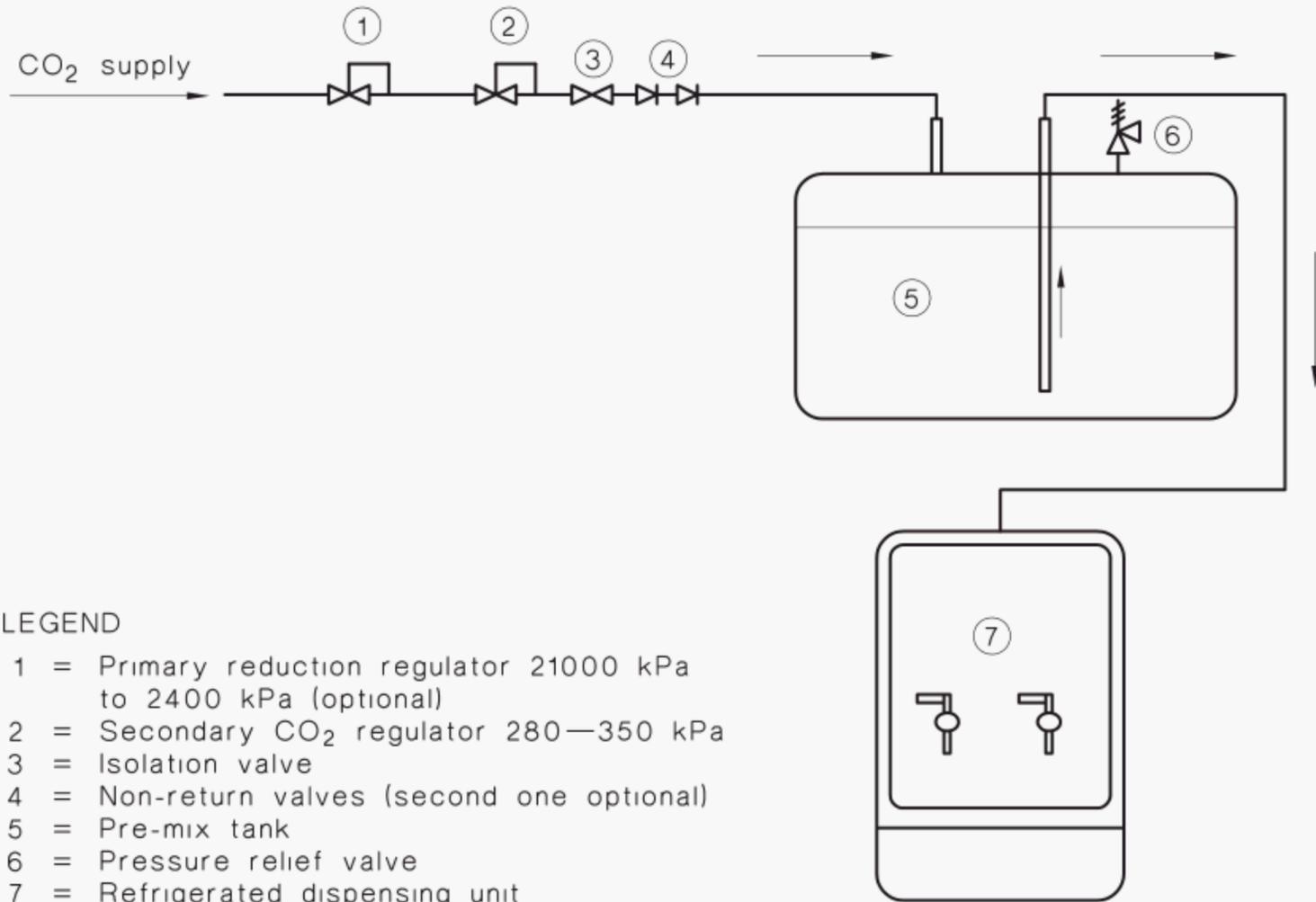
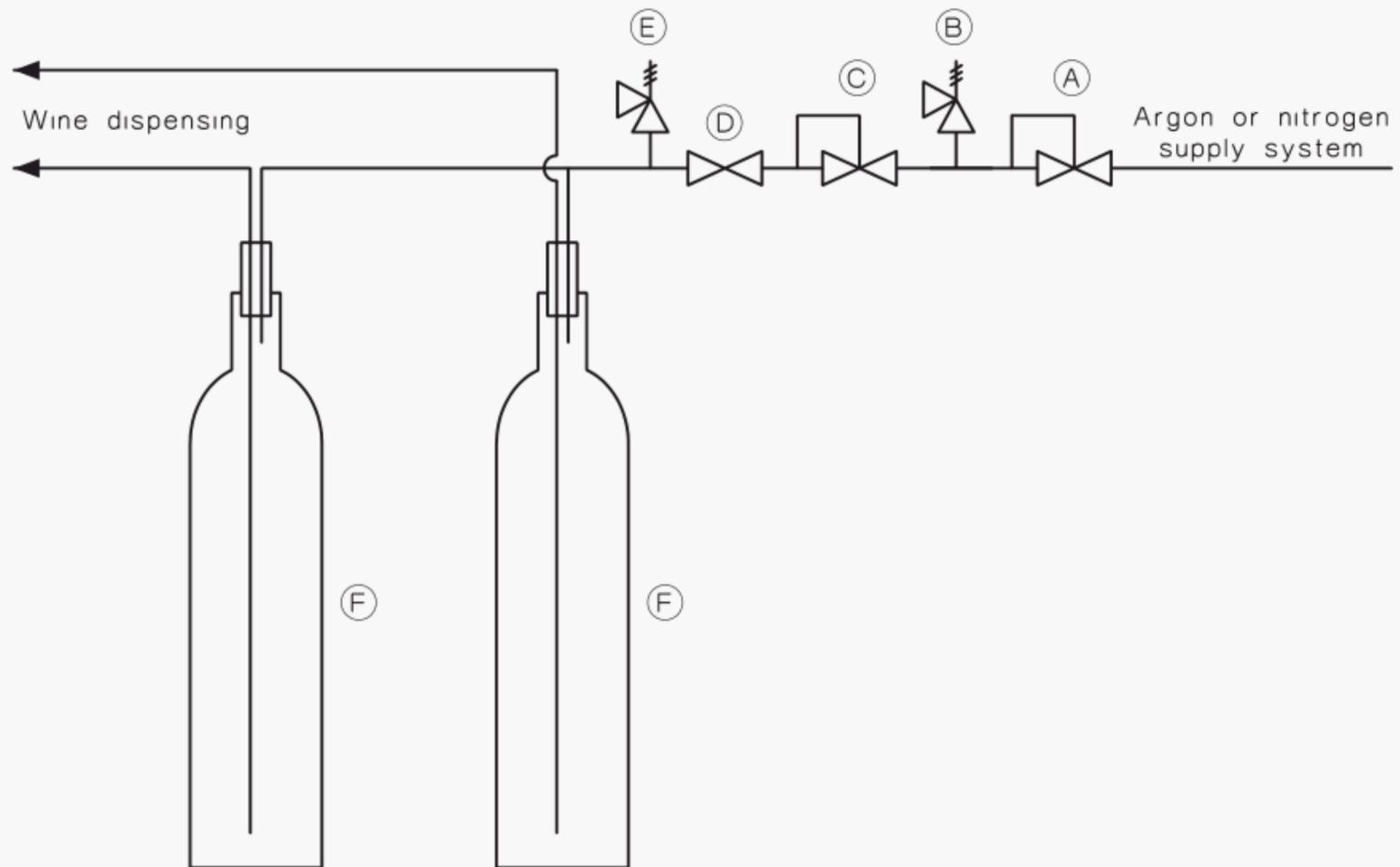


FIGURE 2.10 READY TO DRINK (PRE-MIX) SYSTEM



LEGEND

- A = High inlet pressure regulator
- B = Pressure relief valve (set at no more than 2400 kPa)
- C = Low inlet pressure regulator
- D = Isolation valve
- E = Pressure relief valve (set at no more than 10 kPa)
- F = Bottled wine

FIGURE 2.11 BOTTLED WINE DISPENSING

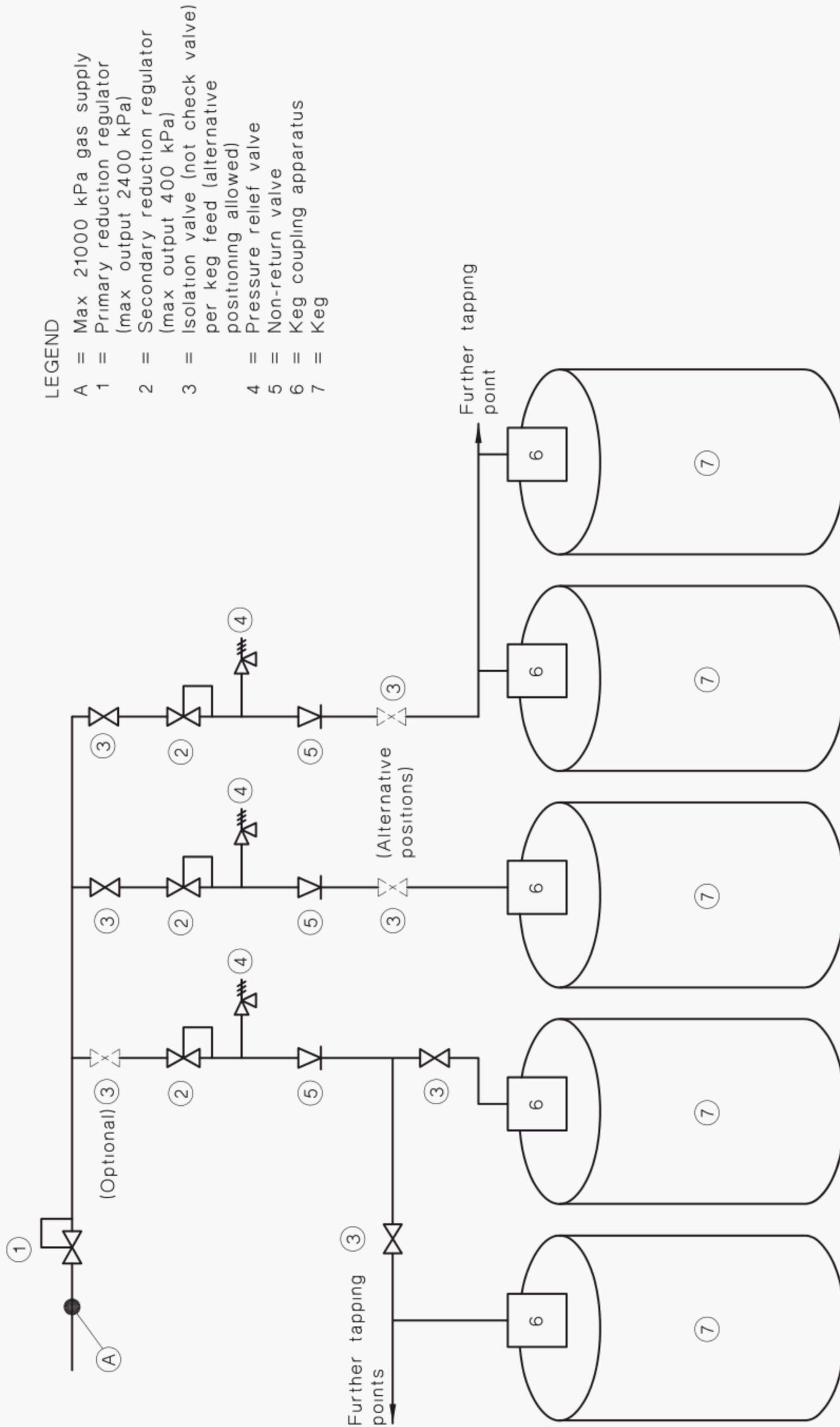


FIGURE 2.12 GAS DISTRIBUTION TO DRAFT BEER AND READY TO DRINK KEGS—SYSTEM 1

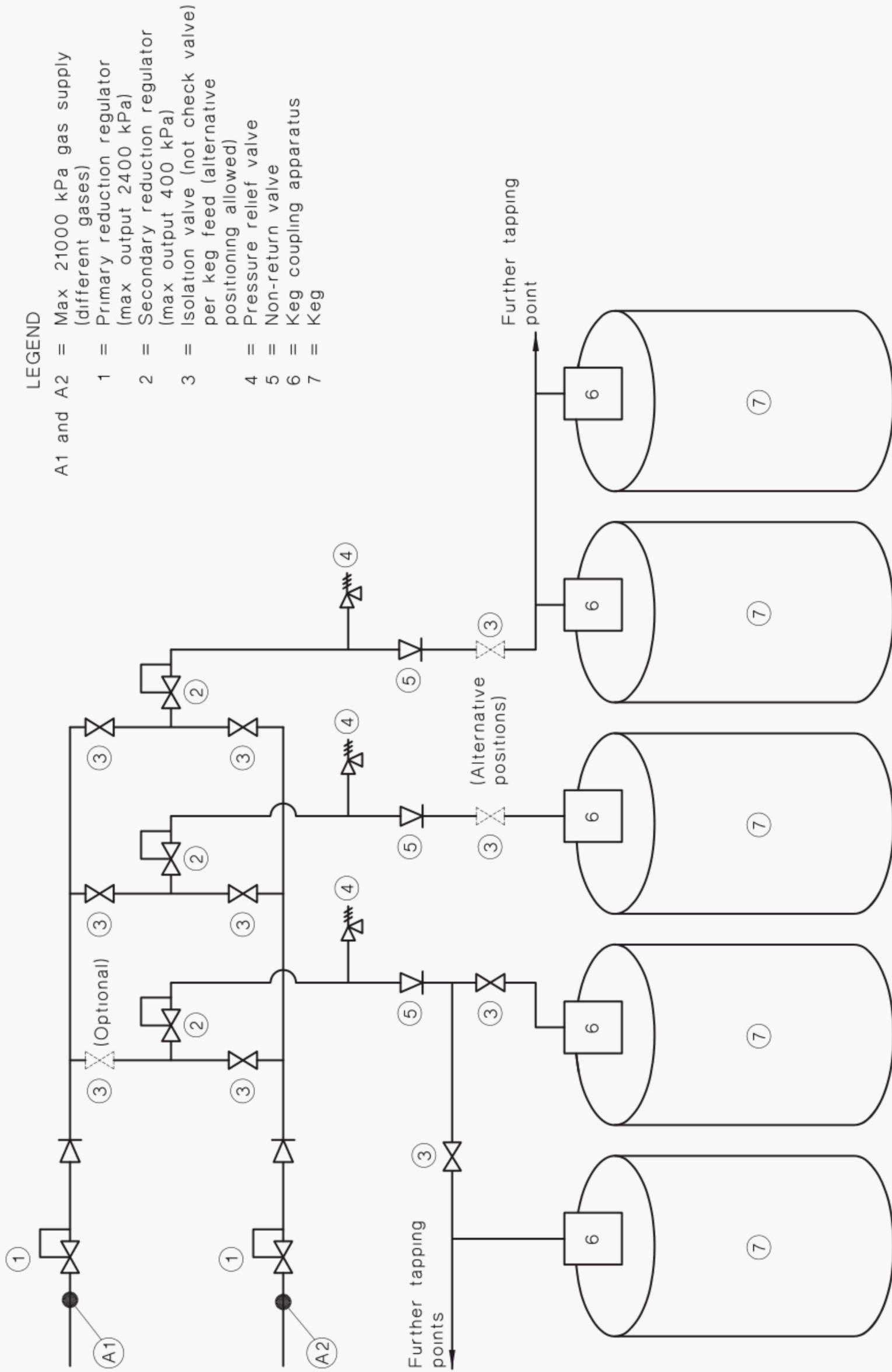


FIGURE 2.13 GAS DISTRIBUTION TO DRAFT BEER AND READY TO DRINK KEGS—SYSTEM 2 (FOR MULTIPLE GAS SUPPLY)

SECTION 3 SAFETY OF GAS SUPPLY INSTALLATIONS

3.1 HAZARDOUS PROPERTIES OF GASES

3.1.1 General

The installation of inert gas supply systems shall be undertaken with consideration of the safety hazards posed by the characteristics and the quantity of the inert gases which they use.

The main hazards posed by the inert gases used in beverage dispensing include:

- (a) Pressure hazards.
- (b) Oxygen depletion (asphyxia and physiological effects).
- (c) Specific toxicity hazard of CO₂.
- (d) Cold hazard.
- (e) Manual handling (see Clause 3.2.4).

These vary with the different supply systems specified in this Standard:

- (i) Single cylinders in direct use in application areas.
- (ii) Single and multiple cylinder supply systems.
- (iii) Refrigerated liquid CO₂ supply systems.
- (iv) Nitrogen gas generators and mixers.
- (v) Air compressors.

3.1.2 Pressure hazard

Gases are usually kept in sealed cylinders or vessels under pressure. Gases kept in this manner present the following pressure-related hazards:

- (a) The possibility of gas leakage to atmosphere, with the consequent risks discussed below.
- (b) The possibility of pneumatic shock, which can lead to the combustion of system components where the gas has oxidizing properties.
- (c) The sudden release of gas when disconnecting pressurized connections.
- (d) The possibility of explosive rupture of the cylinder or vessel, with the following consequent risks:
 - (i) A pressure build up (overpressure) in enclosed areas, which is capable of blowing the enclosed structure apart.
 - (ii) Injury or damage caused by flying parts of the container.

NOTE: The mechanical energy stored in a full 50 kg water capacity high pressure cylinder (and therefore its capacity to cause damage in the event of rupture) is comparable with that of a motor car travelling at 180 km/h.

3.1.3 Oxygen depletion hazard (asphyxia and physiological effects)

Any gas other than air or oxygen will displace oxygen when entering the atmosphere. Any depletion of the oxygen content of the breathing atmosphere from its normal 21% is a threat to life, by asphyxia.

Gases whose only hazard is the displacement of oxygen are known as simple asphyxiants. As the amount of oxygen inhaled is reduced to 14% by volume, the pulse rate will accelerate and the rate and volume of breathing will increase. The ability to maintain attention and think clearly is diminished, muscular coordination is somewhat disturbed. As oxygen decreases to 10% judgement becomes faulty, severe injuries may cause no pain. Muscular effort leads to rapid fatigue. Further reduction to 6% may cause nausea and vomiting and the ability to move may be lost. Permanent brain damage may result even after resuscitation from exposure to this low level of oxygen. Below 6% breathing is in gasps and convulsions may occur.

Inhalation of a gas mixture containing only an asphyxiant will result in unconsciousness from the first breath and death will follow in a few minutes.

Dense asphyxiants preferentially displace oxygen at and below ground level, and disperse less readily than buoyant gases.

Liquefied gases present an increased asphyxiant hazard because of the high mass flow rate from liquid leaks and the likelihood of dense gas evaporating from the low temperature liquid.

3.1.4 Specific toxicity hazard of CO₂

CO₂ has toxic properties which are not related to asphyxiation. Toxic substances react in a manner destructive to human tissues and functions, possibly with fatal results.

The predominant method of exposure is inhalation.

Carbon dioxide at low concentrations of 3% to 5% by volume in air can cause increased respiration and headache if inhaled. Concentrations of 8% to 15% can cause headache, nausea and vomiting which may lead to unconsciousness. Higher concentrations can cause rapid circulatory deficiency leading to coma and death.

Guidelines on exposure limits are given in NOHSC 1003.

3.1.5 Cold hazard

Gases that are kept at a low temperature or that will cool when depressurized (i.e. CO₂ stored in cylinders) present the following specific hazards:

- (a) Frostbite, or cold burns (also known as super cold injury) can result from contact with the gas or uninsulated fittings. Skin can also 'stick' to cold equipment.
- (b) Materials can suffer brittle fracture from loss of ductility, or high strength failure from uneven contraction.
- (c) Moisture ingress can cause the seizure of valves or cause them to leak.
- (d) Cold liquid that is trapped between valves can, when warmed, rupture pipes unless provided with pressure relief devices.

(e) Insulated refrigerated liquefied gas vessels may, after an extended period of non-use

NOTE: See AS 4332 for detailed guidance on storage and handling of gases in cylinders where large quantities of gas need to be kept on site, and other classes of gases, e.g. flammable and oxidizing gases, are also stored in the facility.

AS 1894 gives guidance for cryogenic and refrigerated liquids.

3.2.2 General precautions on storage

The following general precautions should be observed in connection with the storage, handling and use of inert gases in cylinders or vessels:

- (a) Copies of the material safety data sheets (MSDS) for the inert gases that are kept, handled or used on the site, and the appropriate first aid kit for them, should be kept in an accessible location.
- (b) Areas in which cylinders or vessels are kept should be—
 - (i) away from any artificial sources of heat, e.g. radiators, boilers, steam pipes; and
 - (ii) kept clear of combustible matter, vegetation and refuse, for a distance of not less than 3 m.
- (c) Cylinders or vessels should not be used for any purposes other than those for which they were designed.
- (d) For storage of inert gases together with other classes of gases e.g. flammable and oxidizing, the requirements for the storage of those classes of gases in AS 4332 and AS/NZS 1596 should be followed.
- (e) All stores of gases should be separated from other dangerous goods stores by a minimum distance of 3 m. They should be located not less than 1 m from any door, window, air vent or duct.
- (f) Cylinder storage areas should be designated 'No Smoking'.

The floor should be flat, solid and constructed from non-combustible materials. It should drain away from the cylinders and vessels. Concrete flooring is preferred.

Indoor storage of gases should be avoided, wherever possible.

3.2.3 Handling of cylinders and vessels on site

The following requirements and recommendations on handling are applicable:

- (a) Cylinders and vessels shall be kept in such a manner that—
 - (i) they are protected from being knocked over and falling; and
 - (ii) they are protected against impact damage.
- (b) Inert gas cylinder relief devices, e.g. safety valves, should not be directed towards any barrier or other cylinder, as far as practicable.
- (c) Before connection to a cylinder or vessel, pressure regulators and application equipment shall be checked for their compatibility for use with both the gas in the cylinder or vessel and its pressure. The cylinder valve connection shall be checked for leaks.
- (d) Only equipment provided by the cylinder or vessel supplier for the purpose shall be used to open or close valves. No attempt shall be made to stop leaks by applying excessive force to valves.
- (e) Cylinders, vessels and their fittings shall be checked regularly for leaks.
- (f) Cylinder and vessel safety devices shall be checked regularly for damage and obstructions and they shall not be tampered with. Where damage or obstruction is found, the supplier of the cylinder or vessel shall be contacted.

- (g) Cylinders and vessels whose contents are not unambiguously identified by their labels shall not be used. Such cylinders and vessels shall be referred to the supplier.
- (h) Where cylinders or vessels are damaged, heat affected or severely corroded, expert advice shall be sought as soon as possible.
- (i) Appropriate protective equipment (see Clause 3.3.2) shall be used when handling cylinders.
- (j) Gas shall not be discharged directly from a cylinder or vessel to the atmosphere, except in a controlled manner and for a specific purpose, e.g. for purging and depressurizing equipment.

3.2.4 Movement of cylinders on site

The following requirements and recommendations apply during the movement of cylinders on site:

- (a) Cylinder valves shall be closed and where provided, valve protection devices shall be in place.
- (b) A suitable trolley should preferably be used for moving cylinders in an upright

3.2.6 Placarding, signage and identification

3.2.6.1 *Warning notices*

Hazard warning notices identifying the compressed inert gas and other matters appropriate to the installation shall be clearly displayed together with telephone numbers for emergency contact. Notices shall comply with AS 1319. Refer to NOHSC 3009.

3.2.6.2 *Operating instructions*

Instruction cards or labels complying with AS 1319 shall be available in the area, detailing the operation of supply systems and controls.

3.2.6.3 *Supply system signs*

In addition to the above warning notices, it is recommended that exchangeable signs IN USE and RESERVE or similar be provided for supply systems where backup supplies are kept connected to one side of a manifold ready for use.

3.2.6.4 *Piping identification*

The contents of each pipeline shall be identified. The identification markings shall be repeated as often as is necessary to ensure that the pipeline is clearly identified and will not be confused with adjacent pipelines carrying other substances.

If colour coding of a compressed gas pipeline is used in addition to labelling, it should comply with AS 4484.

3.2.6.5 *Isolation valve signs*

Signs clearly establishing the location and identity of section shut-off valves shall be provided.

3.2.7 Cylinder fire and heating protection

3.2.7.1 *Acetylene*

TABLE 3.1
MINIMUM FIRE PROTECTION REQUIREMENTS
FOR INERT MINOR GASES STORES

| Aggregate cylinder water capacity, L | Minimum fire protection equipment required |
|--------------------------------------|--|
| < 1000 | Water hose connection, no specific requirements |
| 1000 to 2000 | One hose reel or one 2A 60B(E) fire extinguisher |
| > 2000 | Refer to AS 4332 |

NOTES:

- 1 Hose reels shall comply with AS/NZS 1221 and be installed in accordance with AS 2441.
- 2 See Appendix D for information on typical cylinder sizes and capacities.

Do not continue to use any cylinder which has been heated or involved in a fire. Any such cylinder shall be labelled 'DO NOT USE—HEATED' or similar, and arrangements made for its separate return to the supplier.

3.2.8 Control of entry

3.2.8.1 General

Only authorized personnel should have access to plant, equipment and materials. For the purposes of this Standard an authorized person is:

- (a) A specified individual who has completed an induction to the facility conducted by a person designated by the owner (the designated person) and covering areas of:
 - (i) prohibited access;
 - (ii) hazardous chemicals, other known hazards, and the precautions to be taken;
 - (iii) exclusion of any person affected by drugs or alcohol; and
 - (iv) the tasks that are agreed may be undertaken by the individual upon entering the premises under a sign-in, sign-out system.

NOTE: The induction should be refreshed yearly, and a record kept at the premises of all persons so authorized.

- (b) A person not authorized according to (a) above, but who before each visit to the facility has been provided with access to, and been advised to read, a list of hazards at the premises, the appropriate precautions to be taken, and has notified the designated person of the task they intend to undertake while at the premises.

Where neither of the above can be accomplished, the visitor or contractor shall be

- (b) Interior lighting shall be of at least the luminance specified in AS/NZS 1680.2.4.
- (c) Sufficient lighting shall be available on the internal roads that lead to areas, rooms or buildings where inert gases are kept or handled and which may be used by people in the course of their work at the premises.
- (d) If in a hazardous zone, or where an explosive atmosphere could be present, reference should be made to the relevant part of the AS/NZS 2430 series.

3.3 PERSONNEL

3.3.1 Training

3.3.1.1 *Job knowledge*

All personnel handling inert gas cylinders and vessels on the premises shall be fully conversant with—

- (a) the properties of the specific gases handled, by reference to the relevant MSDS;
- (b) applicable safety regulations and safe handling procedures; and
- (c) manual handling procedures for heavy cylinders.

3.3.1.2 *Training*

Personnel employed in the premises shall be trained in—

- (a) the nature of the work and safe methods of operation;
- (b) manual handling procedures;
- (c) the properties and hazards associated with the inert gases and gas cylinders being handled;
- (d) the location of first aid equipment and first aid measures to be taken;
- (e) the correct use of personnel protective equipment and its care and maintenance; and
- (f) actions to be taken in various emergencies, including leaks and gas escape.

Simulated emergency exercises shall comprise part of the training.

3.3.1.3 *Contractors*

Contractors and their staff shall be trained in the following, as appropriate to the specific task to be performed:

- (a) Safety rules of the site, including restriction on movement, access and activities and the use of personnel protective equipment.
- (b) Hazards associated with the storage and use of inert gases in cylinders and vessels likely to be encountered on the premises.
- (c) Conditions and obligations of safe work plans.
- (d) Applicable emergency procedures.

3.3.1.4 *Retraining of personnel*

All relevant personnel shall be retrained whenever changes of working or safety procedures have been instituted and at sufficient regular intervals as will ensure that their capability is maintained. Individual personnel shall be retrained when they have demonstrated substandard performance in safety procedures, or when they have spent a significant amount of time away from their accustomed duties.

3.3.2 Personnel protective equipment

3.3.2.1 General

Where inert gas cylinders are kept or handled—

- (a) all persons in the premises shall be provided with appropriate personnel protective equipment where required;
- (b) personnel protective equipment shall be kept, in designated, well identified locations and ready for use; and
- (c) all protective equipment shall be maintained in a fit state of repair.

3.3.2.2 Types of personnel protective equipment

The following personnel protective equipment, as appropriate, shall be provided where gas cylinders are stored and handled:

- (a) Eye protection, complying with AS/NZS 1337.
- (b) Safety footwear, complying with AS/NZS 2210.2, and selected and maintained in accordance with AS/NZS 2210.1.
- (c) Appropriate protective gloves, complying with AS/NZS 2161.
- (d) Hearing protection, complying with AS/NZS 1270.

The provision of self-contained breathing apparatus conforming to AS/NZS 1716 and selected in accordance with AS/NZS 1715 should be considered on premises where oxygen deficient atmospheres could occur (refer to Section 4).

3.3.2.3 Occasions for use of personnel protective equipment

When moving Inert gas cylinders, it is good practice to wear safety shoes and gloves.

When handling or operating refrigerated liquid carbon dioxide systems, overalls, protective gloves, safety footwear and eye protection should be worn.

3.3.2.4 Care and maintenance of personal protective equipment

Personal protective equipment shall be maintained in accordance with the appropriate Australian Standard for that equipment.

Where use of self-contained breathing apparatus is required, it shall be maintained in accordance with AS/NZS 1715.

3.3.3 First aid

3.3.3.1 First aid station

A first aid station shall be provided in a clean area. It shall comprise, as a minimum, an appropriate first aid kit and first aid instructions, e.g. MSDS for all inert gases being kept or handled on the premises.

3.3.3.2 First aid procedures

The first aid procedures set out in the relevant MSDS shall be adopted.

SECTION 4 LOCATION AND VENTILATION OF SUPPLY SYSTEMS

4.1 GENERAL

Supply systems shall only be sited in ventilated areas.

Supply systems excluding cylinders and vessels should be protected from the weather. They shall be located away from fire escape routes. Provision should be made to enclose the supply area or to prevent unauthorized access. The floor on which the equipment is installed should be level and made of concrete or other suitable non-flammable material. Accumulation of water should be avoided.

If the area is fenced, access gates shall open outwards, be large enough to facilitate cylinder handling, permit opening from within in case of emergency, and be lockable to prevent access by unauthorized personnel. The provision of emergency exits should be considered.

4.2 NATURALLY VENTILATED AREAS

An area shall be considered naturally ventilated if it meets one of the following criteria:

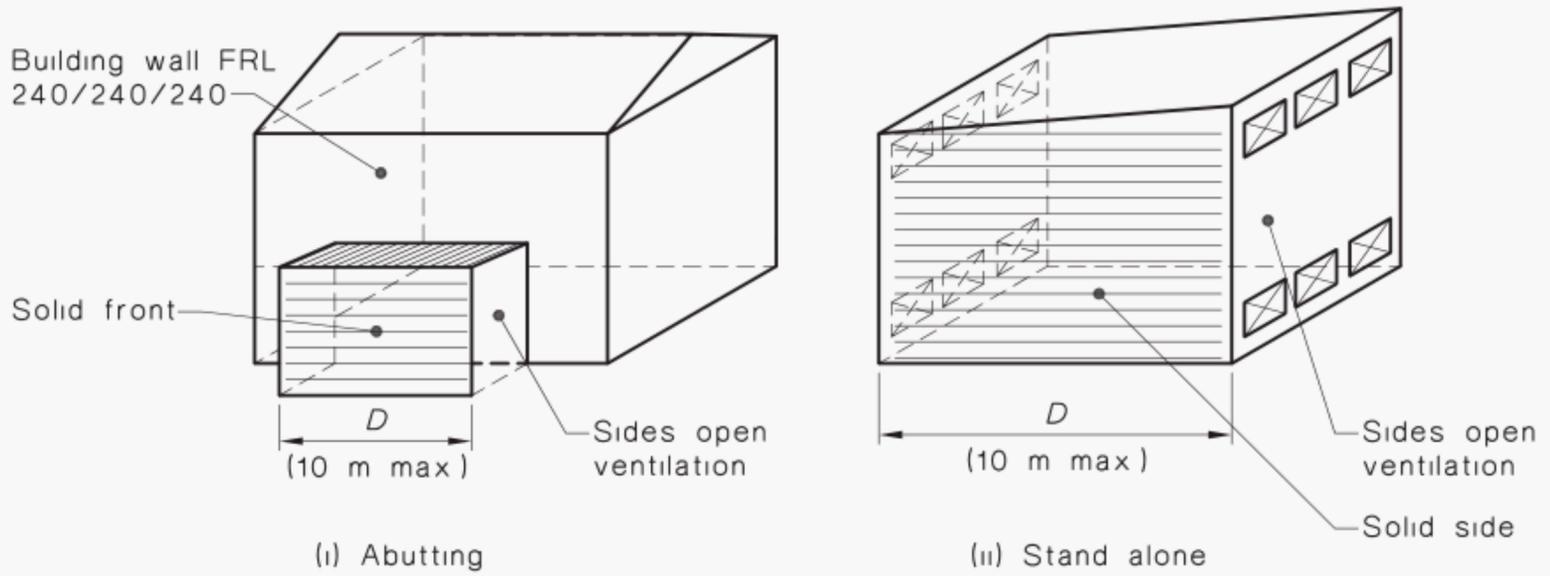
- (a) Two opposing external sides that are open from floor to ceiling (see Figure 4.1(a)).
- (b) One external side that is open, provided that the length of the open side is at least twice the distance of the wall from the opposite side (see Figure 4.1(b)).
- (c) Vents are installed in at least one pair of opposing external walls (see Figure 4.1(a)(ii) and 4.1(c)), provided that—
 - (i) the distance between the opposing external walls does not exceed 10 m;
 - (ii) in every two metre length of the opposing external walls, there are at least two vents; one positioned immediately above the floor and the other positioned immediately below the ceiling;
 - (iii) the total area of the vents per metre length of wall shall be at least 0.1 m²; and
 - (iv) vents are evenly distributed.

NOTE: In addition, if a pitch roof exists ventilation at its highest point should also be considered.

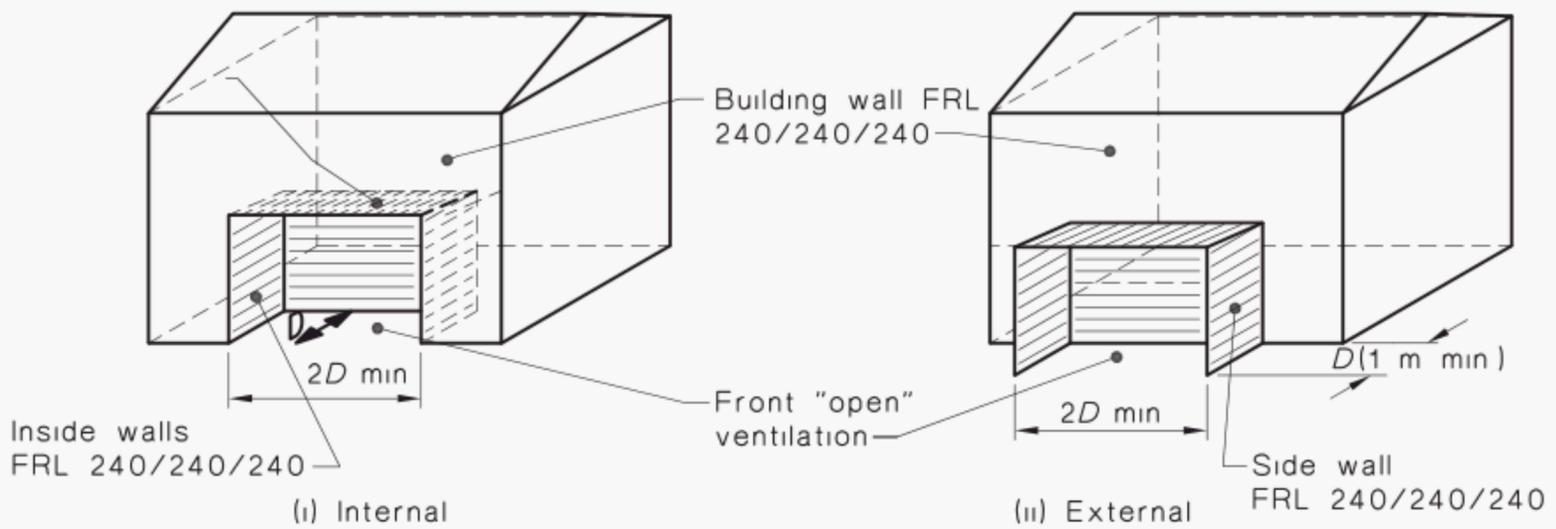
The openings of a natural ventilation system may be covered by one of the following:

- (A) Wire mesh or grill.
- (B) Louvres.
- (C) For open, external walls only, chequered brickwork, vent bricks, slotted roller doors or equivalent.
- (D) Fire dampers, where required.

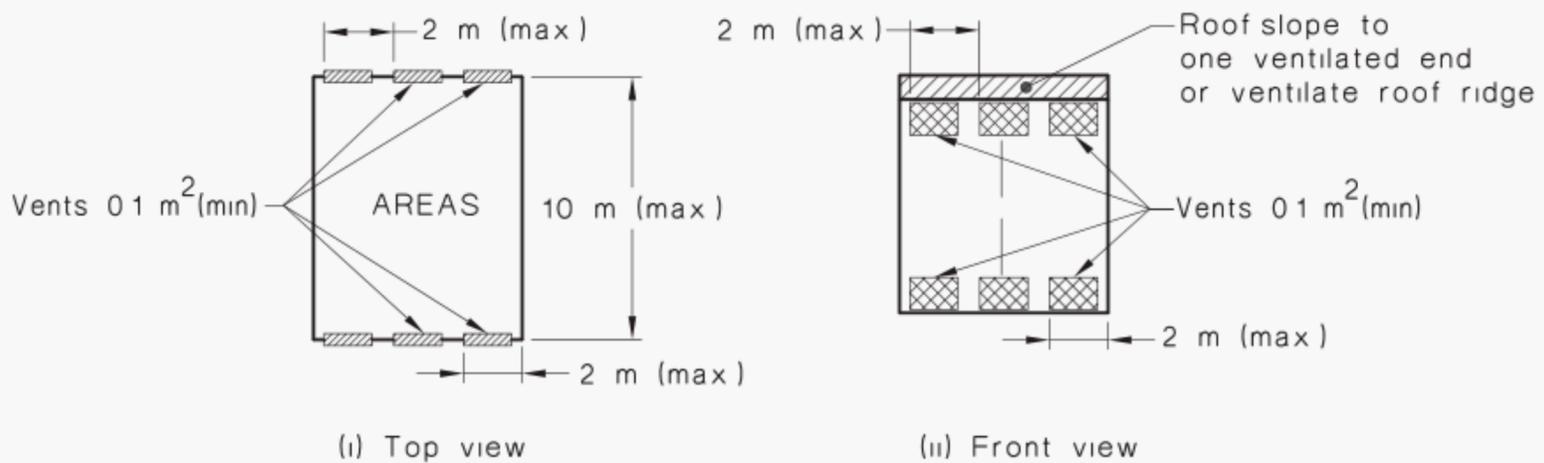
Care should be taken to ensure that any nearby embankments, excavations or retaining walls do not interfere with the operation of a natural ventilation system.



(a) Areas having two "external open" sides



(b) Areas having one "external open" side



(c) Vents, top and bottom in one pair of opposing external walls

NOT TO SCALE

FIGURE 4.1 SCHEMATICS OF NATURALLY VENTILATED AREAS

4.3 NON-NATURALLY VENTILATED AREAS

4.3.1 General

Any area which is neither outdoor nor naturally ventilated shall be considered non-naturally ventilated. Common examples of these areas are underground cellars and cool rooms.

Non-naturally ventilated areas present increased hazards when pressurized gas and gas equipment are contained within them. A risk assessment shall be performed to determine their safe operation. Unless the risk assessment indicates otherwise, these areas shall be protected by the following mechanisms:

- (a) Gas monitoring and alarms (mandatory).
- (b) Safe system of entry and work (mandatory).
- (c) Either of the following:
 - (i) Mechanical ventilation, to be employed where possible to ensure the area is ventilated should any gas leaks occur.
 - (ii) Where mechanical ventilation is not practical or cannot be run continuously, e.g. cool rooms and heritage type buildings, appropriate emergency procedures and emergency equipment to complement the safe system of entry and work.

4.3.2 Gas monitoring

Where gas monitoring of the atmosphere of the non-naturally ventilated area is to be used, consideration shall be given to the following:

- (a) Sensing the levels of oxygen and CO₂. Sensing for only CO₂ may be appropriate unless the supply systems include nitrogen, argon or other inert gases. Monitors for the different supply conditions shall be according to Table 4.1.
- (b) Maintaining oxygen levels above 19%. Alarms shall be provided if the levels fall below 19%.
- (c) Maintaining CO₂ levels below the TLV-TWA of 0.5%. Warnings and alarms shall be provided when the CO₂ levels reach 1.5% and then 3% respectively.
NOTE: TLV-TWA is the Threshold Limit Value on a Time Weighted Average basis of eight hour per day; 5 days per week as listed in NOHSC: 1003.
- (d) Sensors for CO₂ shall be installed at a low level (0.3 to 0.6 m above the level of the floor) in the areas where CO₂ will most likely accumulate.
NOTE: Slope of floor, partitions and barriers which may stem air flow should be considered.
- (e) Visible and audible alarms shall be provided both within the area and the entry points to the area.
- (f) Multiple sensors, positioned near the main potential leak sources.
- (g) For fixed monitors, power shall be hard wired to prevent unauthorized persons turning the monitors off.
NOTE: Battery back up should be considered.
- (h) Maintenance of the monitoring system (see Clause 6.3.2 (d) and (j)).
- (i) Warning signage shall be provided at the entry points to the area.
- (j) Indication of correct operation of the monitor shall be provided at the entry points to the area.

TABLE 4.1
GAS MONITORS

| Gas supply into the non-naturally ventilated area | Type of monitor to use |
|---|---------------------------|
| Carbon dioxide only | Carbon dioxide |
| Pre-mixed carbon dioxide and nitrogen | Carbon dioxide |
| On site carbon dioxide and nitrogen mixing system | Carbon dioxide and oxygen |
| Nitrogen or argon | Oxygen |

4.3.3 Safe systems of entry and work

A documented safe system of work in the non-naturally ventilated area shall be created. The system shall cover operating procedures, safe entry and emergency procedures and as a minimum it shall include—

- (a) nomination of a competent person or persons to perform all the day to day operations and testing;
- (b) shutting off the inert gas supply to the system upon the daily close of business unless the facility operates significantly extended hours;
- (c) inspecting, and replacing if damaged, the washer in the cylinder valve outlet connection at every gas cylinder change;
- (d) checking the supply system for leaks using an approved leak detecting solution at least weekly, after any unusual condition, and following any maintenance work;
- (e) systematic maintenance work and records, including logging of the weekly leak testing results and all repairs on the supply systems and gas monitoring system; and
- (f) actions to be taken if the gas monitor alarm is activated.

4.3.4 Mechanical ventilation

Mechanical ventilation systems consist of suitable fans, controls, electric motors, ducting, inlet and outlet grilles suitably sized with ventilation rates capable of providing room air changes to maintain the air supply in the rooms in a safe breathable state or restore it after an emergency condition has been identified.

No design criteria for mechanical ventilation systems are given in this Standard, but consideration shall be given to the following:

- (a) Control and isolation of the system from outside the non-naturally ventilated area.
- (b) Manual activation of the system before entry to the area or on demand from gas monitoring and alarms.
- (c) Visual indication of whether the system is working or the alarm has activated on failure.
- (d) Addition of circulating fans to mix up and dilute small leaks.
- (e) Need to extract and ventilate at low levels especially for carbon dioxide.
- (f) Exhausting the ventilated gases to a safe area.
- (g) Continuous operation of the system.
- (h) For permanently installed systems, hard wiring of the power supply so that it cannot be turned off by unauthorized personnel.

4.3.5 Emergency procedures and emergency equipment

On activation of the alarm system, the area should be ventilated wherever possible without entering the area. Where on activation of the gas monitor and when the only way to ventilate a non-naturally ventilated area is by entering the area, no entry should be permitted to any person other than appropriately protected personnel.

Entry to the area is hazardous and requires special equipment and training.

SECTION 5 INSTALLATION, TESTING AND COMMISSIONING OF THE SYSTEM

5.1 INSTALLATION

5.1.1 Installation work

5.1.1.1 *General*

All installation work shall be carried out by competent personnel according to a safe work plan.

NOTE: It is generally accepted, e.g. in OHS Regulations, that a competent person for any task means a person who has acquired through training, qualifications or experience, or a combination of them, the knowledge and skills to carry out the task.

5.1.1.2 *Safe work plan*

All gas supply system installation work shall be undertaken only under a safe work plan completed in writing by the installer, specifying all the elements identified in a risk assessment and detailing any control actions to be taken by the installer to control the identified risks.

The owner shall ensure that the installer is competent and aware of any hazards that may exist in the premises and which are not within the normal range of expected knowledge of the installer (see Clause 3.2.8.1).

5.1.2 Routing of distribution piping

5.1.2.1 *General*

All distribution piping shall be adequately supported and protected from damage, vibration or corrosion.

Where pipes have to be routed through spaces which may become non-accessible during or following construction, e.g. cavities between walls, the following precautions shall be adhered to:

- (a) There shall be no mechanical joints within the enclosed pipe run.
- (b) For metal piping, joints shall be fusion-welded or silver-brazed and certified leak-free by pressure test in accordance with Clause 5.2.2 with oil-free inert gas.

NOTE: Consideration should be given to the use of fluxless brazing.

- (c) The piping shall be clearly marked (see Clause 3.2.6.4).

5.1.2.2 *Electrical separation*

The distance between piping and electrical apparatus and wiring shall be not less than 50 mm. Compressed inert gas piping shall not be used as an electrical earth.

5.1.2.3 *Supports*

All piping shall be adequately supported and protected from damage by vibration. Supports shall be capable of carrying the piping system without causing distortion. Supports shall also be adequate for the concentrated loads imposed by valves and risers, and for axial loadings due to expansion and contraction, and the pressure of the inert gases.

NOTE: Table 5.1 gives a guide to the maximum distances between pipe supports.

TABLE 5.1
MAXIMUM DISTANCE BETWEEN SUPPORTS

| Nominal pipe size mm | Maximum distance between supports m | |
|-----------------------------|--|----------|
| | Horizontal | Vertical |
| Up to 15 | 1.5 | 1.8 |
| 20 | 1.8 | 2.0 |
| 25 | 2.0 | 2.5 |
| 32 | 2.0 | 2.5 |
| 38 | 2.5 | 3.0 |

5.1.3 Protection of piping

5.1.3.1 *Painting*

Where painting is required, paint should be applied to the supplier's recommendation on clean, dry and corrosion-free surfaces.

If required, layers should be built up with compatible coats of primers and undercoat prior to the finish coat

NOTE: Some polymers, e.g. nylon, can be affected by paint.

5.1.3.2 *Buried piping*

Piping shall be buried to a sufficient depth or covered to protect piping from physical damage. The depth of cover shall be not less than 600 mm. Piping shall be bedded on firm compacted ground, supported throughout its length. Bedding material and backfill within 100 mm of piping shall be sand, free of stones. Protective markers manufactured from PVC or concrete, to indicate the presence of the pipeline, shall be laid on the sand covering the pipeline.

PVC markers shall have a thickness not less than 3 mm, and shall have a width not less than 150 mm. Precast concrete markers shall have a thickness not less than 40 mm and shall have a width not less than 150 mm.

5.1.3.3 *Wrapping*

For buried piping, or piping in corrosive atmospheres or other areas of potential damage, a protective wrapping, coating or barrier shall be applied. The protection shall be applied as a continuous wrap with sufficient overlap to prevent exposure of the pipe surface.

5.1.3.4 *Cathodic protection*

For buried metallic pipelines, a cathodic protection system appropriate to the piping material used shall be installed to counteract any corrosive nature of the terrain in accordance with AS 2832.1.

5.1.3.5 *Piping concealed in or under concrete*

It is strongly recommended that the casting of compressed inert gas piping into reinforced concrete or installing such piping under slab floors is not undertaken.

In the event that there is no possible alternative route, the following procedures shall apply:

- (a) All concealed piping shall be protected along its entire length with an approved continuous watertight covering giving adequate protection to prevent corrosion at the point of entry and exit.

- (b) Piping shall be installed in a conduit to ensure that the pipe is free to expand independently of the concrete.
- (c) In solid slabs, the piping shall be placed between the top and bottom reinforcement. The pipe shall be installed so that it will not require any cutting, bending or displacement of the reinforcement from its proper location.
- (d) Any pipe or conduit size shall be such that it will not impair the design strength of the slab.
- (e) Mechanical pipe joints shall not be used.
- (f) Pipe laid under concrete shall be covered with 150 mm of clean sand, free from rocks, to protect it from physical damage. The 150 mm of sand shall be measured from the top of the pipe when laid in the trench or excavation.

5.1.3.6 Sleeves

Where piping passes through masonry walls or floors, protective sleeves shall be fitted.

5.1.3.7 Pressure relief devices

Pressure relief devices shall be tested and tagged, or have a test certificate for operation, prior to installation.

Pressure relief devices for refrigerated liquid supply systems if installed indoors shall be provided with exhaust piping to vent to a safe outdoor area. The piping shall not restrict exhaust flow and the discharge outlet shall be installed so as to prevent entry of water and other fine material.

5.1.4 Cleaning and cleanliness

During installation of piping and components, a high standard of cleaning and cleanliness shall be maintained for the following reasons:

- (a) Foreign material can be a hazard in contamination of the beverage product.
- (b) Care is required when using jointing material, such as PTFE tape. The tape shall be of the correct type for the gases in the pipe. When using the tape, the start of the tape shall be one thread profile back from the end of the pipe, in order that no jointing material extends into the bore of the pipe.
- (c) In compressed inert gas piping, insufficient cleaning of internal surfaces can cause filter blockages and other equipment operating difficulties.

Personnel entrusted with the assembly and installation of systems shall wear clothing that is not stained with oil or grease and keep their hands washed clean of all oil, grease, and the like.

The tools and accessories used, such as workbenches and pipe supports, shall be clean and free from oil and grease.

Pipes shall be fully cleaned and degreased before installation and cleanliness shall be maintained thereafter.

In extreme circumstances, solvent washing may be used provided that all traces of the

5.2 TESTING

5.2.1 General

Pressure gauges and pressure relief devices may have to be removed from the distribution piping before testing and replaced by screw plugs. Parts that have been tested prior to installation may be excluded from the pressure strength test at the final inspection. But, when finally installed, leak checks at the connections shall be carried out in accordance with Clause 5.2.2.

Testing shall be carried out by a competent person.

5.2.2 Pneumatic test

All distribution piping shall be pneumatically tested for integrity and leak tightness in accordance with Appendix A. Hydrostatic testing shall not be used. Testing shall be done with oil-free inert gas after taking adequate precautions to avoid any risks associated with the test. Special precautions are necessary, when testing pneumatically, due to the release of a large quantity of energy in the event of piping failure.

Each joint or connection shall be checked for leaks. Leak testing should be carried out using a leak testing solution based on a compatible detergent or equivalent.

To facilitate checking, a log sheet should be used so that all joints can be ticked off as checking is completed. Completed log sheets should be filed with records of maintenance.

NOTE: A typical log sheet shown in Appendix B provides for numbering of the various sections of piping to correspond to any drawings.

5.3 COMMISSIONING

The compressed inert gas system shall be installed, tested and inspected to the relevant specifications and the recommendations of this Standard. All defects revealed during testing shall be rectified before the introduction of the compressed inert gas into the completed system.

5.4 CERTIFICATE OF COMPLIANCE

The installer shall provide to the owner a certificate confirming that the installation satisfies this Standard and the system is safe to use. The certificate shall include reference to:

- (a) Date of compliance.
- (b) Name of the installer.
- (c) Appropriate reference to this Standard, i.e. AS 5034.
- (d) Scope of compliance.

SECTION 6 SYSTEM OPERATION AND MAINTENANCE

6.1 GENERAL

All operators shall receive adequate instruction and training before operating supply and distribution systems. Operating procedures shall be readily available.

Managers, supervisors and operators shall study and give close attention to the suppliers' instructions for the correct and safe use of all equipment and materials used in the processes. They shall give consideration to the hazards that may be associated with the place of work.

NOTE: They should make use of the additional information given in Appendices B and C of this Standard, each in accordance with the nature of the work and responsibility.

Care shall be taken to ensure that the system remains undamaged and that no unauthorized alterations have been undertaken during and after maintenance.

6.2 OPERATION

6.2.1 Connecting gas cylinders

If there is any visible trace of oil or grease or other contamination the cylinder valves, the cylinder shall be put aside for return to the supplier. Contaminated cylinders shall be suitably marked to prevent accidental re-issue.

Before connecting gas cylinders, the operator shall safely remove the valve outlet seals or caps and shall ensure that there are no particles of dirt, foreign matter or water in the cylinder valve outlet.

The operator shall ensure that—

- (a) the cylinders to be connected are correctly identified for the gas contained and for its pressure to suit the application;
- (b) where O-rings and sealing washers are used, they are to be checked that they are in good condition and without damage; and
- (c) the correct tools are used to tighten cylinder connections and valves to avoid damage and over-tightening.

6.2.2 Pressurizing the distribution system

The procedure shall be as follows:

- (a) If the system of inert gas is supplied from a refrigerated liquid supply, proceed as follows:
 - (i) Arrange for the gas supplier to open slowly the isolating valve in the vessel supply system to pressurize the inert gas system up to the pressure regulator.
NOTE: If the regulator is preset and there is no isolation valve before the pressure regulator, the whole system will be pressurized.
 - (ii) Verify that the pressure regulator provides the required downstream pressure to pressurize the piping up to the outlet point isolating valve(s) as recommended by system and equipment supplier.

- (b) If the system is supplied from cylinders, proceed as follows:
- (i) Crack open the cylinder valves on the cylinders connected to the side of each supply system which is in service to pressurize slowly the system.
NOTE: Cylinder valves should not be left completely opened. Leave at least half a turn from the fully open position to let others know the valve is open. Where the valve is not fitted with a handwheel, use only the gas supplier's recommended cylinder key and ensure that once the valve is open, the cylinder key is left fitted to the valve. Normally, a valve is sufficiently open after one and a half turns.
 - (ii) Check the connections at the cylinders, the supply system and valve glands for leaks using a suitable leak-testing solution.
 - (iii) For manifolds, open the supply system valve on each supply system to pressurize each supply system to the regulator.
 - (iv) Check that the pressure in connected cylinders registers on each regulator contents gauge.
 - (v) Verify that the regulator outlet pressure gauge shows the pressure of compressed inert gas as recommended by system and equipment supplier.
 - (vi) Purge the lines with the supply gas, exhausting the gas to a well ventilated safe area.
NOTE: Care should be taken to avoid CO₂ accumulation becoming a hazard through preventing access and the use of safe work plans.

6.2.3 Changeovers at the dispensing end

When changing over dispensing vessels such as beer kegs, the gas distribution connections at the dispensing vessel should be checked for leaks both after disconnection and before reconnection.

6.3 MAINTENANCE

6.3.1 Weekly maintenance

In order to minimize losses of dispensing gas and the associated cost, reduced effectiveness of the dispensing system, and tripping of alarms, competent personnel should leak test the potential leak points of the system at weekly intervals and either rectify any leaks or initiate a service call.

6.3.2 Six-monthly maintenance

In order to maintain the correct function and safety of the installation, inspections shall be carried out at intervals not exceeding six months. These shall include checks to ensure the following:

- (a) Any changes in the vicinity of the installation do not affect its operation or safety.
- (b) Flexible connectors used for connection from cylinders to a supply system are in good condition and within their 'use by' date. Damaged flexible connectors and end fittings shall be replaced immediately.
- (c) Inspection for 'work-hardening' of copper connectors is carried out and, if affected, the tubing shall be re-annealed after removal from the supply system.
- (d) The necessary safety devices and instruments fitted are within test period and do not show signs of deterioration or unauthorized interference.
- (e) Particular attention is given to valves, including glands, to joints of all types, to connections and to areas of corrosion to ensure that no leaks are present.

- (f) The filters in the high pressure flexible connectors and other components, if fitted, are in good condition. If the filter elements appear dirty, they shall be cleaned or replaced.
- (g) Pressure regulators are inspected for leaks, damaged pressure indicators and correct operation. Any faulty regulator shall be removed immediately from service.
NOTE: AS 4839 specifies the required inspection and maintenance of pressure regulators used on mobile oxy-fuel gas applications which can provide useful guidance for pressure regulators in fixed applications in inert gas systems.
- (h) Valves to be used in normal operation or, in an emergency, remain accessible and easy to operate.
- (i) All accessible seals and O-rings in keg couplers and quick disconnect fittings shall be inspected for wear and damage and replaced and lubricated as necessary.
- (j) Testing and calibration of all the alarm systems and gas monitors.

6.3.3 Twelve-monthly maintenance

Inspection of all piping at the designated operating pressure under static conditions shall be carried out at intervals of not more than 12 months during the service life of the installation.

Particular attention should be given to places where corrosion or polymer degradation has occurred. The identity marking with colour or the name of the gas shall be renewed, if necessary.

At the same time, inspection of the piping shall be made to ensure that the surface condition has not deteriorated.

6.3.4 Records of maintenance

Records of maintenance shall be retained for not less than two years.

NOTE: Refer to Appendix B for a typical inspection record sheet.

6.4 REPAIRS AND CHANGES

All repair work or changes shall be authorized by means of a safe work plan or a Modification to Plant procedure, and shall be carried out by competent personnel.

Appropriate safety precautions shall be taken, such as purging with inert gas, exhausting to a well ventilated safe area, and the isolating of the section under repair.

Repairs or changes shall comply with this Standard. Changes to the system or external influences in the vicinity of the installation shall not affect the operation and safety of the system.

APPENDIX A

TEST PROCEDURES FOR COMPRESSED INERT GAS DISTRIBUTION
PIPING INSTALLATIONS

(Normative)

A1 GENERAL

The following three types of test procedures shall be carried out in accordance with the requirements in Clause 5.2:

- (a) An initial major leak check at a low pressure of approximately 200 kPa to check the general completeness of the overall system and to detect any joints where final tightening or completion may have been overlooked.
- (b) A pneumatic proof test at 1.5 times the Maximum Working Pressure to check its physical and mechanical integrity.
- (c) Final leak and pressure drop tests of the whole system or discrete sections if preferable, carried out only after reducing the test pressure when the proof testing is complete. Leak checking shall be done using suitable leak detection solution e.g. soapy water on all joints and connections in the system before the final pressure drop test.

WARNING: IN THE INTERESTS OF SAFETY, IT IS ESSENTIAL THAT ANY PERSON OR PERSONS NOT INVOLVED IN THE TESTING BE KEPT AWAY FROM THE INSTALLATION DURING THE TESTING, ESPECIALLY FOR THE PROOF TEST.

BARRICADING AND WARNING SIGNS MAY BE NECESSARY TO SAFEGUARD PERSONNEL.

MINIMIZING THE NOISE IN THE AREA, E.G. SHUTTING DOWN NOISE-GENERATING EQUIPMENT, WILL ASSIST IN THE DETECTION OF LARGE LEAKS AS THEY CAN OFTEN BE HEARD.

A2 PNEUMATIC TEST PROCEDURE

The procedure shall be as follows:

- (a) Initial integrity and leak check testing
 - (i) A low pressure of approximately 200 kPa shall be introduced into each section of the distribution system in turn.
 - (ii) All connections, fittings etc, shall be checked for any leakage, i.e. signs of bubbling of the soapy water.
 - (iii) Items found leaking shall be tagged or noted

WARNING: DO NOT TIGHTEN LEAKING CONNECTIONS WHILST UNDER PRESSURE.

- (iv) Release all pressure and then repair all tagged leak points.
 - (v) Repeat the leak check of the repaired connections.
- (b) Proof test pressure check

WARNING: ALL PERSONNEL MUST BE KEPT CLEAR OF ALL PIPEWORK DURING THIS TEST IN CASE OF ANY FAILURE. IT MAY ALSO BE NECESSARY TO REMOVE ANY ITEMS SUCH AS PRESSURE GAUGES AND PRESSURE RELIEF DEVICES WHICH ARE NOT SUITABLE FOR THE HIGHER 1.5 TIMES THE MWP LEVEL BEFORE DOING THIS TEST (SEE CLAUSE 5.2.1).

- (i) After Step (a) is complete, slowly raise the system pressure in stages, whilst looking for any signs of failure, until 1.5 times the MWP is reached, e.g.

| | | | |
|---------------------------|-----|------|------|
| MWP (kPa) | 400 | 800 | 2400 |
| Proof Test Pressure (kPa) | 600 | 1200 | 3600 |

- (ii) Once the proof test pressure has been reached, it shall be maintained for 5 minutes to ensure that no pipework or fittings fail.

- (c) Final leak and pressure drop tests.

NOTE: Any fittings removed during the proof test should be refitted prior to carrying out the following tests.

- (i) After the proof test pressure check in Step (b) has been completed successfully, reduce the pressure to approximately the MWP of the system i.e. 400, 800 or 2400 kPa.
- (ii) Carefully recheck all connections and fittings for leakage using a suitable leak detection solution.

WARNING: ANY LEAKS SHOULD BE TAGGED. DO NOT TIGHTEN FITTINGS UNDER PRESSURE AS THEY MAY FAIL.

- (iii) Depressurize the system and repair any leaks. Repressurize and repeat testing as necessary until all connections and fittings are leak tight.
- (iv) Finally carry out a pressure drop leak check at 90 to 100% of the system MWP.
NOTE: A pressure gauge of the appropriate maximum scale range and accuracy for the pressure to be checked should be used.
- (v) Once the required test pressure has been reached, shut off and disconnect the pressurizing source and hold the system for a minimum holding period as shown in Table A1.

**TABLE A1
MINIMUM HOLDING PERIOD**

| Internal volume (litres) | Minimum holding period (hours) | Examples of System Internal Volume (Total length × Nominal copper tube diameter × litres/metre = System volume in litres) |
|--------------------------|--------------------------------|---|
| 0 – 10 | $\frac{1}{2}$ | 40 m of 20 mm × 0.23 L/m tube = 9.20 L |
| 10 – 25 | 1 | 100 m of 20 mm × 0.23 L/m tube = 23 L or 55 m of 25 mm × 0.428 L/m tube = 23.5 L |
| 25 – 50 | 2 | 100 m of 25 mm × 0.428 L/m tube = 42.5 L or 60 m of 32 mm × 0.75 L/m tube = 45 L |
| 50 – 100 | 8 | 200 m of 25mm × 0.428 L/m tube = 85.6 L or 95 m of 40 mm × 1.00 L/m tube = 95 L |
| >100 | ≥24 | No example given. To be determined in each case |

(vi) The temperature corrected final pressure shall be calculated from

$$P_2 = P_1 \times T_2 / T_1$$

where

P_1 = start pressure, in kPa

P_2 = final pressure, in kPa

T_1 = start temperature, in Kelvin

T_2 = final temperature, in Kelvin

(vii) The pressure drop test shall be passed if the difference between P_1 and P_2 is no more than 1% of the test pressure, i.e.

For 400 kPa MWP Max. allowable difference for $(P_1 - P_2) = 4$ kPa

For 800 kPa MWP Max. allowable difference for $(P_1 - P_2) = 8$ kPa

For 2400 kPa MWP Max. allowable difference for $(P_1 - P_2) = 24$ kPa

A3 TEST FOR CROSS-CONNECTION

Where, for any reason, cross-connection of pipelines is possible, the following checks shall be made:

- (a) Isolate the pipeline from all gas supplies except the one under test.
- (b) Check that gas is supplied at each outlet point of the pipeline under test.
- (c) Check that no gas is supplied into the system or from the outlet points of any other system.
- (d) Prove each pipeline supply and distribution system in turn with all other systems isolated.

A4 FLOW CHECK

If straight-through tee or cross fittings are installed, ensure that the gas flows from the branch. In the event of no gas flow, the fittings and the pipe shall be checked.

A5 REPLACEMENT OF PRESSURE GAUGES AND PRESSURE RELIEF DEVICES

Install all items previously removed (see Clause 5.2.1).

Oil-free inert gas or oil-free air shall be used to pressurize to the normal operating pressure of the system. Joints shall be checked for leaks on items which have replaced temporary screwed plugs. Any leaks shall be eliminated.

When all the leaks have been eliminated, pressure shall be released through outlet point isolating valves.

A6 FUNCTION TESTS

Non-return supply system changeover valves and isolating valves shall be checked for closure tightness and gland leakage.

Automatic changeover devices shall be checked for correct operation.

A7 PURGING PRIOR TO SYSTEM USE

Total systems shall be purged with the service gas before introducing service gases systematically into the system.

A8 CERTIFICATE

When the system is tested, purged and ready for use, a certificate shall be issued by a competent person as confirmation that the system is safe to use.

APPENDIX B
TYPICAL PIPING JOINT INSPECTION AND LEAK CHECK SHEET
(Informative)

PIPING JOINT LEAK TEST LOG (see Clauses 5.2.2 and 6.3.4)

| Piping item for leak test | Fitting 1 | | | Fitting 2 | | | Fitting 3 | | | Fitting 4 | | | Fitting 5 | | |
|------------------------------|------------------|------|---|------------------|------|---|------------------|------|---|------------------|------|---|------------------|------|---|
| | No. of points | Test | | No. of points | Test | | No. of points | Test | | No. of points | Test | | No. of points | Test | |
| | | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 |
| Line no. details | | | | | | | | | | | | | | | |
| Screwed fitting | | | | | | | | | | | | | | | |
| Union | | | | | | | | | | | | | | | |
| Flanged joint | | | | | | | | | | | | | | | |
| Tee or cross | | | | | | | | | | | | | | | |
| Others | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Line no. details | | | | | | | | | | | | | | | |
| Screwed fitting | | | | | | | | | | | | | | | |
| Union | | | | | | | | | | | | | | | |
| Flanged joint | | | | | | | | | | | | | | | |
| Tee or cross | | | | | | | | | | | | | | | |
| Others | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Line no. details | | | | | | | | | | | | | | | |
| Screwed fitting | | | | | | | | | | | | | | | |
| Union | | | | | | | | | | | | | | | |
| Flanged joint | | | | | | | | | | | | | | | |
| Tee or cross | | | | | | | | | | | | | | | |
| Others | | | | | | | | | | | | | | | |

NOTE: Compressed inert gas piping test pressures are as follows:

| Test No. | Proof test pressure kPa | Leak test pressure kPa |
|----------|-------------------------------|------------------------------|
| 1 | 300 | 350 |
| 2 | 1.5 MWP | MWP |

MWP = Maximum working pressure, see Clause 2.4.2.2.

APPENDIX C
GENERAL CYLINDER SAFETY
(Informative)

The following should be observed for general cylinder safety:

- (a) All government and insurance regulations relating to the storage of compressed inert gas cylinders should be closely observed.
- (b) Keep all cylinders, empty or full, away from radiators, furnaces and other sources of heat. Also avoid contact with electrical circuits.
- (c) Keep oil and grease away from cylinders.
- (d) Cylinders standing in the open should be screened against the direct rays of the sun.
- (e) Protect cylinder valves from bumps and falling objects. Keep the valves clean, free from oil, grease and all foreign materials.
- (f) Close cylinder valves when not in use, when empty, or when moving the cylinders. Always remove regulators when moving cylinders. Be sure the cylinder valve is tightly closed before removing regulators.
- (g) Never allow anyone to strike an arc or tap an electrode against any cylinder.
- (h) Never try or fill a cylinder or mix gases in a cylinder.
- (i) Never tamper with or alter cylinder numbers or markings.
- (j) Never use cylinders as supports or rollers.
- (k) When transporting cylinders by crane, do not use slings, use a cylinder cradle.
- (l) Never draw gas from cylinders except through properly attached pressure regulators or equipment designed for the purpose. If damaged, replace and send damaged regulator to the supplier for repairs.
- (m) If unable to make a gas tight seal between the cylinder valve and a regulator spigot, first check whether the spigot nut is tight. If so, check the regulator spigot. If the cylinder valve is damaged, notify the supplier. Check the condition of O-rings and sealing washers.
- (n) Never insert lead washers or other material between the regulator and cylinder valve. Never use oil or grease on this connection.
- (o) For cylinders with key operated valves, use only standard cylinder keys to open cylinder valves, and never extend the length of these keys under any circumstances. If valves cannot be opened by hand, do not use a hammer or a wrench, notify the supplier.
- (p) Open all cylinder valves slowly.
- (q) If the cylinder valve is operated by a key, leave the cylinder key in position when the inert compressed gas cylinder valves are open.
- (r) Valves should not be left completely opened so that the spindle is tight against the backstop. Leave at least half a turn from the fully open position to let others know the valve is open. Care is to be exercised where backstop valves are fitted as only some of these valves seal in the fully open position.

APPENDIX D
CYLINDER DIMENSIONS AND CAPACITIES
(Informative)

Table D1 provides nominal dimensions and capacities for cylinders for high pressure inert gases.

TABLE D1
APPROXIMATE DIMENSIONS AND CAPACITIES OF CYLINDERS FOR HIGH PRESSURE INDUSTRIAL GASES

| Dimension and unit | Cylinder classifications (see Figure D1) | | | | |
|----------------------------|--|---------|---------|------|---------|
| | C | D | E | F | G/K |
| Water capacity, L | 2–3 | 9–10 | 22–24 | 34 | 48–50 |
| Height, mm | 460 | 760 | 910 | 1295 | 1410 |
| Diameter, mm | 100–120 | 150–175 | 200–215 | 215 | 230–250 |
| Empty weight—steel, kg | 3–5 | 11 | 28 | — | 50 |
| Empty weight—aluminium, kg | 3.0 | 10 | 22 | 24 | 42 |

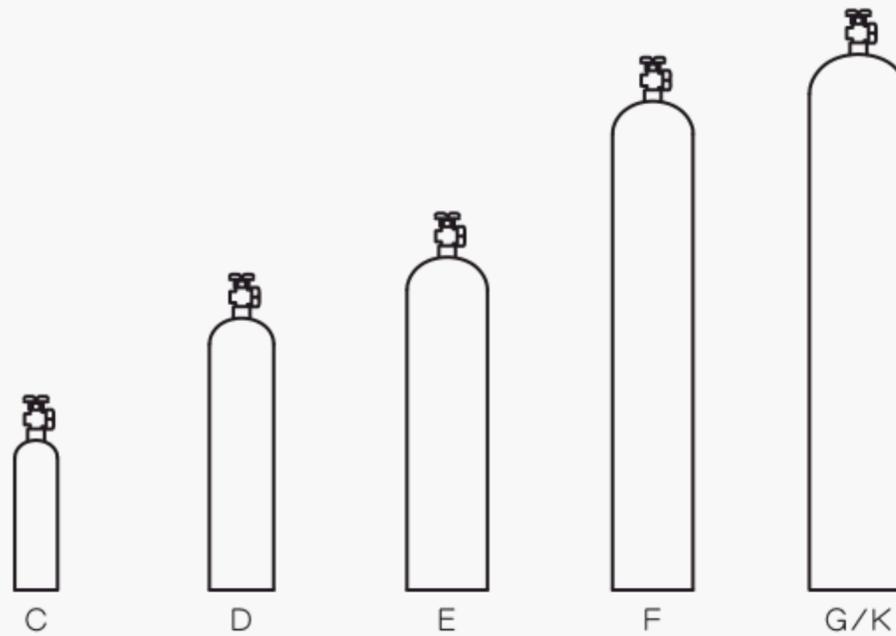


FIGURE D1 RELATIVE CYLINDER SIZES FOR
HIGH PRESSURE INDUSTRIAL GASES

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