



GUIDELINE FOR THE SAFE INSTALLATION AND USE OF CRYOGENIC FOOD FREEZING AND CHILLING EQUIPMENT

Doc 174/25

Revision of Doc 174/21

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GUIDELINE FOR THE SAFE INSTALLATION AND USE OF CRYOGENIC FOOD FREEZING AND CHILLING EQUIPMENT

Published in May 2025

As part of a programme of harmonisation of industry standards, the European Industrial Gases Association (EIGA) has published EIGA Doc 174, *Guideline for the Safe Installation of Cryogenic Food Freezing and Chilling Equipment*. This publication was jointly produced by members of the International Harmonisation Council.

This publication is intended as an international harmonised publication for the worldwide use and application by all members of the International Harmonisation Council whose members include the Asia Industrial Gases Association (AIGA), Compressed Gas Association (CGA), European Industrial Gases Association (EIGA), and Japan Industrial and Medical Gases Association (JIMGA). Regional editions have the same technical content as the EIGA edition, however, there are editorial changes primarily in formatting, units used and spelling. Regional regulatory requirements are those that apply to Europe.

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Amendments to 174/21

Section	Change
	DOC174 has been globally harmonised

NOTE Technical changes from the previous edition are underlined

1 Introduction

This publication has been prepared to cover the safety requirements and best practices for the installation and use of equipment for the chilling and freezing of food using refrigerated liquefied gases (liquid nitrogen and liquid carbon dioxide) as the cooling medium. This publication uses the expressions cryogenic and refrigerated liquefied gas when referring to both liquid nitrogen and liquid carbon dioxide. As the hazards of refrigerated liquefied gases may not be widely appreciated, specifically the differences between liquid nitrogen as a cryogen and liquid carbon dioxide, anyone installing or using this equipment is strongly advised to consult their liquefied cryogenic gas supplier and/or equipment supplier before installing or making any alteration to the system.

2 Scope and purpose

2.1 Scope

This publication covers the installation and operation of food freezing and chilling equipment and associated supply systems and the use of that equipment with refrigerated liquefied gases (nitrogen and carbon dioxide). Topics covered in this publication include but are not limited to safety, design, handling, storage, use, ventilation, maintenance, and monitoring of areas where these gases can accumulate and cause hazardous conditions. General safety guidelines or information within this publication are also applicable to non-food cryogenic applications.

This publication does not replace any risk assessment required by the operating company or employer.

This publication does not address food safety related to biological, chemical (including radiological), or physical contamination. These should be controlled through good manufacturing practices, materials of construction, and other risk-based controls identified in other publications.

2.2 Purpose

The purpose is to provide minimum requirements on the design, installation, and operation of food freezing and chilling equipment and the associated supply system so that they can be operated safely.

This publication will also inform about risks and their mitigation when refrigerated liquefied gases are used for freezing and chilling. These specific risks are:

- asphyxiation (oxygen deficiency);
- elevated carbon dioxide concentration;
- pressure build up due to confined evaporation/sublimation (bursting/leaking); and
- hazards due to low temperatures.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

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

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

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

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions**3.2.1 Asphyxiation**

To become unconscious or die from a lack of oxygen.

3.2.2 Automatic shutoff valve

Supply isolation valve that automatically closes when actuated by gas detection signal or activation switch, and in the event of a power failure.

3.2.3 Carbon dioxide intoxication

Carbon dioxide overexposure that is physiologically harmful.

3.2.4 Cryogenic liquid

See refrigerated liquefied gas.

3.2.5 Dilution air

Air that is mixed in with the cold exhaust gases from the food freezing and chilling equipment in order to warm them up as they are exhausted.

3.2.6 Exhaust system

Components utilized to remove the residual refrigerated gases and/or dilution air to an area where venting does not cause a hazard.

3.2.7 Food gases

Gases in solid, liquid, gaseous form intended to be used as a food additive, direct contact processing aid or ingredient in accordance with relevant regional regulatory requirements.

3.2.8 Fresh air

Having a composition that is indistinguishable from atmospheric air.

3.2.9 Food freezing and chilling equipment

Equipment that uses a liquefied gas (cryogenic or refrigerated) to freeze or chill.

3.2.10 Gas detector

Device designed to detect the concentration of a specific gas and is a component of a gas monitoring system.

3.2.11 Inert gas

Gas(es) that does not readily react chemically with other substances under normal conditions of temperature and pressure.

3.2.12 Life safety controls

Comprehensive safety systems consisting of elements that are designed to protect occupants during an emergency.

3.2.13 Operating company

Responsible company operating the food freezing and chilling equipment and that is accountable for personnel safety and maintaining the risk assessment.

3.2.14 Oxygen depletion

Reduction of oxygen concentration in normal atmospheric air (concentrations of less than 20.9%).

3.2.15 Refrigerated liquefied gas

Gas that when packaged is made partially liquid because of its low temperature.

3.2.16 Risk assessment

Overall process of risk identification, risk analysis, and risk evaluation.

3.2.17 Spray nozzle

Attachment that causes the refrigerated liquefied gas to be delivered as a spray.

3.2.18 Supply system

Assembly of dedicated equipment designed to store and distribute refrigerated liquefied gas.

4 Overall description of installation

Installations shall consist of five main parts as shown in Figure 1:

- storage vessel for the refrigerated liquefied gas complete with pressure control;
- pipeline to supply the food freezing and chilling equipment;
- food freezing and chilling equipment;
- exhaust system for the residual refrigerated gases and/ or dilution air; and
- gas monitoring system.

All these main parts shall be present to ensure a safe installation. The operating company shall ensure a risk assessment is performed.

From an engineering perspective, the complete installation should be treated as a single entity even though the individual components may be provided from different sources and/or suppliers.

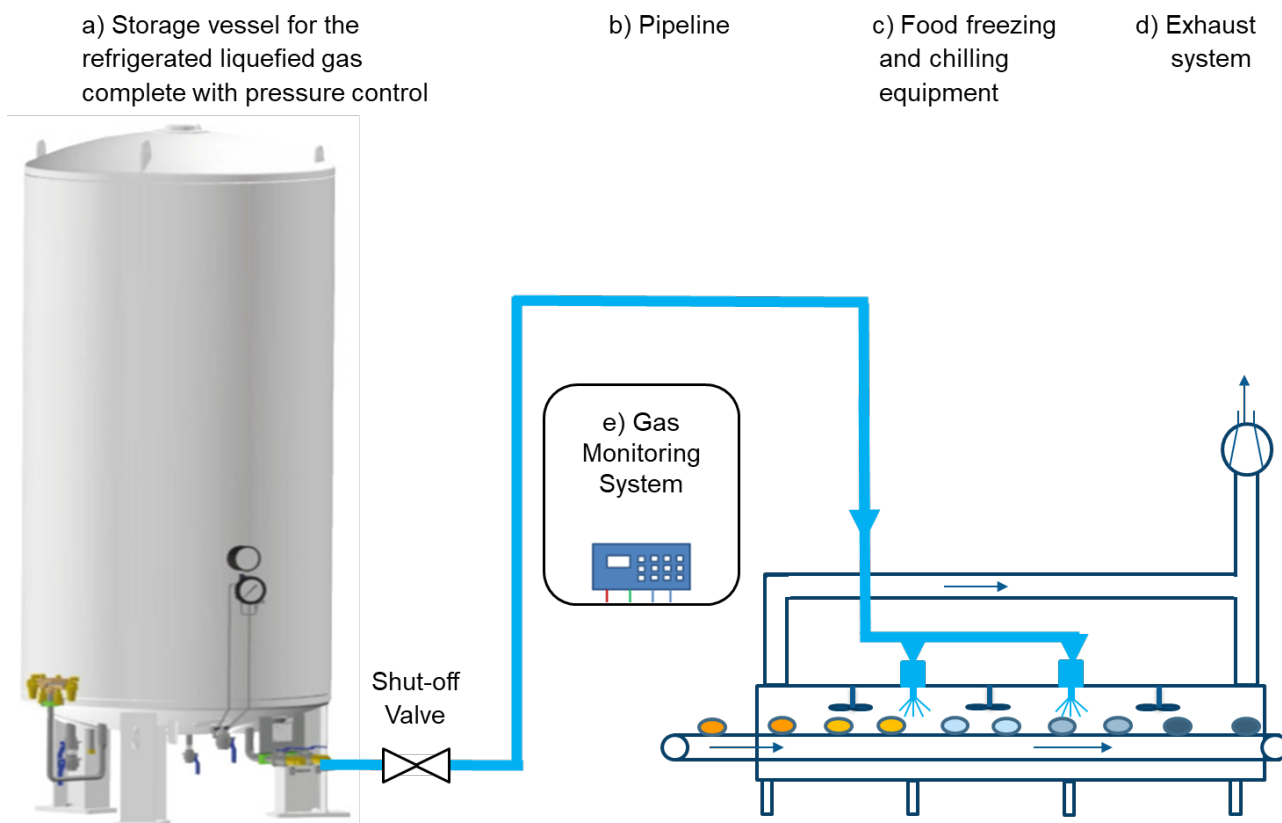


Figure 1—Example of a food freezing and chilling equipment installation using refrigerated liquefied gas

5 General refrigerated liquefied gas safety

5.1 Physical and chemical properties

Nitrogen, 78% of the air, is inert, chemically inactive, and non-corrosive at food freezing temperatures. It cannot be detected by humans by smell (odour), taste, visibility or any other natural senses. The operating company should refer to the supplier's safety data sheets (SDS) for the hazards of nitrogen. See CGA P-9, *The Inert Gases: Argon, Nitrogen, and Helium* or EIGA Doc 23, *Safety Training of Employees* [1, 2].¹

Carbon dioxide, 0.04% of the air, is non-corrosive at food freezing temperatures. It cannot be a liquid under atmospheric conditions but can be in a solid or gaseous form. It can be undetectable by humans by smell (odour), taste, visibility, or any other natural senses. The operating company should refer to the supplier's SDS for the hazards of carbon dioxide. See CGA G-6, *Carbon Dioxide* or EIGA SI 24, *Carbon Dioxide Physiological Hazards - "Not just an Asphyxiant!"* [3, 4].

When at food freezing temperatures, both carbon dioxide and nitrogen are heavier than air and if there is a leak, they will tend to collect at the floor.

5.2 Skin or eye frostbite

Because of their extremely low temperatures refrigerated liquefied gases, whether liquid, solid or gas, can cause frostbite on exposed skin. Delicate tissues such as eyes can be damaged by exposure to these cold gases, even when the contact is too brief to affect the skin of the hands or face.

Do not allow any unprotected part of the body to touch uninsulated pipes or vessels that contain refrigerated liquefied gases. The extremely cold metal will cause the flesh to stick, and tearing will occur

¹ References are shown by bracketed numbers and are listed in order of appearance in the reference section.

when removal is attempted. Even non-metallic materials at food freezing temperatures are hazardous to touch.

5.3 Asphyxiation and carbon dioxide intoxication

Oxygen is the only gas that supports life. The normal oxygen concentration in air is approximately 21% by volume.

All other gases can cause asphyxiation in an enclosed workspace by displacing oxygen. The hazards of reduced oxygen levels are given in Table 1.

Table 1—Oxygen concentration and effects

Oxygen percent at sea level (atmospheric pressure = 760 mmHg)	Effects ^{1) 2) 3) 4)}
20.9	Normal (below 19.5% is considered oxygen deficient)
19.5 – 10	Increased breathing rates; accelerated heartbeat; and impaired attention, thinking, and coordination
10 – 6	Nausea, vomiting, lethargic movements, and perhaps unconsciousness
<6	Convulsions, then cessation of breathing, followed by cardiac standstill (death). These symptoms can occur immediately.
NOTES ¹⁾ Adapted from Title 29 of the U.S. <i>Code of Federal Regulations</i>, Parts 1910 and 1926 [5]. ²⁾ These indications are for a healthy average person at rest. Factors such as individual health (being a smoker), degree of physical exertion, and high altitudes can affect these symptoms and the oxygen levels at which they occur. ³⁾ A hazardous atmosphere oxygen concentration range as defined by the U.S. Occupational Safety and Health Administration (OSHA) is outside the range of 19.5% to 23.5% [5]. ⁴⁾ While the percentage of oxygen does not change with altitude, the partial pressure of the atmosphere decreases, which creates physiological effects similar to oxygen deficiency. These effects increase at higher altitudes. Working at altitudes above 2 438 m (8 000 ft) can have similar effects to working in a 15% oxygen atmosphere and working at altitudes of 4 267 m (14 000 ft) can have effects similar to a 12% oxygen atmosphere. Precautions such as supplemental oxygen and acclimatization shall be taken when working at altitudes to protect the employees against the effects of altitude sickness and other physiological effects similar to those experienced with decreasing oxygen concentrations. Consult knowledgeable medical and safety professionals regarding the specific precautions to take when working at high altitudes.	

Consideration should be given to undertake a specific risk assessment aligned together with reference to EIGA Doc 44, *Hazards of Oxygen-Deficient Atmospheres* [6].

The presence of inert gases cannot be detected without instrumentation. Therefore, workers can be asphyxiated before they realise an asphyxiating atmosphere exists.

In addition to asphyxiation, carbon dioxide can cause adverse physiological effects including fatality depending on exposure level and duration, see EIGA SI 24, and CGA G-6 [3, 4].

Carbon dioxide is naturally present in air at a level of approximately 350 ppm to 420 ppm (0.035% to 0.042%). Carbon dioxide at these concentrations is non-toxic. However, at elevated concentrations, carbon dioxide can be intoxicating and ultimately act as an asphyxiant. Carbon dioxide hazards and physiological effects are much more complex compared to other gases classified as asphyxiants. Namely, in contrast to other asphyxiant gases, carbon dioxide is a normal product of metabolism in human beings and takes an active part in pulmonary gas exchange principle when people breathe. It forms a part of the human body's normal chemical environment as an active messenger substance in the linking of respiration, circulation, and vascular response to the demands of human metabolism.