

CGA P-1—2022
STANDARD FOR SAFE
HANDLING OF COMPRESSED
GASES IN CONTAINERS

THIRTEENTH EDITION

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NOTE—Technical changes from the previous edition are underlined.

NOTE—Appendix A (Normative) is a requirement.

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1 Introduction

Users of gases supplied in containers as compressed or liquefied gases or as cryogenic or refrigerated liquids shall become familiar with the properties and inherent hazards of the products they use. Valuable information about each specific gas is contained in its product labeling and safety data sheet (SDS). Read this information and inform others of the importance of understanding and applying the precautions recommended within the available safety literature.

The user is cautioned that hazard classification systems exist for labeling, storage, transportation, security, and other purposes, particularly from regulatory agencies, which can result in a different classification of the hazard. In addition, there can be additional hazards not addressed in this standard; therefore, the user should consult the gas supplier's SDS for specific information. See Title 29 of the U.S. *Code of Federal Regulations* (29 CFR); CGA C-7, *Guide to Classification and Labeling of Compressed Gases*; and CGA P-19, *CGA Recommended Hazard Ratings for Compressed Gases* [1, 2, 3].¹ The user should perform due diligence to research any necessary codes or regulations that can affect the use of these products.

Safe handling practices for refrigerated liquefied gases and cryogenic liquids are based on understanding the specific properties of each gas. Procedures should be developed based on those specific properties and knowledge of the material compatibility of each gas. The compressed gas industry has developed safe handling, delivery, and equipment design methods that are specific to each refrigerated liquefied gas or cryogenic liquid discussed in this publication by obtaining a thorough understanding of the risks and hazards associated with each gas. This individualized approach minimizes the risks of handling and use of these gases.

2 Scope

This standard is primarily for the users of compressed gases in containers and is based upon accepted good practices. This standard also contains precautions that are applicable to gas suppliers and distributors. It should not be assumed that all applicable safety and security precautions or regulations are contained here.

The term “container” as used in this publication shall refer to portable compressed gas cylinders and liquid containers made in accordance with the U.S. Department of Transportation (DOT), Transport Canada (TC), or the American Society of Mechanical Engineers (ASME) specifications [4, 5, 6].

Additional information on the movement and handling of liquid containers with wheel bases can be found in CGA P-84, *Guideline for Safe Handling of Liquid Containers on Wheel Bases* [7].

Additional information and requirements contained in CGA P-2, *Guideline for Characteristics and Safe Handling of Medical Gases*, and other related publications it references should be reviewed when handling medical gases [8].

For the purpose of this publication, the use of the term compressed gas(es) includes cryogenic liquids, refrigerated liquids, and liquefied gases, unless otherwise noted.

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.

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

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 Absolute pressure**

Based on a zero pressure reference, the perfect vacuum. Measured from this reference, the standard atmospheric pressure at sea level is 14.696 psia (101.325 kPa, abs); however, local atmospheric pressure can deviate from this standard value because of weather conditions and the elevation above or below sea level.²

NOTE—Absolute pressure is commonly denoted as psia or kPa, abs.

3.2.2 Apparatus

Accessory equipment such as valves, pressure relief devices (PRDs), regulators, etc., used with compressed gas containers.

3.2.3 Charging

Synonym sometimes used by regulatory agencies for the word filling.

3.2.4 Compressed gas**3.2.4.1 Corrosive liquid or gas**

Liquid or gas that when in contact with living tissue causes full thickness destruction of the human skin within a specified period of time [4].

NOTE—In this publication, this term shall not refer to action on metal surfaces.

3.2.4.2 Cryogenic liquid

Refrigerated liquefied gas having a boiling point colder than $-90\text{ }^{\circ}\text{C}$ ($-130\text{ }^{\circ}\text{F}$) at 101.3 kPa, abs (14.7 psia) [4].

3.2.4.3 Flammable gas

Any material that is a gas at $20\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F}$) or less and 101.3 kPa, abs (14.7 psia) of pressure (a material that has a boiling point of $20\text{ }^{\circ}\text{C}$ [$68\text{ }^{\circ}\text{F}$] or less at 101.3 kPa, abs [14.7 psia]) that:

- is ignitable at 101.3 kPa, abs (14.7 psia) when in a mixture of 13% or less by volume with air; or
- has a flammable range at 101.3 kPa, abs (14.7 psia) with air of at least 12% regardless of the lower limit.

The limits specified shall be determined at 101.3 kPa, abs (14.7 psia) of pressure and a temperature of $20\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F}$) in accordance with ASTM E681-09, *Standard Test Method for Concentration Limits of Flammability of Chemicals*, or other approved equivalent methods [10].

² kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure or (kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Guideline for Metric Practice in the Compressed Gas Industry* [9].

3.2.4.4 Gas poisonous by inhalation (toxic gas)

Any material that is a gas at 20 °C (68 °F) or less and a pressure of 101.3 kPa, abs (14.7 psia) (a material that has a boiling point of 20 °C [68 °F] or less at 101.3 kPa, abs [14.7 psia]) that:

- is known to be so toxic to humans as to pose a hazard to health during transportation; or
- in the absence of adequate data on human toxicity, is presumed to be toxic to humans because when tested on laboratory animals it has an LC₅₀ value of not more than 5000 mL/m³ [4].

NOTE—LC₅₀ values for mixtures can be determined using the formula in 49 CFR Part 173.133(b)(1)(i) or CGA P-20, *Standard for Classification of Toxic Gas Mixtures* [4, 12].

NOTE—Regulations such as 29 CFR and the *Globally Harmonized System of Classification and Labelling of Chemicals* can have different LC₅₀ threshold values for classifying gases as toxic [1, 13]. As a result, additional requirements for these gases can be imposed on the user.

NOTE—Some local codes and ordinances use the term toxic to define those gases that have LC₅₀ values less than or equal to 2000 ppm and highly toxic for gases that have LC₅₀ values less than or equal to 200 ppm. As a result, additional requirements for these gases can be imposed on the user.

3.2.4.5 Inert gas

Nontoxic, nonreactive, nonflammable, noncorrosive gas.

NOTE—Examples of an inert gas include argon, carbon dioxide, helium, krypton, neon, nitrogen, and xenon.

3.2.4.6 Nonflammable, nonpoisonous compressed gas

Any material (or mixture) that:

- exerts in the packaging a pressure of 200 kPa (29.0 psi) or greater at 20 °C (68 °F), is a liquefied gas or is a cryogenic liquid; and
- does not meet the definition of a flammable gas or gas poisonous by inhalation [4].

3.2.4.7 Oxidizing gas

Gas that can support and accelerate combustion of other materials more than air does [11].

3.2.4.8 Pyrophoric gas

Gas that ignites spontaneously in air at or below a temperature of 130 °F (54 °C).

3.2.4.9 Refrigerated liquefied gas

Gas having a boiling point less than −50 °C (−58 °F) but greater than −90 °C (−130 °F) at 101.3 kPa, abs (14.7 psia).

NOTE—For example, carbon dioxide and nitrous oxide are refrigerated liquefied gases but do not meet the definition of a cryogenic liquid. See 3.2.4.2.

3.2.5 Container owner

Business or individual holding the legal title for the container(s).

3.2.6 Containers

Vessels of various shapes, sizes, and materials of constructions such as cylinders, portable tanks, or stationary tanks that meet the specifications of either American Society of Mechanical Engineers (ASME), Transport Canada (TC), U.S. Department of Transportation (DOT), European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), Japanese Industrial Standards (JIS), or national authorities, and are filled with gases under pressure.

NOTE—Containers include cylinders, portable tanks, spheres, or stationary tanks.

3.2.7 Cryogenic liquid container

Pressurized, double-walled, insulated container used to hold either cryogenic liquefied gas or refrigerated liquefied gas.

3.2.8 Cylinder

Pressure vessel designed for pressures higher than 40 psia (276 kPa, abs) and having a circular cross section. It does not include a portable tank, multiunit tank car tank, cargo tank, or tank car [4].

3.2.9 Dewar

Open-mouthed, nonpressurized portable liquid containers that are vacuum jacketed or insulated vessels designed to hold cryogenic liquids.

3.2.10 Distributor

Business engaged in the sale and/or resale of compressed and liquefied gases.

3.2.11 Gas pressure

Force per unit of area exerted by a gas on its surroundings.

NOTE—In the United States, gas pressure is commonly designated in pounds per square inch (psi). The analogous SI unit is the kilopascal (kPa). 1 psi equals 6.895 kPa. Another term used to express gas pressure is bar; 1 bar equals 14.5 psi.

3.2.12 Gas service

Specific type of gas for which a container and its apparatus are designed and used.

3.2.13 Gas supplier

Business that produces, fills, and/or distributes compressed gases in compressed gas containers.

3.2.14 Gauge pressure

Pressure above or below local atmospheric pressure; therefore, absolute pressure (psia or kPa, abs) minus local atmospheric pressure (psia or kPa, abs) equals gauge pressure.

NOTE—Gauge pressure is commonly designated by the abbreviation psi or kPa.

3.2.15 Handling

Moving, connecting, or disconnecting a compressed or liquefied gas container under normal conditions of use.

3.2.16 Liquefied natural gas (LNG)

Cryogenic natural gas in the liquid form.

3.2.17 Liquefied petroleum gas (LPG)

Butane, isobutane, propane, propylene (propene), butylenes (butenes) and any mixtures of these hydrocarbons.

3.2.18 Manifold

Gas distribution system that interconnects individual containers allowing filling or withdrawal of product into/from multiple gas containers at the same time.

3.2.19 Nesting

Method of securing flat-bottom cylinders upright in a tight mass using a contiguous three-point contact system whereby all cylinders within a group have a minimum of three points of contact with other cylinders, walls, or bracing.

NOTE—See Appendix A.

3.2.20 Normal temperature and pressure

Temperature of 20 °C (68 °F) and an absolute pressure of 101.325 kPa, abs (14.7 psia) [11].

NOTE—Local atmospheric pressure can deviate from this standard value because of weather conditions and the distance above or below sea level.

3.2.21 Pressure regulator

Gas pressure-reducing and -controlling device designed to provide a controlled delivery (downstream) pressure over a range of variable inlet (cylinder) pressures and/or flow rates.

NOTE—A pressure regulator can have one or more stages of pressure reduction.

3.2.22 Pressure relief device (PRD)

Pressure and/or temperature-activated device that may be used to prevent the pressure from rising above a predetermined maximum and thereby prevent equipment or container failure due to overpressurization.

NOTE—The term PRD is synonymous with safety relief device as used in DOT and TC regulations.

3.2.23 Regulations

Federal, state, provincial, territorial, or local laws to which the handling of compressed gas containers shall comply.

3.2.24 Safety data sheet (SDS)

Written or printed information concerning a hazardous material prepared in accordance with the provisions of Title 29 of the U.S. *Code of Federal Regulations* (29 CFR) Part 1910.1200 in the United States and in Canada, the federal *Hazardous Products Act* and *Controlled Products Regulations* (CPR), and provincial *Workplace Hazardous Materials Information System Regulations* (WHMIS) [1, 14, 15].

3.2.25 Single-use cylinder

Cylinder designed and constructed in accordance with DOT or TC regulations and, by those regulations, is only allowed to be filled once [4, 5].

NOTE— Also known as disposable, nonreturnable, or nonrefillable cylinders. See CGA PS-60, *CGA Position Statement on Prohibition on Refilling Single-Use Cylinders and Containers*, for further information [16].

3.2.26 Transfilling

Transfer of cryogenic liquid, refrigerated liquefied gas, and/or compressed or liquefied gas from one container to another.

3.2.27 Use

Act of withdrawing and applying the product gas by a consumer.

3.2.28 User

Individual, group, or business entity that uses the containerized gas in a nonrecoverable manner.

NOTE—Users can be, but are not necessarily, customers.

3.2.29 Valve outlet caps and plugs

Device that serves as a pressure barrier against leakage out of the valve outlet and provides a protective covering against contamination from external sources.

3.2.30 Valve outlet dust caps and plugs

Removable attachment that provides valve thread protection and a protective covering against contamination from external sources.

3.2.31 Valve protection cap

Rigid removable cover provided for container valve protection during handling, transportation, and storage.

3.2.32 Valve protection device

Device attached to the neck ring or body of the container for the purpose of protecting the container valve from being struck or damaged by impact resulting from a fall or an object striking the container in accordance with 49 CFR and CSA B340, *Selection and Use of Cylinders, Spheres, Tubes, and Other Containers for the Transportation of Dangerous Goods, Class 2* [4, 17].

4 Regulations and standards applicable to compressed gases in containers

4.1 Transportation regulating authorities

In the United States, the transportation, safety, and security of compressed gases, refrigerated liquefied gases, and cryogenic liquids in containers by highway is regulated by DOT through the Pipeline and Hazardous Materials Safety Administration and the Federal Motor Carrier Safety Administration. Rail transport is regulated by the Federal Railroad Administration and air transportation of hazardous materials is regulated by the Federal Aviation

Administration. Transportation safety and security of compressed gases, refrigerated liquefied gases, and cryogenic liquids by water is regulated by the U.S. Coast Guard under the authority of the Department of Homeland Security. Most states and some municipalities also regulate the intrastate and intracity transportation of compressed gases through state and local transportation authorities.

DOT's regulations for compressed gases are also reproduced for carrier and shipper use by associations such as the Association of American Railroads, the Bureau of Explosives, and the American Trucking Association. Additional requirements for air transportation are covered by the carrier tariffs of the Air Transportation Association for domestic shipments and by the International Air Transport Association for foreign shipments.

In Canada, TC has the responsibility for the transportation of compressed gases in conjunction with provinces for all modes of transportation [5].

International shipment of compressed gases by water is governed by the International Maritime Organization [18].

4.2 Container regulations

DOT regulations in 49 CFR require that compressed gases be shipped in DOT-approved containers and maintained in accordance with DOT regulations [4]. In Canada, containers in which compressed gases are shipped shall comply with TC's *Transportation of Dangerous Goods Regulations* [5].

4.3 Container filling regulations

In the United States, containers filled for the transportation of compressed gases shall comply with DOT regulations governing the following subjects:

- ownership of the container and authorization to fill it;
- type of containers in which each gas is allowed to be shipped;
- charging of containers as to the amount of gas and conditions of filling;
- requirements for marking and labeling containers in transportation;
- requirements for qualifying, maintaining, and requalifying containers;
- conditions under which a container is allowed to be transported and the placarding of transport vehicles; and
- type(s) of PRD(s), where required [4].

In Canada, the filling requirements of containers are governed by TC's *Transportation of Dangerous Goods Regulations* [5].

The compressed gas industry recognizes that the filling process for DOT/TC cylinders used to contain nonliquefied gases is subject to variations and regulatory requirements that affect the settled pressure. See CGA P-77, *Standard for Filling Nonliquefied Gases in TC/DOT Specification Cylinders to a Specified Settled Pressure*, for further information [19].

4.4 Regulating authorities of workplace safety and health

Matters affecting safety and health in the workplace are regulated by the U.S. Department of Labor. Compressed gas containers shall be marked, labeled, stored, handled, and used in accordance with applicable Occupational Safety and Health Administration (OSHA) standards as well as other federal, state, provincial, territorial, or local regulations [1].

In Canada, workplace safety and health are covered by federal and provincial/territorial occupational safety and health regulations including the federal *Controlled Products Regulations* (CPR) and provincial WHMIS regulations [14, 15].

5 General safe handling rules for compressed gas containers

5.1 Personnel

Compressed gases shall only be handled and used by persons trained in their safe handling and use.

5.2 Content identification

Containers offered for shipment in North America shall have their contents identified as prescribed by DOT, OSHA, Health Canada, and TC. Containers may have the contents identified in accordance with Appendix A of CGA C-7 [2]. Content identification should be applied to the container before its removal from the filling manifold or when mixtures are analyzed. The identification shall be present during the transportation and delivery to the user.

OSHA requires that physical and health hazards and precautions be identified on each container [1]. CGA C-7 includes precautionary and warning information for each of the gases listed in that publication [2].

In Canada, identification shall be in accordance with TC's *Transportation of Dangerous Goods Regulations*, CPR, and provincial WHMIS regulations [5, 14, 15].

5.2.1 Labels

The labels applied by the gas supplier to identify the container contents shall not be defaced or removed by the user.

5.2.2 Color markings

The container color shall not be used as the primary method to identify its content. The primary identifier is the container label. Medical gas containers shall be color marked in accordance with CGA C-9, *Standard Color Marking of Compressed Gas Containers for Medical Use* [20].

5.2.3 Unidentified container contents

Containers not bearing a legible label shall not be used. They shall be segregated for return to the gas supplier or distributor. Refer to CGA P-22, *The Responsible Management and Disposition of Compressed Gases and their Cylinders*, for guidance in dealing with containers with unknown contents [21].

5.3 User responsibilities

The user is responsible for the safe handling, use, and storage of the container and its contents and for returning the container to the gas supplier or distributor in the same safe condition that it was received. The following precautions concerning the container and its apparatus shall be observed by the user:

- Container maintenance—Maintenance of the container and its valve or PRD (if required) shall be performed only by trained personnel under the direction of the container owner or an authorized representative;
- Prescribed markings—The prescribed stamped or other permanent-type markings on the container shall be kept in a legible condition. The user shall not add, remove, or alter any of these markings;
- Container modifications—The user shall not modify, tamper with, paint, deface, obstruct, remove, or repair any part of the container including the PRD and the container valve or the valve protection device;
- Contamination—Contamination can occur when foreign substances enter the container or valve. If this has happened or even if the possibility exists, the user shall identify and clearly mark the container and notify the gas supplier by providing the container serial number and the details of the contamination; and
- Workplace risk assessment—The user shall assess the environment where containers are being stored or used to ensure conditions in the environment are conducive to the gas and container. For example, steel cylinders shall not be used near a magnetic resonance imager and flammable gases shall not be stored in areas that do not meet electrical code classifications.