



CGA G-6.13—2023 STANDARD FOR STATIONARY UNINSULATED CYLINDER SUPPLY SYSTEMS FOR CARBON DIOXIDE

FIRST EDITION

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Full document details: CGA G-6.13-2023

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Work Item 19-96
Carbon Dioxide Committee

FIRST EDITION: 2023

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1 Introduction

Fill by pressure carbon dioxide dispensing systems are used in beverage dispensing, grow houses, extraction equipment, swimming pool pH control applications, etc. These types of systems are installed inside a customer's building (see Figures 1 and 2) and allow for filling the system remotely from outside the building. Beverage, extraction, and swimming pool applications are batch processes, and grow houses are continuous processes.

CGA G-6, *Carbon Dioxide*, contains information critical to safe storage and handling of carbon dioxide [1].¹ To ensure personnel safety and proper system design, reference to CGA G-6 is highly recommended [1]. Without obtaining CGA G-6, the reader will not be provided with significant information related to the physical properties and common hazards associated with storage, production, transportation, and handling of carbon dioxide [1].

2 Scope

This publication describes the design, installation, filling, use, and maintenance of a stationary uninsulated cylinder supply system for carbon dioxide using two or more cylinders with a directional flow control device that allows the system to function in a manner similar to a single cylinder. Unlike CGA G-6.3, *Carbon Dioxide Cylinder Filling and Handling Procedures*, where cylinders are filled individually by weight, this publication describes cylinders filled in place in accordance with the requirements of this standard [2].

This publication does address the hazards specifically associated with stationary uninsulated cylinder supply systems for carbon dioxide.

The systems in this publication have a total usable carbon dioxide capacity of 1500 lb (680.4 kg) or less. It is intended to assist designers, engineers, distributors, restaurant personnel, inspectors, other users, and all interested parties.

This publication contains minimum requirements and recommended practice for the design, construction, installation, operation, maintenance, and filling of stationary uninsulated cylinder supply systems for carbon dioxide in temperature controlled indoor environments. This publication does not address indoor or outdoor installation of these systems where the system temperature can exceed 87.9 °F (31.05 °C) (i.e., supercritical temperature of carbon dioxide) which requires additional safety and engineering controls.

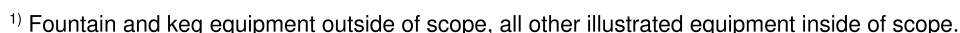
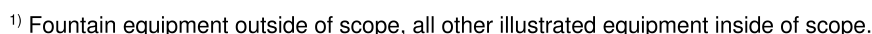
This publication covers stationary uninsulated cylinder supply systems from the delivery unit pumping system to the carbon dioxide cylinder gas outlet regulator reverse flow check valve inside the building (see Figures 1 and 2). This includes interconnecting piping between cylinders and their pressure relief device (PRD) systems (see Figure 1). These systems might also be covered by various national, provincial, state, and local codes. The details of these codes are not covered in this publication. Verify applicable codes in your place of business to ensure compliance.

This publication does not address the use of individual uninsulated carbon dioxide cylinders that are filled at non-use locations, nor filling of ASME cylinders. This publication also does not address small stationary insulated supply systems which are addressed in CGA G-6.5, *Standard for Small Stationary Insulated Carbon Dioxide Supply Systems* [3].

Although this publication shows placement of carbon dioxide detection monitors in various portions of the user facility, the responsibility for the proper location, installation, maintenance, and monitoring of the detection monitoring systems and its component parts is not specifically identified in this publication. The responsibility for these activities generally lies with the user. If not, they should be fully described in an agreement between the user and their monitoring equipment manufacturer and installer or, in some instances, between the user and their carbon dioxide supplier.

While this standard provides requirements for user installations, final approval for the design, equipment, appurtenances, installation, and maintenance rests with authorities having jurisdiction (AHJ) in this area.

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



3 Definitions

For the purposes 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 Appurtenances

All system components (excluding the cylinders and directional control device) such as PRDs, valves, pressure gauges, vaporizers, pumps, control equipment, and regulators.

3.2.2 Authority having jurisdiction (AHJ)

Organization, office, or individual responsible for approving equipment, an installation, or a procedure.

3.2.3 Blow-down valve

Manually operated valve used to depressurize lines or systems.

3.2.4 Capacity

Amount of carbon dioxide the uninsulated cylinder supply system will hold under equilibrium conditions at normal operating pressure and temperature when filled to its design level.

3.2.5 Carbon dioxide leak detection system

System of components used to measure and announce potentially hazardous concentrations of carbon dioxide. This can include sensors, monitor, control unit, and audible and visual notification devices.

3.2.6 Design pressure

Pressure that is equal to the lowest cylinder burst disk pressure rating. Most severe condition of coincident pressure and temperature expected in normal operation. This considers the maximum allowable working pressure (MAWP), static head of the product, and the vacuum if vacuum jacketed.

3.2.7 Directional flow control device

Controls the flow of carbon dioxide liquid and vapor in the dispensing system.

3.2.8 Fill box

Connection point of the fill line that allows the carbon dioxide delivery truck to transfer liquid carbon dioxide into a stationary uninsulated system for carbon dioxide.

NOTE—The fill box may contain outlet for PRDs.

3.2.9 Fill connection

Manufacturer's specific proprietary fitting within the fill box to which the proprietary liquid carbon dioxide fill gun is attached.

3.2.10 Fill gun

Manufacturer's specific proprietary assembly attached to the delivery end of the liquid carbon dioxide delivery vessel fill hose. The fill gun includes, a manual venting discharge valve, and an isolation valve.

3.2.11 Fill line

Line connecting the fill box to the stationary uninsulated cylinder supply system for transferring carbon dioxide under pressure

3.2.12 Liquid carbon dioxide

Carbon dioxide that exists as a liquid only at pressures between 60.4 psi and 1055.9 psi (416 kPa and 7280 kPa) and temperatures between -69.9 °F and 87.9 °F (-56.6 °C and 31.1 °C).²

3.2.13 Liquid full

Condition in which thermal expansion of the liquid has displaced all the vapor space causing any additional liquid expansion to increase the pressure hydrostatically instead of pneumatically.

3.2.14 Operating pressure

Pressure at which the system normally operates, as distinguished from design pressure.

3.2.15 Pressure relief device (PRD)

Device designed to open at a specified value of pressure to prevent the internal pressure from rising above a specified value.

NOTE—It may be a pressure relief valve, a nonreclosing PRD, or a nonreclosing PRD in combination with a pressure relief valve. The term "pressure relief" is synonymous with the expression "safety relief" as used in various applicable regulations, codes, standards, or specifications.

3.2.16 Pumping system

System mounted on the delivery unit which includes pump, sensors, and controls to ensure the safe filling of the uninsulated cylinder supply system.[4]

3.2.17 Purging

Procedure for displacing air, moisture, and other foreign materials by using carbon dioxide vapor.

3.2.18 Qualified carbon dioxide technician

Person who by reason of education, training, and experience knows the properties of carbon dioxide; is familiar with stationary uninsulated carbon dioxide systems and has met the training requirements of the system manufacturer. The technician shall be trained in the precautions necessary to safely use carbon dioxide.

NOTE—Local or state jurisdictions may require additional training and/or certification.

3.2.19 Stationary uninsulated carbon dioxide system

Assembly of equipment consisting of two or more uninsulated carbon dioxide cylinders, with a directional flow control device, manifolded with interconnecting piping, and appurtenances designed to deliver gaseous carbon dioxide for beverage carbonation and other applications.

NOTE—The total useable liquid carbon dioxide capacity of the system using DOT or TC specifications cylinders is not greater than 1500 lb (680.4 kg) functioning as a single cylinder.

3.2.20 Sublimation

Process of changing from the solid phase directly to the gas phase without passing through the liquid phase.

3.2.21 System designer

Individual responsible for the design and analysis of the system to ensure it meets the requirements of this standard.

² psi, bar, and kPa shall indicate gauge pressure unless otherwise noted as (psia; bar, abs; and kPa, abs) for absolute pressure or (psid; bar, dif; and kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Metric Practice Guide in the Compressed Gas Industry* [5].

3.2.22 System installer

Individual responsible for the installation of the system following system manufacturer's recommendations requirements in accordance with requirements of authorities having jurisdiction.

3.2.23 System manufacturer

Individual responsible for design, manufacture, and assembly and testing at the factory of components, used in the system.

3.2.24 Triple point

Temperature and pressure at which a material exists simultaneously as a solid, liquid, and gas.

NOTE—For carbon dioxide the triple point is -69.9°F and 75.1 psia (-56.6°C and 518 kPa, abs).

3.2.25 Vent line

High pressure line used to conduct gas from a PRD to a location outside the facility.

4 Hazards

4.1 General

There are several conditions in which extreme danger to personnel and equipment can exist. Although all hazards shown in CGA G-6 are applicable to this operation, dry ice blocking/plugging, dry ice low temperature, and trapped liquid are hazards more prevalent with this type of system [1]. For information on and remediation of these and all hazards of carbon dioxide, see CGA G-6 [1].

4.2 Personnel overexposure

When carbon dioxide is used indoors, or in any enclosed area (both indoors or outdoors), preventing carbon dioxide overexposure is critically important to maintain a safe working environment for personnel. Carbon dioxide in the gaseous state is colorless, odorless, not easily detectable, and requires specific equipment to identify and warn of its presence. Since gaseous carbon dioxide is 1.5 times denser than air, it will be found in greater concentrations at low levels. Measuring the oxygen content in the air will not alert to dangerous levels of carbon dioxide even when adequate oxygen for life support is present. For additional information, see 5. Methods for mitigating the risks for exposure to high levels of carbon dioxide include mechanical ventilation and carbon dioxide monitors with alarms.

When designing a mechanical ventilation system, adequate performance should be defined in accordance with the International Association of Plumbing and Mechanical Officials (IAPMO), *Uniform Mechanical Code*, and assuring that specifications conform with provincial, state, and local jurisdictional building and fire codes.

Ventilation systems shall exhaust from the lowest level with the make-up air entering at a higher point. Make-up and exhaust rate of flow shall meet code requirements.

Standard commercial HVAC systems or additional fans do not provide sufficient protection or meet the code requirements for carbon dioxide ventilation.

A carbon dioxide monitor with an appropriate alarm system shall be installed where dangerous concentrations of carbon dioxide can accumulate including, but not limited to, below grade applications. Oxygen detection equipment shall not be used to monitor carbon dioxide concentration levels. Carbon dioxide leak detection systems shall be equipped with audible and visual warning devices located in the room or area in which the system is installed. This also includes the areas leading to the location of the leak detector to warn personnel of a hazardous condition before entering this location. Installation shall comply with any local code requirements. Basement, enclosed spaces, or below grade installations of system components, including downstream system equipment, require additional considerations because carbon dioxide gas is 1.5 times heavier than air and will collect and remain in low elevations and other areas without an exhaust system venting from the floor level. Basements should be used as container installation sites only as a last resort. A fan and a ducting system are recommended to vent carbon dioxide vapors continuously from the lowest floor level while fresh "make-up" air is introduced at a higher point, see Figure 6. All carbon dioxide monitoring and ventilation systems shall be code compliant. The hazards associated with containers in basements or enclosed spaces also apply to the