Chapter 13: Compressed Gas Safety

Guidelines for Compressed Gas Cylinders

The University of Illinois at Chicago (UIC) wants to ensure the safety of employees who handle compressed gases on campus. To achieve this objective, employees need to understand regulatory compliance with (OSHA) Compressed Gases in 29CFR, Subpart H Hazardous Materials 1910.101-1910.106, and the Compressed Gas Association (CGA) requirements. This standards and regulations cover the health and physical hazards of the compressed gas cylinders, proper handling storage requirements, and disposal of gas cylinders. To ensure safe handling of gas cylinders on campus, review this chapter for information on gas cylinder hazards, storage guidelines, special hazards, and disposal requirements.

General Physical Hazards of Gas Cylinders

Compressed gas cylinders can present a variety of hazards due to their pressure and contents. A typical gas cylinder is filled to 2,400 psi; it will contain almost 300 cubic feet of internal gas. This pressurized gas cylinder can become a flying missile if the inlet valve breaks off. All gas cylinders are pressurized and present a physical hazard.

Gas Cylinder Labels

Proper storage is essential for the safe use of compressed and liquefied gases. Hazard information regarding the gases should be clearly marked on the label of the gas cylinder. Never use a gas cylinder that does not have a label. Gas cylinders in the United States used the labeling system from the Department of Transportation (DOT). An example of the label below shows the hazard sign with DOT number, gas name, and hazard statement about the gas.

Storage Guidelines

General Rules

Store gas cylinders:
• In an upright position, in a well-ventilated area such a laboratory, research corridor, gas storage room, etc.
• Separate from empty cylinders from full gas cylinders.
• With a chain or appropriate belt above the midpoint of the cylinder. Laboratory cylinders less than 18 inches tall may be secured by approved stands or wall brackets.
• Store gas cylinders with the cap on when not in use.
• Store gases with the same hazard class in the same area. Inert gases are compatible with all other gases and may be stored together.

Do not store gas cylinders:
- In exits or egress routes.
- In damp areas; near corrosive chemicals, fumes, or by heat sources

Storage Quantity of Compress Gas Cylinders

The National Fire Protection Association's NFPA 45-*Standard on Fire Protection for Laboratories Using Chemicals* sets limits on the use and storage of hazardous gases.

At UIC, researchers are allowed to have the maximum allowable quantities (MAQ). The recommendation is made from NFPA 45, where they define a laboratory work area as “a room or space for testing, analysis, research, instruction, or similar activities that involve the use of chemicals.”

Table 1: Maximum Allowable Quantities of Hazardous Gases

	Flammable Gas Compressed (e.g. Hydrogen, Methane)	Oxidizing Gas Compressed (e.g. Oxygen)	Toxic Gas Compressed (e.g. Carbon Monoxide)
Amount Allowed per 500 ft^2 of Laboratory Work Area	6 cu ft. internal cylinder volume	6 cu ft. internal cylinder volume	0.3 cu ft. internal cylinder volume
Maximum Number of standard cylinders	4 cylinders (9"x51" cylinder)	4 cylinders (9"x51" cylinder)	1 lecture bottle
Lecture Bottle Limits	In addition to the maximum internal volumes above, the total number of lecture bottle cylinders shall be limited to 25 per Laboratory Work Area.		

Special Ventilation Requirements for Gas Cylinders

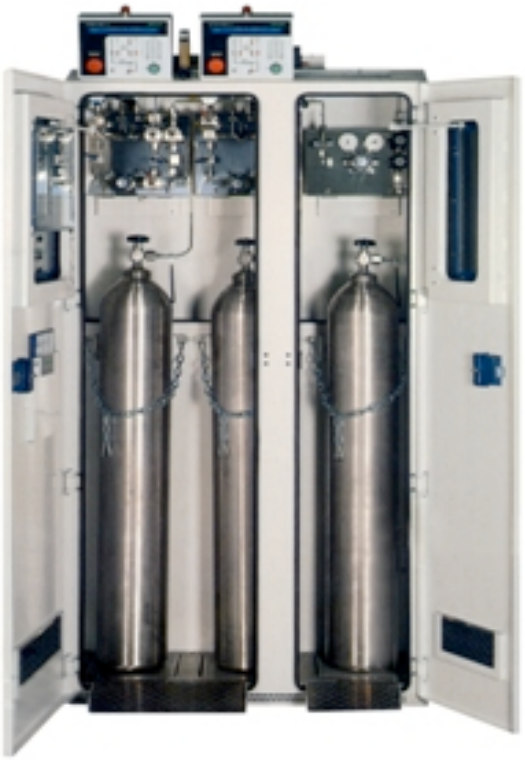
Lecture bottles of the following gases located in laboratory units must be kept in a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure:

- Toxic Gases that have an NFPA Health Hazard Rating of 3 or 4 (e.g. Hydrogen sulfide)
- Inhalation Hazard Gases that have an NFPA Health Hazard Rating of 2 without warning properties (e.g. Carbon monoxide)
- Pyrophoric gases (e.g. Silane)

Cylinders of hazardous gases that have health hazard ratings of 3 or 4, but do not have physiological warning properties must be stored in approved continuously mechanically ventilated gas cabinets.

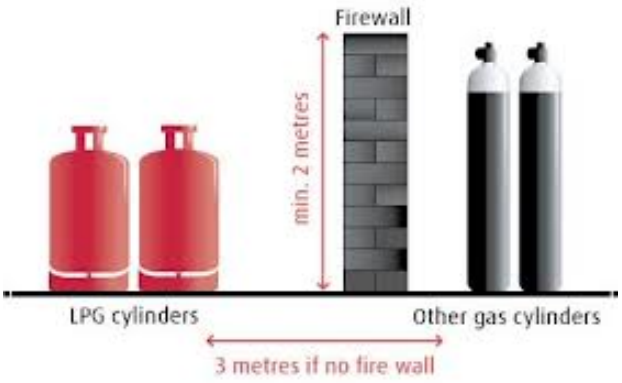
Cylinders of pyrophoric gases and toxic gases that are larger than lecture bottle size must be kept in approved continuously mechanically ventilated gas cabinets.

Mechanically Ventilated Gas Cabinets



Flammable Gas Cylinders

All flammable gas cylinders need to be separated from oxidizer gas cylinders by at least 20 feet away. However, you may construct a noncombustible wall at least 5 feet (1.524 meters) in height and with a fire resistance rating of at least 30 minutes as a barrier of separation between gas cylinder hazard classes.



Compressed Gas Regulators

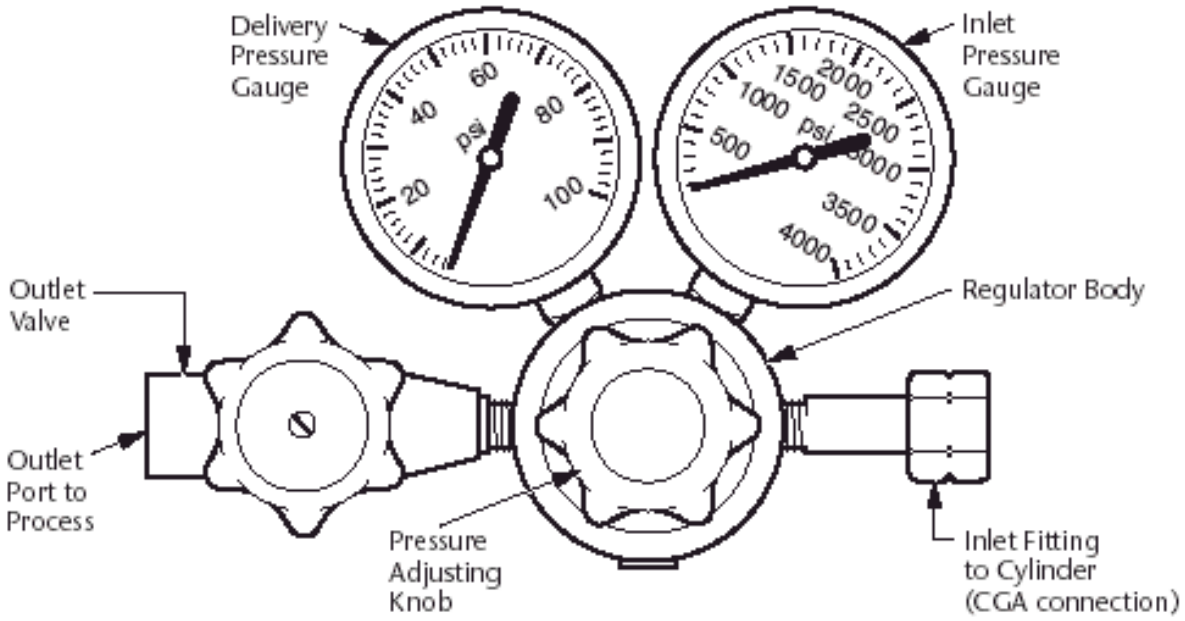
When choosing a gas regulator for the compressed gas, remember to match the gas cylinder CGA number with the regulator. The CGA number helps to ensure the right regulator is chosen for the right gas.

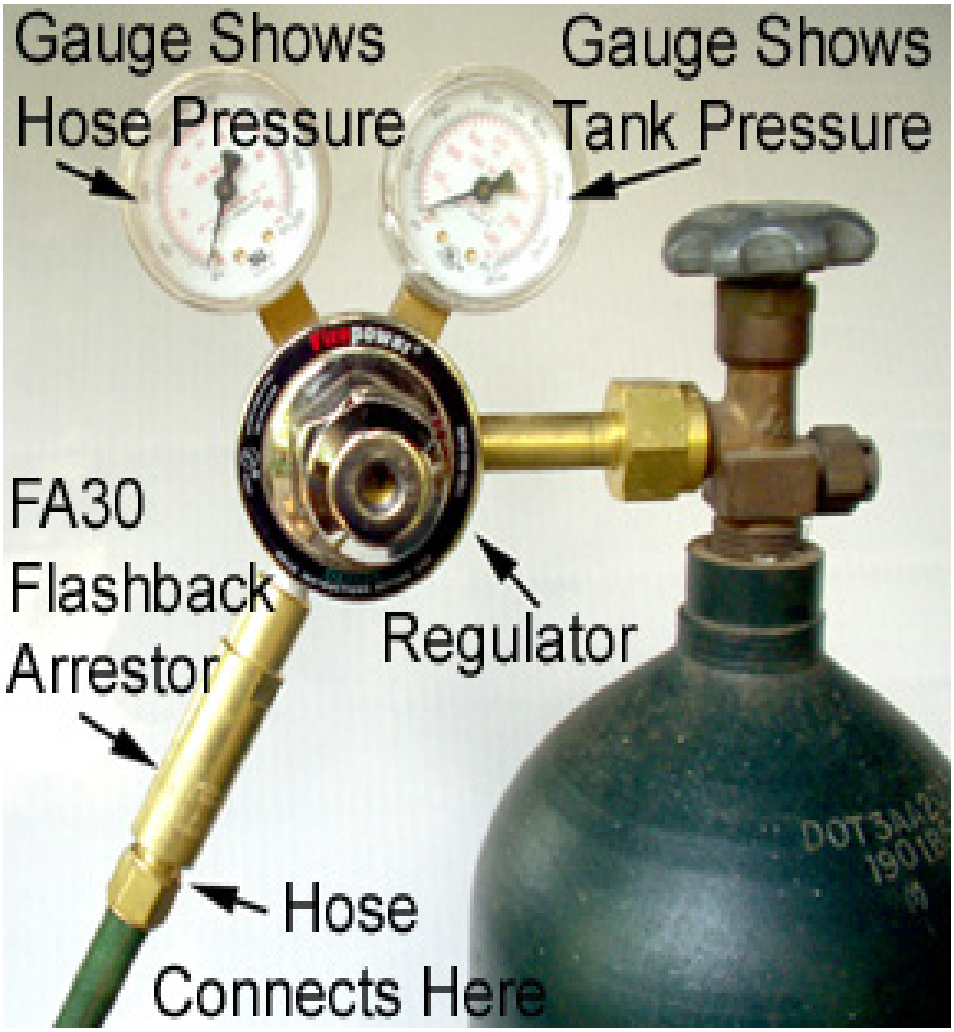
The Compressed Gas Association (CGA) creates the standard cylinders valve connection requirements. The association's goal for standardization is to prevent the mixing of incompatible gases.

To minimize safety hazards, only use CGA standard combinations of valves and fittings in compressed gas installations. The threads on cylinder valves, regulators, and other fittings should be examined to ensure they correspond and are undamaged.

You should never obstruct the cylinder valve when attaching a regulator. Operators of compressed gases need to be able to turn off the gas when no longer needed.

Common Laboratory Gases	CGA Regulator Number
Nitrogen	580
Helium	580
Argon	580
Oxygen	540
Air (non-medical)	590
Air (medical grade)	346
Propane	510
Acetylene	510
Methane	350
Hydrogen	350
Carbon Dioxide	320





Corrosive gases

If you are planning to use corrosive gases, it is recommended to purchase specialty gases in returnable mini-cylinders such as the 6AL. Lecture bottles are expensive to dispose of and departments must pay for their disposal. There is a hidden cost to using corrosive lecture bottles. When using a mini 6AL cylinder, it will be possible to have them inside your fume hood. However, any size larger than a mini 6AL cylinder will require a ventilated gas cabinet.

Toxic gases

Even in very small concentrations, brief exposure can result in serious poisoning. Symptoms of exposure may be delayed. Before beginning experiments, prepare a neutralizing scrubber in the event of a leak. When not in use, store gas cylinders securely fastened in a ventilated cabinet; do not stack on a shelf. Include detection equipment to monitor leaks for acutely toxic gases. Before use, secure smaller sized cylinders to a stable fixture in the fume hood.

- Do not work with a specialty gas unless you are familiar with its proper handling procedures and its toxic or corrosive effects.
- In cases where an inhalation hazard is present, contact EHSO if you think you need a respirator.

Cryogenic Liquids

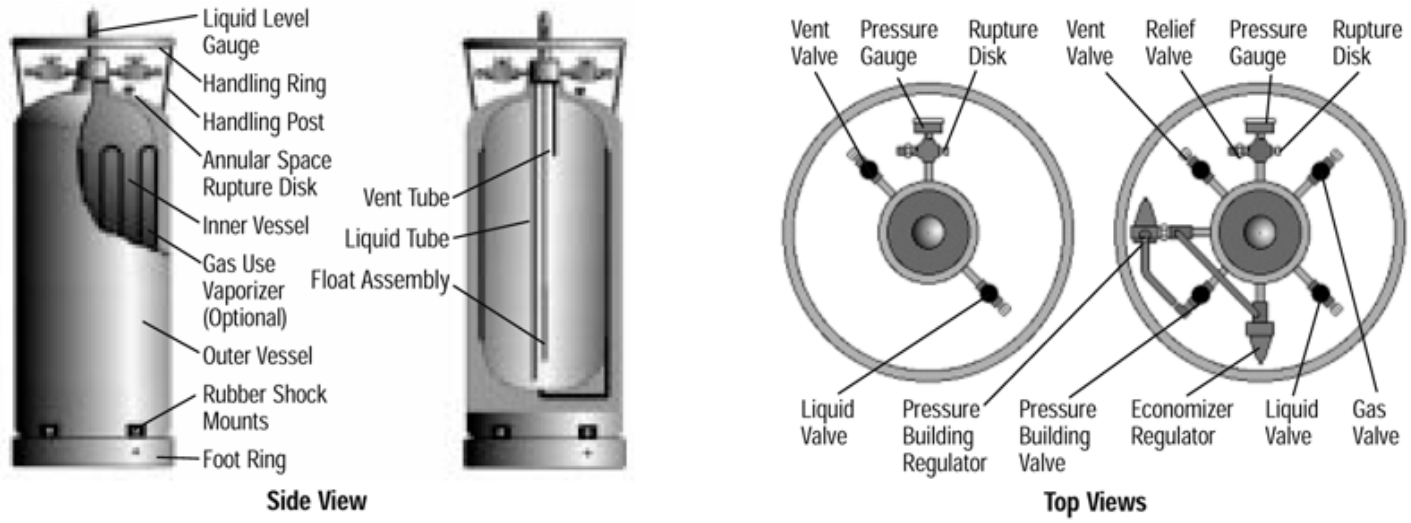
Cryogenic liquids exist at very low temperatures, for example, argon is a liquid at –302°F. Cryogenic liquids produce large volumes of gas when they vaporize. The expansion ratio of argon is 847:1. If cryogenic liquids were to vaporize in a sealed container, the vessel could rupture. Most metals become stronger upon exposure to cold temperatures, but materials such as carbon steel, vinyl flooring, plastics, and rubber become brittle or even fracture under stress at these temperatures. Both cryogenic liquids and the "boil-off' vapor can rapidly freeze human tissue, causing extensive tissue damage. Always wear a face shield and cryogenic gloves when working with cryogenic liquids.

- If these liquids are vaporized in a sealed container, they can produce enormous pressures, which could rupture the vessel. For this reason, pressurized cryogenic tanks are usually protected with multiple pressure relief devices. They usually have a pressure relief valve for primary protection and a frangible disc for secondary protection. Do not tamper with these devices.
- Vaporization of liquid oxygen in an enclosed work area can cause an oxygen-enriched atmosphere, which could saturate a worker’s clothing. Although oxygen is not flammable, it will vigorously support and accelerate the combustion of other materials. There are well-documented cases of clothing catching on fire after being sprayed with oxygen and meeting an ignition source.
- Vaporization of liquid hydrogen in an enclosed work area can cause a flammable or explosive mixture in air.
- Most cryogenic liquids are odorless, colorless, and tasteless when vaporized to the gaseous state.
- The frigid liquid and vapor have a warning property that appears whenever they are exposed to the atmosphere. The cold "boil-off" gases condense the moisture in the air, creating a dense, visible fog. The fog typically extends over a larger area than the vaporizing liquid.

Storage Precautions

Cryogenic liquid cylinders are insulated, vacuum-jacketed pressure vessels, which operate at pressures up to 350 psi and hold 80 to 450 liters of liquid. They are equipped with pressure relief devices to control internal pressure. Under normal conditions, they periodically vent, producing a hissing sound. Do not plug, remove, or tamper with these devices.

Liquid Nitrogen Gas Diagram



Liquid Nitrogen Safe Handling PPE

Cryogenic Liquids PPE Requirements

- Insulated Cryogenic Gloves
- Safety Goggles (unvented)-required at all times
- Face Shield-required when pouring or filling
- A lab coat
- Close Toed Shoes
- Cryogenic Lab Apron when handling large quantities of liquid nitrogen