Standard Safety Protocol

# Compressed Gas Cylinder Use and Safety

## 1. Introduction

### 1.1. Purpose

To outline the procedure for safe use, maintenance, transportation, and storage of compressed gas cylinders and liquified petroleum gases. In reference to this document, each laboratory group is responsible for the proper use of controls, personal protective equipment, and disposal techniques when handling compressed gases.

### 1.2. Scope

Applicable to all users that order, use, handle, or store compressed gas. A compressed gas is any pure gas or mixture of gases or material in a container with either an absolute pressure exceeding 40 psi at 20°C or an absolute pressure exceeding 104 psi at 55°C. Any liquid flammable material having a vapor pressure exceeding 40 psi at 38°C is also considered a compressed gas. What is not covered is **Cryogenic liquids and Liquified gases.** Please see the following:

- UofT's Compressed Gas Safety https://ehs.utoronto.ca/wp-content/uploads/2018/12/Compressed-gas-safety-standard-March-2018.pdf
- UofT's Standard for Inert Cryogenic Liquid Usage in the Laboratory (https://ehs.utoronto.ca/wp-content/uploads/2015/10/Standard-for-Inert-CryogenicLiquid-Usage-in-the-Laboratory-Updated.pdf)).
- The TRACES Centre also maintains the Safe Use and Transportation Of Cryogenic Substances in TRACES/EV Building (http://www.utsc.utoronto.ca/~traceslab/PDFs/Use%20and%20Transport%20of%20Cryogens%20SOP.pdf)

### 1.3. Responsibility

Principal Investigator/Supervisor:

- provide training and appropriate personal protective equipment to all compressed gas cylinder users.
- ensure that all gas cylinders are used, stored, and transported according to applicable legislation and guidelines.
- inspect labs using or storing compressed gas cylinders as part of the standard walkthrough.

User:

- be aware of hazards associated with compressed gasses and the equipment connected to them.
- read the safety data sheet (SDS) for all compressed gasses to obtain hazard and emergency response information.
- receive appropriate training prior to contact with compressed gasses.

- follow procedures and wear the appropriate personal protective equipment provided.

**1.4. Accountability**

Principal Investigator/Supervisor

**1.5. Emergency Contacts**

- Principal Investigator/Supervisor
- Emergency Fire/Police/Ambulance:911
- UofT Police:416-978-2222
- Scott Ballanytne : 416-287-7220
- EHS (UTSC): 416-208-5141

## 2. Referenced Documents

**2.1.** Ontario Fire Code O. Reg. 213/07, s.5.6
**2.2.** https://www.ccohs.ca/oshanswers/chemicals/compressed/compress.html
**2.3.** https://industry.airliquide.us/regulator-maintenance
**2.4.** https://ehs.utoronto.ca/wp-content/uploads/2018/12/Compressed-gas-safety-standard-March-2018.pdf
**2.5.** https://ehs.umich.edu/wp-content/uploads/2016/03/Compressed_Gas_Use.pdf
**2.6.** CGA P-1, Safe Handling of Compressed Gases in Containers

## 3. Chemicals & Supplies

**3.1.** Properly operating cylinder cart (with safety straps).
**3.2.** Cylinder harness (at the point of use & storage).
**3.3.** Appropriate regulator with CGA fitting (Figure 1).
**3.4.** 15cm adjustable wrench or CGA universal cylinder wrench.

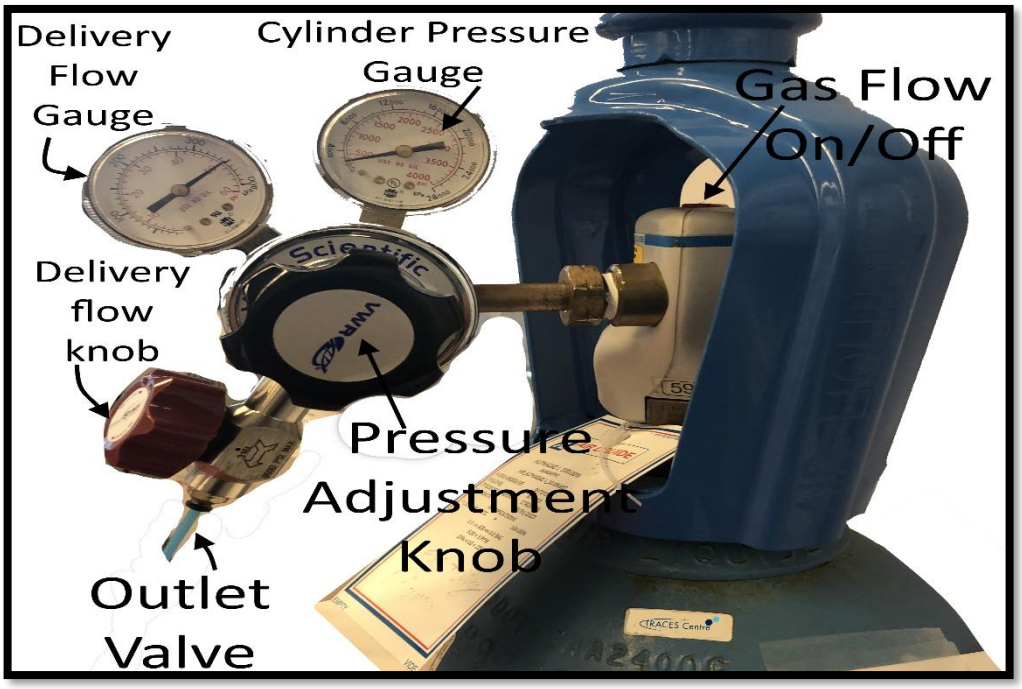


Figure 1

**4. Personal Protective Equipment**

**4.1.** Laboratory Coat/Jacket

**4.2.** Safety Glasses

**4.3.** Appropriate closed toe footwear

**5. Safety concerns**

**5.1. Cylinder Safety**

- All compressed gases are under pressure and a great deal of potential energy is contained within the walls of each cylinder. This danger stores a potential rocket or bomb if the pressure is released through rupture of the valve or container failure.

**5.2. Chemical Safety**

- Read and become acquainted with the SDS of all the gases you will be using/transporting.
- **Compressed gases may be toxic, flammable, or explosive – check the SDS for more information.** All safety procedures must be met before, during and after use of the compressed gas cylinder in the laboratory. Section 6: Compressed Gas Hazards, provides the user with basic hazards associated with compressed gases.
- Propane (Liquefied Petroleum Gases) cylinders may not be stored or used indoors in a lab with the exception noted under Ontario Fire Code s.6.7.3.

**5.3. Warning Signs (**<u>NOT FOR Transportation outside of the building</u>**)**

- **Pictogram of Gas Cylinder (Gas under pressure)**

Figure 2

**6. Compressed Gas Hazards**

**6.1. Fire and Explosion Hazards**

- **Flammable Gas**
  - Fire and explosion may occur when gas concentration is within the flammable or explosive range in the presence of an ignition source or when the auto-ignition temperature is reached. MUST BE KEPT AWAY FROM Oxidizing Gases.
    - **6.1...1.** Examples: Acetylene, Hydrogen, Methane.
- **Oxidizing Gas**
  - Gas can react rapidly and violently with combustible materials and result in fire and explosion when mixed with oxygen at or above atmospheric concentrations. MUST BE KEPT AWAY FROM Flammable Gases.
    - **6.1...1.** Examples: Oxygen, Nitrous Oxide, Xenon.
- **Reactive Gas**
  - When exposed to slight temperature or pressure increases, or mechanical shock, these can readily undergo certain types of chemical reactions such as polymerization or decomposition leading to fire or explosion.
    - **6.1...1.** Examples: Vinyl Chloride, 1,3 Butadiene, Acetylene.

**6.2. Health Hazards**

- **Inert Gas**
  - The largest group of gases. They will displace air thus reducing oxygen levels and can cause loss of consciousness or even death.
    - **6.2...1.** Examples: Nitrogen, Helium, Argon.
- **Toxic Gas**
  - These gases can cause various health problems (including death) upon inhalation, eye, or skin contact.
    - **6.2...1.** Examples: Hydrogen Sulphide, Suphur Dioxide, Silane.
- **Corrosive Gas**
  - Typically, the gas attacks and corrodes metals and in turn can destroy and burn body tissues on contact.
    - 6.2...1. Examples: Hydrogen Chloride, Ammonia

**7. Compressed Gas Groupings**

- Non-liquefied gases are also known as compressed, pressurized, or permanent gases. These gases do not become liquid when they are compressed at normal temperatures, even at very high pressures. Common examples of these are **oxygen, nitrogen, helium, and argon.**
- Liquefied gases are gases which can become liquids at normal temperatures when they are inside cylinders under pressure. They exist inside the cylinder in a liquid-vapour balance or equilibrium. Initially the cylinder is almost full of liquid, and gas fills the space above the liquid. As gas is removed from the cylinder, enough liquid evaporates to replace it, keeping the pressure in the cylinder constant. **Anhydrous ammonia, chlorine, propane, nitrous oxide and carbon dioxide** are examples of liquefied gases.
- Dissolved gases as gases dissolved in an inert material. **Acetylene** is the only common dissolved gas. Acetylene is chemically very unstable. Even at atmospheric pressure, acetylene gas can explode. Nevertheless, acetylene is routinely stored and used safely in cylinders at high pressures (up to 250 psig at 21°C). This is possible because acetylene cylinders are fully packed with an inert agamassan. The filler is saturated with acetone or other suitable solvent. When acetylene gas is added to the cylinder, the gas dissolves in the acetone. Acetylene in solution is stable.

## 8. Cylinder Transportation

- **All cylinder transportation is within the building. Transportation is permitted between adjacent buildings with an internal tunnel or internal bridge connection.**
- **Elevator must be used in all cases (including lecture bottles).**
- Make sure the valve protective cap of the gas cylinder is in place-or that the smart-top valve is closed. Never move a cylinder with the regulator attached.
- Ensure the cylinder's content label matches the invoice and packing slip.
- Use an appropriate compressed gas cylinder cart for transportation.

Figure 3

Figure 4

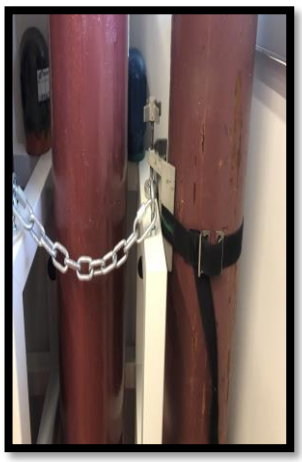

Figure 5

- Move cylinders individually onto the cart (in the upright position) avoid striking other objects. Place the cylinder on the cart in an upright position, do not roll or drag them. The cylinder must now be tightly secured with straps or chains (Figure 3).
- Lecture size or small compressed gas cylinders less than 3 inches in diameters and less than 20lbs can be hand carried.

- While holding the cylinder, tilt the cylinder so that the rear wheels are touching the floor. It is now secure to transport the cylinder (Figure 4).
- Cylinder MUST BE SECURED WITH STRAPPING once in position at the storage or point of use area (Figure 5).

## 9. Cylinder Storage/Point of Use Area

### 9.1. General Storage

- Cylinders must be stored in dry, ventilated areas.
- Gas cylinders must be stored upright and capped when not in use to protect the valve from damage.
- Keep valves closed and cylinders capped when not in use. Use an appropriate pressure regulator. Use the cylinder valve to shut off the gas flow, not the regulator.
- Gas cylinders must be labelled.
- A cylinder should usually be strapped securely to an immovable object. Gas cylinders in use should be individually held in place.
- Cylinders must be kept away from fire; sparks and electricity, including intense sources of heat e.g. radiators, welding, and Bunsen flames. Ambient temperature should not exceed 52$^{o}$C.

## 10. Regulator Use

### 10.1. Before commencing connection to the regulator

- Ensure the gas cylinder contains the gas of interest and it is securely fastened.
- Remove the valve protective cap. It may require some force to remove.
- Ensure the appropriate gas regulator is available.
- The appropriate tubing (chemically resistance, proper sizing, pressure sustainable) must be available to connect to the outlet valve/port.

### 10.2. Connecting the regulator to the cylinder

- Please note that some gas nut tightens clockwise (helium, nitrogen, argon) and some have gash which denotes they tighten counterclockwise (hydrogen, methane, air).
- Teflon tape can be placed along the threads of the nut (Figure 6).
- Take the regulator in your hand and place the nut onto the nipple of the regulator, to ensure a tight seal. HAND TIGHTEN the nut as far as possible. the appropriate gas regulator is available.
- Once the regulator is secured tightly by hand, use the palm of the hand to firmly tap the wrench to secure an even tighter seal. When a dull metal thud sound is heard, similar to a muffled bell, then the regulator is attached properly (Figure 7).

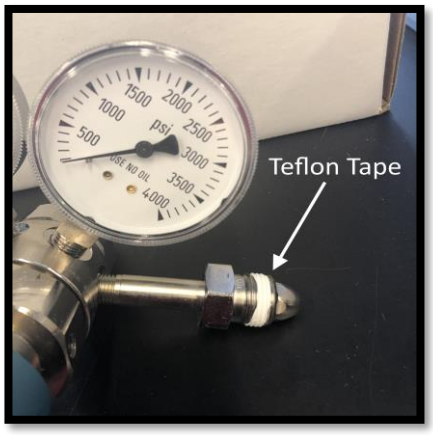


Figure 6

Figure 7

**10.3. Connection from the regulator**

- Insert an equipment specific outlet valve to one (or more) of the outlet ports. Securely tighten the connection and check for leaks.
  - The outlet port should have an outlet valve to control the gas flow to your system.
  - Connections to the outlet valve can be quick-connect, hose bard and Swagelok (1/8",1/4").
  - Set up the appropriate tubing to the valve that will be able to sustain the pressure and chemical interaction with the gas.

    10.3...1. Consult the gas supplier or the equipment manufacture.
- Connect the tubing from the equipment to the outlet valve.

**10.4. Operating the regulator**

- Two major types of regulators exist. Single stage and Dual Stage
  - Single stage is less accurate when reducing the source pressure down to the desired delivery pressure in one step.
  - Dual stage is more accurate in its ability to deliver a constant pressure, even with a decrease in inlet pressure.
- Turn on the flow of gas by turning the valve on the top of the gas cylinder counterclockwise in the direction of the arrows labeled "Open".
  - When using SmartTops ™, the flow of gas is 'opened' when raising the red valve at the top of the cylinder.
- The cylinder regulator has two pressure gauges. The gauge to the right will read the pressure remaining in the cylinder. This gauge will IMMEDIATELY become active.
- NOTE: In most cases the gas supplier only guarantees the purity of the gas in the cylinder so long cylinder pressure is above 500psi.
- The gauge to the left is the delivery pressure. This gauge should be set to the required delivery pressure by turning the pressure adjustment knob.
- Turn the delivery flow knob to "Open" and at this point the flow of gas should commence into the desired system.
  - In many cases the instrument/equipment must be operational to correctly 'fine tune' the delivery pressure.
- If the gas is not needed it should be turned off by closing the valve on the top of the gas cylinder clockwise in the direction of the arrows labeled "Close".

- When using SmartTops ™, the flow of gas is 'closed' when lowering/dropping the red valve at the top of the cylinder.

**10.5. Removing the regulator**

- Cylinder should be replaced once the pressure inside the cylinder has dropped below 500psi.
- Ensure that the valve on the top of the gas cylinder clockwise in the direction of the arrows labeled "Close".
- At this point, allow the gas to purge into the system until it **reads zero in BOTH gauges**.
- Alternatively, close the delivery flow knob.
  - Disconnect the tubing from the outlet valve.
  - Slowly release the pressure by opening the delivery flow knob and release the pressure until it **reads zero in BOTH gauges**.

**10.5...1. CAREFUL. THIS SHOULD ONLY BE DONE WITH INERT GASES.**

- Disconnect the tubing from the outlet valve.
- Place the wrench onto the nut of the regulator, where it meets the cylinder. Firmly work the wrench in the opposite direction that it was secured.
- Once it is loosened with the wrench, it is preferable to loosen the regulator by hand.
- Remove the regulator and store for future reuse.

## 11. Cylinder Return and Transportation

**11.1. Tags and Identifier**

- Identify the cylinder as empty by placing "MT" on the cylinder using chalk (not marker).
- In some cases, the tag will have a tear away section to denote the cylinder is empty.

**11.2. Transporting Cylinder**

- Follow the instructions in Section 7 for transportation of the cylinders.

**11.3. Chemstores**

- Return the cylinder to the Chemstores.

**End of Document**

*Contact the TRACES Manager for further details.