

Corrosive Gases	7
Storage Separation Guide for Special Gases	7
Inert Gases.....	7
Cyrogenic Gases.....	7
Lecture bottles	8
Transportation	8
Spill Response	9
Compressed Gas Leak – Inert gas.....	9
Compressed Gas Leak – Major	9
Additional Information on Preparedness for Gas Leaks	9
Emergency Plan	9
Liquefied Gas Emergency	10
Training.....	10
Labeling and Warning Signs	10
Disposal	10
Standard Gas Cylinder Chart (for reference)	10
References	10

Scope

It is the policy of UAB that special precautions are taken to assure the safe use and storage of compressed gases and cryogenics in all areas of campus and the hospital to minimize the risk of injury from falling cylinders and exposure to toxic chemicals. This policy does not supersede existing federal, state or local applicable codes but is a supplement to clarify specific UAB requirements for safe handling and storage of compressed gas cylinders. Some hazardous materials may require additional precautions. This policy shall apply to all areas of the University where compressed gas cylinders are used or stored.

Introduction

Management of compressed gas cylinders is very dangerous because of the unusual characteristics some of them possess: e.g. stored under pressure, flammability and many toxic gases don't have distinguishable odor or color. Improper handling, storage and use could lead to catastrophic events like:

- Oxygen depleted atmosphere
- Fires
- Adverse health effects or even death

A leaking compressed gas cylinder can penetrate through walls just like a torpedo and can cause structural damage, severe injury, and even death.

This document contains guidelines for the proper storage, handling, use and disposal of compressed and liquified gas cylinders.

Ordering and Receiving Compressed gas Cylinders

Before ordering compressed gas cylinders,

- Review the Safety Data Sheet for physical and health hazards.
- Ensure the storage location has the required ventilation for safe use of the gas
- Ensure piping, regulator etc. are compatible with the gas
- If the gas is listed on the United States Department of Homeland Security *Chemicals of Concern – United States Department of Homeland Security Chemical Facility Anti-Terrorism Standards*, 6 CFR Part 27 (**list in Appendix**), contact OH&S prior to ordering and receiving the gas
- Train the laboratory staff on the hazards, pressure systems, regulators etc.

Before receiving compressed gas cylinders:

- Inspect all cylinders to ensure that they are not damaged/dented and properly labeled.
- Never rely on the color of the cylinder to identify the gas. Different suppliers may use different colors for cylinders of the same gas.
- Look for visible signs of leaks like odors, visible fumes, or hissing sounds.
- Make sure the hydrostatic pressure test stamped on the cylinder is within the required time (usually five years).
- Do not accept cylinders that are rusted, unlabeled, mislabeled, or damaged. They must be returned to the vendor right away.

Once accepted, mark the cylinder as **Full** and write the date received on it.

General Handling Guidelines

1. All compressed gases received, used or stored must be fabricated and labeled according to the specifications of the Department of Transportation (DOT) and the Occupational Safety and Health Agency (OSHA) regulations.
2. A label or a tag with the name of its contents must mark each cylinder. Use the cylinder tag to identify the contents of the cylinder, never rely on color for identification purposes.
3. Safety Data Sheets (SDS) must be obtained and maintained for all compressed gases. SDSs can be obtained online at ChemWatch (<https://jr.chemwatch.net/chemwatch.web/dashboard>) or from the vendor directly.
4. Only trained employees are allowed to handle compressed gas cylinders
5. Cylinders must be transported, stored and used at up right position and firmly secured to prevent falling at all times
6. Use compressed gases only in well-ventilated areas.
7. When using compressed gases, wear appropriate protective equipment, such as safety goggles or face shield, rubber gloves, and safety shoes.
8. Never use a leaking, corroded or damaged cylinder. Contact the supplier immediately for return.
9. Never transfer gases from one vessel to another except for cryogenic liquids
10. Never use a cylinder without a regulator and use only those regulators designed for the gas being used.

11. Do not use the laboratory or adjacent hallways for storage of excess gas cylinders (full or empty).
12. Cylinders “not in use” shall not be stored in a laboratory unit. If necessary, one reserve cylinder may be maintained next to the cylinder that is in use.
 - a. A cylinder shall be considered to be “in use” if it is in compliance with the following
 - i. Connected through a regulator to deliver gas to a lab operation
 - ii. Connected to a manifold being used to deliver gas to a lab operation
 - iii. A single cylinder secured alongside the cylinder described in above situations as the reserve cylinder
13. Do not have full and empty cylinders connected to the same manifold
14. Keep the cylinder cap on when the cylinder is not in use (empty or full).
15. Do not purposely vent a cylinder.

General Storage Guidelines

1. Cylinder storage areas must be prominently posted with the names and hazard class of the gases being stored.
2. Secure all cylinders in racks, holders, or clamping devices. Fasten cylinders individually or up to a maximum of three cylinders within one chain in a well-ventilated area.
3. Close valves, and release pressure on the regulators when cylinders are not in use.
4. Minimize the number of hazardous gas cylinders in a laboratory.
5. Do not store cylinders near hallways, public areas, exits or egress routes
6. Store cylinders of flammable and oxidizing gases at least 20 feet apart, or separate these items with a fire wall.
7. Never store cylinders at extreme temperature or near combustible materials or never expose cylinders to corrosive fumes, toxic chemicals or excessive dampness
8. Keep heat, sparks, flames, and electrical circuits away from gas cylinders.
9. Never store empty and full cylinders together
10. Never store cylinders more than a year without use

Storage and Handling of Speciality Gases

Facility Requirements

A continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure is required for the **storage and use** of *lecture sized bottles* of the following types of gases:

- Gases that have health hazard ratings of 3 or 4.
- Gases that have a health hazard rating of 2 without physiological warning properties
- Pyrophoric gases.

At a minimum, a continuously mechanically ventilated gas cabinet is required for the above gases in cylinders that exceed a lecture-bottle size

Maximum Internal Cylinder Volume per Laboratory

Maximum allowed usage and storage of compressed gases are set for laboratory work areas by Fire Codes, and standards such as NFPA 45 and 55

Class	Labs less than 500sq.ft	Labs greater than 500sq.ft
Liquefied flammable gas	1.2 sft ³	0.0018 ft ³ per sq.ft of lab space
Flammable gas	6.0 sft ³	0.012 ft ³ per sq.ft of lab space
Oxidizing gas	6.0 sft ³	0.012 ft ³ per sq.ft of lab space
Toxic gas	0.3 sft ³	0.0006 ft ³ per sq.ft of lab space
Corrosive gas	0.3 sft ³	0.0006 ft ³ per sq.ft of lab space

A maximum of 25 lecture bottles of all gases combined is specified for any laboratory area.

Flammable Gases

Examples of flammable gases include acetylene, hydrogen, methane etc. Follow the below guidelines while working with flammable gases

1. Flammable gases must be stored in well-ventilated areas away from flammable liquids, combustible materials, oxidizers, open flames, sparks and other sources of heat or ignition. A distance of 20 feet or a noncombustible barrier having a fire rating of at least 1/2 hour is the minimum separation requirement.
2. All piping and equipment associated with flammable gas systems must be grounded and bonded.
3. Do not use flammable gases near ignition sources (except for welding gases).
4. Have a portable fire extinguisher (carbon dioxide or dry chemical type) readily available for fire emergencies.
5. Use spark-proof tools when working with, or on, a flammable compressed gas cylinder or system.
6. Post a sign stating "**No Open Flames**" on access doors to areas where flammable gases are stored and used.
7. Manifold systems must be designed and constructed by trained personnel. Consultation with the gas supplier and OH&S before installing manifolds is required.
8. In an emergency involving a flammable gas leak, fire or explosion, leave the lab immediately. Do not attempt to extinguish burning gas if the flow of product cannot be shut off immediately and without risk.

Oxidizer Gases

Oxidizing gas: a gas that can support and accelerate combustion of other materials. Examples include oxygen, chlorine, fluorine, and nitrous oxide

Follow the below guidelines to work safely with oxidizer gases:

1. Oxidizers shall be stored separately from flammable gas containers or combustible materials. A distance of 20 feet or a noncombustible barrier at least 5 feet high having a fire rating of at least 1/2 hour is the minimum separation requirement.
2. Do not use oil or other hydrocarbon products to clean any equipment used with oxidizer gases.
3. Gauges and regulators for oxygen use should be labeled with a warning statement - "**Oxygen - Use No Oil**".

Highly Toxic Gases

Toxic gases are those having a health hazard (HH) rating of 3 or 4, as defined by NFPA 704. The toxic effects of a substance can be either acute or chronic. Examples include arsine, phosphine, hydrogen sulfide, phosgene, and nitrous oxide.

Notification of OH&S Prior to Obtaining HH3 and HH4 Gases

OH&S must be notified prior to obtaining HH3 and HH4 gases (regardless of quantity). OH&S can be notified by phone 934-2487

Notification must include the following information:

1. Name and location of the PI
2. Project Registration and training information
3. Type, concentration and quantity of the gas
4. Storage and use location(s)
5. Vendor name – including written acknowledgement / agreement confirmation that the vendor will accept the “used” cylinders for return

Quantities of gases may be subject to reporting requirements of the Department of Homeland Security Chemical Facility Anti-Terrorism Standard

Guidelines for working with toxic gases:

1. **Store all toxic gases with a health hazard rating of 3 or 4 in a continuously, mechanically ventilated gas cabinets, or other exhausted enclosures. Exhausts must be vented directly to outside. Lecture bottles of toxic gases must be kept in fume hoods.**
2. Review the Safety Data Sheets (SDS) to determine safety use guidelines.
3. Limit the work to under a fume hood only and avoid contact with skin and eyes
4. PPE must be used at all times while working with toxic gases
5. A gas detection system with visible and audible alarms to detect the presence of leaks, etc. must be installed ^[L]_[SEP] for all toxic and highly toxic gases with hazard rating 3 or 4 (in compliance with NFPA 55 Guidelines)
6. Emergency power must be provided for the gas cabinet exhaust, system shut offs, monitoring, alarms, and associated components
7. Gas detection and alarm system must be serviced and maintained according to manufacturer's guidelines
8. An emergency response procedure must be in place and everyone working in the area must be trained on the procedures.
9. Standard Operating Procedures (SOPs) shall be developed when using Highly Toxic or gases. These SOPs shall include emergency response, and training for all involved employees
10. Only trained employees are allowed to work with highly toxic gases
11. Container Storage Areas must be clearly **posted with the hazard class, the name of the gases stored and emergency contact information.**

Corrosive Gases

Examples of corrosive gases: hydrogen bromide, hydrogen chloride and ammonia

Cylinders of corrosive or unstable gases should be returned to the vendor when the expiration date of the maximum retention period has reached. In the absence of this date, a 36-month interval should be used. In the case of hydrogen chloride and hydrogen fluoride the cylinder should be returned to the vendor after 2 years.

Special precautions for the use of corrosive gases:

1. Use only under an approved fume hood.
2. Always use required PPE and avoid contact with skin and eyes
3. An emergency shower and eyewash must be installed within 50 feet where corrosive gases are used and the path to the fixture must not be hindered with obstructions.
4. An emergency response procedure must be in place and everyone working in the area must be trained on the procedures.

Storage Separation Guide for Special Gases

Gas	Reactives	Corrosives	Oxidizers	Flammable/ Pyrophoric	Toxic
Toxic	20ft	20ft	20ft	20ft	20ft
Flammable/ Pyrophoric	20ft	20ft	20ft	20ft	20ft
Oxidizers	20ft	20ft	20ft	20ft	20ft
Corrosives	20ft	20ft	20ft	20ft	20ft
Reactives	20ft	20ft	20ft	20ft	20ft

Inert Gases

Inert gases are non-combustible, non-flammable, and non-reactive to many materials. Examples include argon, helium, nitrogen, and neon. Precautions include:

1. Inert gases also displace oxygen and can produce a localized oxygen-deficient atmosphere, and therefore should not be used in enclosed or confined spaces without proper ventilation.
2. Always check for leaks and ensure equipment is in proper working order.

Cryogenic Gases

Cryogenic liquids rapidly freeze human tissue and cause many common materials to crack or fracture under stress. All cryogenic liquids vaporize generating large volumes of gases, and may create oxygen-deficient atmosphere. Examples include liquid nitrogen, and helium (for more information refer to Cryogenic Liquid Policy).

Safety Precautions:

1. Use appropriate personal protective equipment when working with cryogenic liquids, including insulated gloves, goggles and a face shield.
2. Never allow an unprotected part of the body to touch uninsulated pipes or containers of cryogenic material. In the event of any skin contact with cryogenic liquids, do not rub the skin. Place the affected part in a warm water bath.
3. Store cylinders or dewars containing cryogenic liquids in well-ventilated areas. A leak or venting from the container could cause an oxygen deficient atmosphere

Lecture bottles

Lecture bottles, just like regular cylinders, contain pressurized gases that pose hazards with the chemical composition of the gases, stored energy of compression, and possibility of release. Lecture bottles present a potential hazard even for inert gases. Please follow the guidelines below for the proper use and storage of lecture bottles

- Inspect the bottle prior to use for leaks and damages
- Never use regulators that are damaged or corroded
- Lecture bottles must be stored in upright position
- Only use regulators and tubing that are appropriate for the gas
- Bottles must be secured during the use and bottles of hazardous gases must be used and stored in a fume hood.
- Evacuate the laboratory if a hazardous lecture bottle is leaking and not in a fume hood or gas cabinet
- Contact OH&S immediately if there is a leak involving a hazardous lecture bottle.
- A maximum of 25 lecture bottles of all gases combined is specified for any laboratory area.

Transportation

When cylinders are being moved from a storage area into the laboratory or from one lab to another:

1. Transport by means of a suitable hand truck with a chain or belt for securing the cylinder. Use hand trucks even for short distances.
2. Never move without the cylinder cap is in place and the cylinder is chained or otherwise secured to the cart
3. Do not lift cylinders by the cap.
4. Avoid dragging or sliding cylinders.
5. Once the cylinder reaches its destination, it must be secured to a wall, or to some other firm support.
6. Use freight elevators to transport cylinders. When moving cylinders in an elevator, place the cylinder chained securely to the cart in the middle of the elevator with the cart handgrip. If a passenger elevator is used, it should be locked out to ALL other users. This is a confined space that would be impossible to escape from if there were an accidental release of gases. When transporting dangerous gases, send the cylinder alone and a second person must receive it at the destination and warning signs must block all the exits

between the floors.

Spill Response

All leaking gas cylinders are an emergency. Leaks, which occur away from the cylinder in gas lines, tubing, or apparatus: can generally be stopped by closing the main cylinder valve.

Compressed Gas Leak – Inert gas

If closing the cylinder valve cannot stop the leak, and it is an inert atmospheric gas (e.g. nitrogen, carbon dioxide, etc) clear the affected area and/or floor.

- Isolate any leaking cylinders of inert gases in a well-ventilated area.
- Place cylinder in or next to a fume hood if available/possible.
- Move leaking cylinders only if it can be done safely.
- Remove any ignition sources
- Restrict access to the area.
- Contact OH&S at 4-2487
- Contact your supplier and return all problem cylinders to the supplier for proper repair.

Compressed Gas Leak – Major

If the leak is of a flammable, toxic, or corrosive gas and is outside of a ventilated enclosure that will contain the gas, immediately activate the building fire alarm system and evacuate the building.

- Call 911; Provide information to emergency responders.
- Call OH&S at 934-2487
- Turn off ignition sources.
- If possible, ventilate the affected area (only if it can be done safely and only if the leak is vented to the outside) prior to leaving the area. Leave fume hoods running.
- If ignition takes place at the source of the leak, do not try to extinguish the flame unless the supply of flammable gas can be stopped. Extinguishing a fire without eliminating the flammable gas supply can result in an accumulation of the gas and a possible explosion.
- The manufacturer/supplier may need to be contacted for emergency repair information.

Emergency Plan

If your area is using a compressed gas, plans should be developed regarding how to handle a simple and major leak prior to using the gas. This plan should consider the nature of the gases being handled, which are their chemical and physical properties.

At a minimum, the plan should specify the following:

- Alarm System & Evacuation Procedure
- Response Personnel
- Emergency Equipment
- Containment or disposal methods

Before use, consult with OH&S for additional safety procedures and recommended methods for respond to leaks. Emergency plans for toxic and flammable gases must have approval from OH&S.

Liquefied Gas Emergency (**Cryogenic Liquid policy for details**)

- Do not walk or step into pools of liquefied gas.
- Do not put water spray or fog on pool of liquefied gas (this can result in it freezing delaying evaporation or it can significantly increase the rate of vaporization).
- A wet towel can be used to temporarily stop leaks.
- Due to the large expansion ratios, oxygen deficient environment can quickly develop
- Warn others in the area
- Contact OH&S/911

Training

Individuals using compressed gases must be trained in the safe use of compressed gases and pressurized systems. Anybody working with compressed gases must complete the online training OH&S (**OHS200: Managing Compressed Gas Cylinders**) along with lab specific trainings. Primary responsibility for specific operations training is with the employee's supervisor. OH&S may be consulted as necessary.

Labeling and Warning Signs

- Empty cylinders must be marked **EMPTY or MT** and never store along with full cylinders
- Rooms or cabinets containing compressed gases must be conspicuously labeled **COMPRESSED GAS**.
- Areas of flammable and toxic gases must be clearly **posted with the hazard class, the name of the gases stored and emergency contact information.**

Disposal

Close the valve and place the safety cap and contact the vendor for return. Contact OH&S for removal of cylinders that cannot be returned to the supplier/vendor or supplier is not known.

Standard Gas Cylinder Chart (**for reference**)

<http://www.mathesongas.com/pdfs/products/Standard-Gases-Cylinder-Size-Chart.pdf>

References

1. Compressed Gas Association: (<http://cganet.com>)
CGA P-1, 2000. *Safe Handling of Compressed Gases in Containers*
2. NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals*, 2015 Edition
3. ^[1]_[5EP] NFPA 55 *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, 2015 Edition
4. OSHA 29 CFR 1910.101 *Compressed Gases – General Requirements* (<http://www.osha.gov>)
5. DOT 49 CFR 173 *Hazardous Materials Transportation* (<http://hazmat.dot.gov/>)

OH&S APPROVED