

UNIVERSITY OF TOLEDO

SUBJECT: COMPRESSED GAS AND CRYOGENIC MATERIALS
TRANSPORT, USE AND STORAGE

Procedure No: HM-08-003

PROCEDURE STATEMENT

The following regulations are established to ensure that standards of safe practice are followed by all persons on campus working with compressed gases.

PURPOSE OF PROCEDURE

To provide guidelines to ensure that safe transport, use and storage of compressed gases takes place in accordance with appropriate regulations and guidelines.

PROCEDURE

Equipment Provided

Cylinder contents shall be identified by attached labels or stencils, naming the components, industry established colors and giving their proportions for all cylinders received. Labels and stencils shall be lettered in accordance with ANSI.

Piping Systems

Before building piping systems for medical gas are initially put into use, the Director of Facilities or designee, shall be responsible for ascertaining that the gas delivered at the outlet is that shown on the outlet label, and that proper connective fittings are checked against their labels. This testing and validation shall be documented. Piping systems must be in accordance with NFPA 45.

Transportation

Compressed gas cylinders shall be transported and handled with protective caps/guards in place. Cylinders without regulators shall be chained or strapped at an angle on carts designed to be used with such cylinders. Cylinders with regulators shall be upright, attached to the wall, or a sturdy structure, or left secured upon the cart.

"E" Cylinders can be kept in carts, wheelchairs and beds as long as they are chained, strapped, or placed in recessed areas/holders designed for their storage and are considered "in use." If regulators and administration equipment are attached, protective caps need not be in place. Cylinders so equipped, shall not be kept unattended in halls or other areas where unauthorized persons could turn them on.

Cylinders transported by truck or other vehicle must be fastened securely, in an upright position so that they will not fall or strike each other.

Use

Appropriate regulators shall be selected for each use. Adapters and cheaters shall not be used to adapt one connector to another, and grease or oils shall not be used to lubricate or seal fittings.

Great care shall be exercised in handling oxygen, to prevent contact of oxygen, under pressure, with oils, greases, organic lubricants, rubber and other materials of an organic nature.

A cylinder valve must never be forced. If a valve cannot be opened by hand, the cylinder shall be returned and another obtained. Separate handles or wrenches needed to open a cylinder shall be either on the valve, or chained nearby, when the cylinder is in use.

When gases in small cylinders are used, Compressed Gas Association (CGA) pin index systems must be used to avoid accidental connection of improper gas contents. Large cylinders use specific thread configurations, and adapters must never be used to defeat these safeguards.

Tanks shall be returned to suppliers as soon as they are empty. Laboratory tanks shall have a test date stamped on the upper surface, near the valve. These tanks shall be hydro-tested every five (5) years and shall not be kept beyond the fifth (5th) year after the test date.

On the Health Science Campus, full cylinders (2200 psig = FULL) are located in the Dowling Hall Tank Room. Partially Full, and Empty (500 psig, or less is considered EMPTY) cylinders are segregated. Once the cylinder is removed from the Dowling Hall Tank Room, it is considered Partially Full and must be stored as such. Tanks shall be placed in the appropriate racks which are clearly labeled. Empty tanks are stored in racks, away from partially full cylinders to avoid confusion. Partially full cylinders will be placed in racks labeled partially full. Oxygen storage tank holders should be cleaned by wiping them down with the PDI Super Sani-Cloth Germicidal Disposable Wipes before and after use.

Cylinders in Use

1. Cylinders, when in use, shall be connected to gas delivery systems designed by a qualified person.
2. Cylinders shall be attached to an instrument for use by means of a regulator.
3. A compressed gas cylinder shall be considered to be "in use" if it is in compliance with one of the following:
 - When on a patient stretcher, code carts, wheelchair, or other cart in a patient care area
 - Connected through a regulator to deliver gas to a laboratory operation
 - Connected to a manifold being used to deliver gas to a laboratory operation
 - A single cylinder secured alongside the primary cylinder as the reserve cylinder

Cylinder and Container Management

Cylinders or supply containers shall be constructed, tested, and maintained in accordance with the U.S. Department of Transportation specifications and regulations.

Note: Regulations of the U.S. Department of Transportation (formerly U.S. Interstate Commerce Commission) outline specifications for transportation of explosives and dangerous articles (*Code of Federal Regulations*, Title 49, Parts 171-190). In Canada, the regulations of the Canadian Transport Commission, Union Station, Ottawa, Ontario, apply.

Contents of cylinders and containers shall be identified by reading the labels prior to use. Labels shall not be defaced, altered, or removed.

Tank Storage Room Health Science Campus, Dowling Hall 0140, (medical grade gases)

Compressed gases, other than cylinders actually in use or intended for immediate use, shall be stored in the designated storage area, reserved for the storage of such gases. This area shall be ventilated by mechanical methods and oxidizers such as oxygen and nitrous oxide shall be separated from flammable gases, such as methane and ethylene oxide. Tanks in storage areas shall be secured to the wall, or to a similar secure structure, and shall have their protective caps securely in place. All tanks shall be stored upright. Additional storage is available in HEB room 010A on the Health Science Campus for non-medical grade gases only. The storage area shall possess at least a one-hour fire wall construction and be used for gas storage only. The storage area is protected by a fire suppression system. The storage areas exhaust ventilation is protected by a fire damper and is vented to the outside and should have a high and low return grill. Compressed gas storage areas shall remain locked to prevent public access.

General Storage

Cylinders in use or intended for immediate use should be stored in a safe location away from immediate work areas. Tanks in storage areas shall be secured to the wall, or to a similar secure structure, and shall have their protective caps securely in place. All tanks shall be stored upright, or in a suitable manner, strapped or chained in place, based on the particular gas stored within. Oxygen cylinders (green) shall be stored in amounts not to exceed safe storage limits as designated by the National Fire Protection Association (NFPA).

Sources of heat in storage locations shall be protected or located so that cylinders or compressed gases shall not be heated to the activation point of integral safety devices. In no case shall the temperature of the cylinders exceed 130° F (54° C). Nitrous Oxide and carbon dioxide cylinders do not reach temperatures lower than the manufacturer's recommendations or -20° F. Care shall be exercised when handling cylinders that have been exposed to freezing temperatures or containers that contain cryogenic liquids to prevent injury to the skin.

Cylinders containing gases that are corrosive to cylinders or cylinder valves or that may become unstable while stored in the cylinder should have a maximum retention period of six months, unless a shorter period is otherwise specified by the manufacturer.

Oxygen cylinders (empty or full) in storage should be separated from fuel-gas cylinders and combustible materials by a minimum distance of 20 feet or by a barrier at least 5 feet high having a fire-resistance rating of at least one-half hour.

Cylinders attached to a manifold system must be secured individually, so if one tank should happen to fall it would not dislodge the entire manifold assembly.

Do not store flammable gas cylinders with oxygen or nitrous oxide cylinders, or adjacent to oxygen charging facilities.

Full, partially full and empty cylinders of all gases should be stored separately and identified by signs to prevent confusion.

Cylinders located outside shall not be included when determining maximum volumes where a passive means of limiting the volume of gas leaking into a laboratory is in place.

No combustible materials shall be kept near cylinders containing oxygen or N₂O, with the exception of the packaging used to transport and separate small tanks.

Small cylinders can be stored in their shipping boxes, or stored in racks, shelves, or bins, that preferably are non-combustible. Small cylinders shall never be chained together in large groups. Large cylinders shall be chained or strapped to walls, or sturdy structures, but do not require special racks. Cylinders shall not sit upright without some method of secure support.

Tanks shall always be stored and handled with protective caps in place. The caps shall be removed just before the use, and replaced when the use is disconnected, or when the tanks are empty.

Containers shall not be in a tightly enclosed space, such as a closet.

A minimum of 12 E-sized cylinders or one (1) H-sized cylinder may be stored for use in a clinical area (i.e., nursing unit) outside a designated storage room. Indoor rooms designated for storage of compressed gas cylinders in excess of 12 E cylinders or one (1) H-sized cylinder are:

- Constructed with a minimum of 1-hour fire resistance rating
- Secured with lockable/self closing doors
- Provided with dedicated mechanical ventilation that operates continuously, with high and low exhaust vents.

Special Ventilation Requirements for Gas Cylinders

Lecture bottle-sized cylinders of the following gases located in laboratory units shall be kept in a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure:

1. All gases that have Global Harmonized System (GHS) health hazard ratings of 1 or 2
2. All gases that have a GHS health hazard rating of 3 without physiological warning properties
3. Pyrophoric gases

Cylinders of all gases that are greater than lecture bottle size and have GHS health hazard ratings of 1 or 2 and cylinders of gases that have a health hazard rating of 3 without physiological warning properties that are located in laboratory units shall meet both the following conditions:

1. Storage in approved continuously mechanically ventilated gas cabinets
2. Compliance with NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*

Cylinders of pyrophoric gases that are greater than lecture bottle size that are located in laboratory units shall be kept in approved continuously mechanically ventilated, sprinklered gas cabinets.

Cylinder Safety

Cylinders shall be secured from tipping over by holders designed for such service.

Cylinders in the laboratory shall be equipped with a pressure regulator designed for the specific gas and marked for its maximum cylinder pressure.

The regulator system shall be equipped with two gauges, either on the regulator or remote from the regulator, installed so as to show both the cylinder pressure and the outlet pressure.

Where the source cylinder is outside of the laboratory, a station regulator and gauge shall be installed at the point of use to show outlet pressure.

Cylinders shall have a manual shutoff valve. A quick connect shall not be used in place of a shutoff valve.

Outdoor Installation of Compressed Gas Cylinders for Servicing Laboratory Work Areas (Located Outside of Laboratory Work Areas)

Toxic or flammable gas cylinders shall not be installed within 2 m (6 ft) of windows, doors, or other openings to building(s).

Toxic or flammable gas cylinders shall not be installed within 9 m (30 ft) of ventilation intakes.

Outdoor storage areas shall have a minimum of 25 percent of the perimeter open to the atmosphere.

This open space shall be permitted to incorporate chain-link fence, lattice construction, open block, or similar materials for the full height and width of the opening.

The following are requirements for outdoor storage:

1. Storage areas shall be kept clear of dry vegetation and combustible materials for a minimum distance of 4.6 m (15 ft).
2. Cylinders stored outside shall not be placed on the ground (earth) or on surfaces where water can accumulate.
3. Storage areas shall be provided with physical protection from vehicle damage.
4. Storage areas shall be permitted to be covered with canopies of noncombustible construction.

Disposal of Throw-a-way Tanks

Pressure shall be released from non-hazardous disposable tanks by slowly bleeding the contents into the atmosphere, under an appropriate laboratory hood and the tanks will be clearly labeled as empty (MT) and disposable. High pressure tanks shall be bled through regulators, with toxic or flammable gases disposed of through the Safety and Health Department. All tanks shall be disposed of by contacting Environmental Health and Radiation Safety at 419-530-3600.

Handling and Storage of Cryogenic Materials

Cryogenics may be defined as the technology of temperatures below -73.3 degrees Centigrade. There are four principal areas of hazard related to the use of cryogenic fluids:

- Hydrogen, methane and acetylene (ethyne) are obvious flammability hazards. However, oxygen greatly increases the flammability of ordinary combustibles and can cause non-combustible materials to burn readily. Liquefied inert gases (such as nitrogen and helium) or very cold metal surfaces can condense oxygen from the atmosphere;
- The high pressure gas hazard is always present when cryogenic fluids are used because of the large expansion ratio from liquid to gas on evaporation;
- Equipment must be carefully selected for cryogenic service because of the changes in their properties at very low temperatures – normally ductile materials may become extremely brittle. Methods of joining materials must also receive careful consideration, because of different rates of contraction and embrittlement of sealant;
- Chemical reactivity between the fluid and apparatus must be studied also – personnel hazards exist in several areas. Exposure of personnel to the above hazards must be avoided, but of prime concern is bodily contact with the extremely low temperatures involved. Brief contact with cryogenic materials can cause burns similar to

thermal burns from high temperature contact. Prolonged contact with these temperatures will cause embrittlement of the affected parts because of the high water content of the body. The eyes are especially vulnerable, so eye protection is mandatory. While a number of gases in the cryogenic range are not toxic, they are capable of causing asphyxiation by displacing oxygen. Even oxygen may have harmful physiological effects with prolonged breathing of the pure gas.

General Precautions with Cryogenic Material Including Liquid Nitrogen, Liquid Oxygen and Dry Ice

When working with cryogenic materials the Safety Data Sheet (SDS) must be available and should be consulted before use.. The following are general precautions for handling cryogenic material:

- Areas where liquid nitrogen is used or stored must be identified by signage.
- Personnel must be thoroughly instructed and trained in the safe handling of cryogenic materials including emergency procedures, operating equipment, safety devices, the properties of the materials used and personal protective equipment required (refer to [Table I](#) for First Aid Treatment);
- When decanting or opening a vessel of liquid gas or when handling dry ice, chemical goggles or faceshield, an impervious coat, thermal gloves, trousers without cuffs and high top shoes or boots must be worn;
- Jewelry (i.e., watches and metal bracelets) is not permitted, nor anything capable of trapping a cryogenic fluid close to the skin;
- Gloves are necessary to handle containers or cold metal, they should be impervious and large enough to be thrown off the hand in case of a spill. Care is required in the transport and storage of cryogenic substances. Cryogenic materials must only be stored in areas of good ventilation. Cryogenic substances should not be carried along with passengers in a passenger lift. It is recommended that large amounts of cryogenic material be transported on elevators without anyone on them, by arranging with staff on each floor.
- Low boiling point gases are protected in their vacuum vessel by a guard jacket of liquid nitrogen which must be replenished regularly. If the supply of liquid nitrogen fails on a helium storage vessel, explosion may occur. Equipment and systems should be kept scrupulously clean and avoid contaminants creating hazardous conditions on contact with the cryogenic fluids. This is particularly important when working with oxygen. If the boiling point of a gas is below that of liquid gas, care must be taken in transferring the liquid into Dewar-type vessels or cryostat. A vacuum jacketed siphon must be used. If the gas is poured from the container, a plug of solid air may form in the outlet. These operations may only be undertaken after consultation with the supplier of the liquefied gas.
- Liquid oxygen and nitrogen containers should not normally be emptied – occasionally they should be allowed to warm to room temperature and purged with dry nitrogen. This avoids danger from accumulated hydrocarbon gases extracted from the atmosphere and the nuisance of water freezing out in the container.
- It may be convenient to transfer liquid oxygen or nitrogen from its container by pressurization. This may be done safely if the appropriate dry gas is used and the container can withstand the pressure. Instructions for handling liquid nitrogen, helium, argon and methane should be sought from the supplier and the experimental work should proceed based on their advice with the full knowledge and agreement of the Safety and Health Department.

Table I
First Aid

Lungs	Following exposure to cold gas resulting in respiratory distress, medical attention should be obtained immediately by dialing Ext. 2600.
Skin	Medical attention should be obtained and any clothing that may constrict the blood circulation to the burn should be removed. Sticking clothing should not be removed until completely thawed. The part of the body should be thawed slowly in lukewarm water between 42 and 45 degrees centigrade. Dry heat should not be used. Burns should be covered with a large sterile dressing. The person should be taken to hospital as soon as possible. The person should not be given alcohol or allowed to smoke.

Source: Safety & Health Committee

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