



Health & Safety Standard Operating Procedure

SOP- 03

Compressed Gas Cylinders

Produced by

Health & Safety – Facilities & GS Department

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SOP-03: Compressed Gas Cylinders

1 Overview

1.1 Purpose

To provide procedure for the safe handling and use of portable compressed gas cylinders. Compressed gases are unique in that they represent both a physical and potential chemical hazard (depending on the particular gas).

1.2 Hazards and Risks

1.2.1 Hazard Definition

The gases contained in these cylinders vary in chemical properties, ranging from inert and harmless to toxic and explosive. The high pressure of the gases constitutes a serious hazard in the event that the cylinders sustain physical damage and/or are exposed to high temperatures.

1.2.2 Potential Outcomes

Potential risks from mishandling compressed gases include leaks, fire and explosion.

1.3 Key Terminology

Term	Definition
Asphyxiate gas	A gas, usually inert, that may cause suffocation by displacing the oxygen in the air necessary to sustain life.
Compressed gas	A gas or mixture of gases having an absolute pressure exceeding 40 psi at 70 degrees F (21.1 degrees C); or, a gas or mixture of gases having an absolute pressure exceeding 104 psi at 130 degrees F (54.4 degrees C) regardless of the pressure at 70 degrees F; or, a liquid having a vapour pressure exceeding 40 psi at 100 degrees F (37.8 degrees C) as determined by ASTM D-323-72.
Corrosive gas	A gas that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact or is labelled by the DOT as Division 2.3 and Division 8 (Corrosive).
Cryogenic fluid	A refrigerated liquefied gas having a boiling point colder than -90 °C (130 °F) at 14.7 psi.
Fire Control Area	A Fire Area is an area enclosed and bounded by fire walls, fire barriers, exterior walls or fire-resistance rate horizontal assemblies of a building. Control Areas are spaces within a building and outdoor areas where quantities of hazardous materials not exceeding the maximum quantities allowed are stored, dispensed, used or handled Control areas must be separated from each other by not less than a 1 hour fire barrier.

Term	Definition
Flammable gas	A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or, a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.
Oxidizer gas	A gas that is non-flammable but can support and vigorously accelerate combustion in the presence of an ignition source and a fuel.
Toxic gas	A gas that has a median lethal concentration (LC ₅₀) in air of 2,000 parts per million or less by volume of gas (Highly Toxic has an LC ₅₀ of 200 ppm or less or a gas that has an NFPA Health Hazard Rating of 3 (Toxic) or 4 (Highly Toxic).

2 Scope

The requirements outlined in this SOP are applicable to all QU employees, students, contractors, and visitors who are working for QU, and/or conducting work on QU premises. The following subsections outline some of routine and non-routine activities in which the conditions covered by this SOP may be encountered.

The procedure covers the use, handling and storage of compressed gases in laboratories (research and academic) and non-laboratory areas (Maintenance, Chiller Plant, Workshop, Warehouse, etc.).

2.1 Routine

Compressed gas is routinely used, handled and stored in labs and maintenance areas.

2.2 Non-routine

Compressed gas may be used, handled and stored during non-routine activities such as construction activities (e.g. use of gas for welding).

3 Roles and Responsibilities

QU Top Management appropriate resources are allocated to ensure that employee and student exposure to compressed gases and hazardous materials/chemicals are within acceptable risk levels.

3.1 (VPs), Deans, Directors, Managers, Head Sections/Units and Project Managers

VPs, Deans, Directors, Managers, Head Sections/Units and Project Managers have the primary responsibility for ensuring that employees and students under their supervision and who may be exposed to compressed gas risks comply with the requirements of this SOP.

3.2 Employees, Contractors and Students

Employees, contractors and students are responsible for compliance with safety regulations and this SOP, as applicable.

Employees, contractors and students shall report any activity or defect relating to compressed gases which they believe is reasonably foreseeable to endanger their safety or that of another person.

Employees, contractors and students shall use appropriate equipment or safety devices in accordance with any training or instruction received in the use of the work equipment or device concerned.

Employees, contractors and students shall not perform any task requiring training until they have received the required training and it is documented.

Employees, contractors and students shall not operate any piece of equipment that they are not familiar with, competent to operate and/or appropriately trained on its use.

3.3 Health & Safety Section (HSS)

The HSS is responsible for the implementation of this procedure.

The HSS shall develop and implement an inspection, testing and preventative maintenance plan to ensure compressed gas systems are safe and working efficiently and according to manufacture specifications and applicable legal requirements.

The HSS shall ensure compressed gases systems are tested and inspected regularly (at a minimum annually) to ensure the system work in accordance with manufactures specifications.

The HSS shall monitor the use of compressed gases systems to ensure employees are using compressed gases appropriately.

3.4 HS Committee

The HS Committee shall be responsible for assisting in the implementation, maintenance and review of this procedure, as requested.

4 Risk Prevention

4.1 General Prevention Requirements

QU shall ensure that an assessment of the various risks is undertaken and systems of work are established which are safe to all parties involved or affected including the public.

QU shall ensure that appropriate control measures are implemented in order to manage activities safely and without risk to health.

4.2 Specific Prevention Methods

When performing risk assessments, the following shall be considered:

- the condition of the equipment being used (compressors, hoses, couplings etc.) and if they are rated by an appropriate International Standard for their intended use;
- the type, frequency and duration of the compressed air work;

- the environment in which the compressed air work is to be undertaken (e.g. dirty/dusty conditions, uneven work surfaces, cramped conditions);
- the pressure at which the compressor is operating at;
- the level of experience of the personnel involved in the work; and
- other identified hazards associated with the work.

When using compressed gas systems (to include pneumatic tools), the following requirements shall be met:

- Pipes, hoses, and fittings shall display the rating of the maximum pressure of the compressor. Compressed air pipelines shall be identified and tested to maximum
- Working pressure;
- Under no circumstances shall the pressure of the compressed air exceed the maximum working pressure of any of the components in use;
- Couplings shall have safety clips fitted to them to prevent inadvertent uncoupling when under pressure – makeshift tie-wire shall not be used;
- Ensure all components comply with the appropriate International Standard for their intended use and are regularly maintained in a fit for purpose condition;
- The setting of safety valves or reducing valves shall only be adjusted by a competent person;
- Air supply shutoff valves shall be located, as near as reasonably practicable, at the point-of-operation;
- Air hoses shall be kept free of grease and oil to reduce the possibility of deterioration;
- Hoses shall not be located across floors or aisles where they are liable to cause personnel to trip and fall. When reasonably practicable, air supply hoses shall be suspended overhead, or otherwise located to afford efficient access and protection against damage;
- Hose ends shall be secured to prevent whipping if an accidental cut or break occurs;
- Pneumatic impact tools, such as riveting guns, shall never be pointed at a person;
- Before pneumatic tools are disconnected (unless it has quick disconnect plugs), the air supply shall be turned off at the control valve and the tool bled;
- Compressed air shall not be used under any circumstances to clean dirt and dust from clothing or off a person's skin;
- Air used for cleaning shall be regulated to 15 psi unless equipped with diffuser nozzles to provide lesser pressure;
- Static electricity may be generated through the use of pneumatic tools. This type of equipment shall be grounded or bonded if it is used where fuel, flammable vapors or explosive atmospheres are present;
- When used for cleaning, the compressed air equipment (air nozzle) shall reduce the outlet (working) air pressure to less than 30 pounds square inch (psi) at the discharge tip. In-line chip protection shall be used when airlines are connected directly to a compressed air system. This does not mean that the supply air or line

pressure be reduced to 30 psi as long as the static (dead head) pressure exiting the nozzle when restricted does not exceed the mandatory maximum 30psi;

- Reduction of air pressure for cleaning can be done with nozzles and tips designed for this purpose. Employees shall not remove, damage, cover (e.g. tape), replace or in any way alter the equipment provided for this purpose. Nozzles that have been altered or "home-made" and shall not be used;
- Goggles, face shields or other eye and hearing protection shall be worn by personnel
- Using compressed air for cleaning equipment; and
- All defects shall be immediately reported to the employer and the use of the defected
- Equipment shall be ceased.

5 Safe Work Practices

5.1 General Worker Safety

- Cylinders must be transported, stored and used upright (with the valve up), and must be securely fastened to prevent them from falling or being knocked over. Suitable racks, straps, chains or stands are required to support cylinders.
- Cylinder valves are to be protected with the standard cap when not in use (empty or full). Regulators are to be protected with covers where there is likelihood of damage.
- Never force a cap or regulator. The cap should only be hand tight.
- Cylinders should not be exposed to excessive dampness, or to corrosive chemicals or fumes.
- Cylinders are not to be exposed to temperature extremes nor stored in the vicinity of combustibles.
- Gases are not to be transferred from one vessel to another (except dry ice and cryogenic material). Do not try to refill compressed gas cylinders.
- Before using a cylinder, slowly "crack" the valve to clear dust or dirt, being sure the opening is not pointed toward anyone. Additional precautions must be taken when toxic or flammable gases are involved (see Section 4.4.) Do not stand in front of the regulator gauge glass when opening the valve.
- Never use a cylinder without a regulator. Always use the correct pressure regulator.
- After attaching the regulator, and before the cylinder is opened, check the adjusting screw of the regulator to see that it is released. Never permit the gas to enter the regulator suddenly.
- Never try to stop a leak between a cylinder and regulator by tightening the union nut unless the valve has been closed first.
- Never strike an electric arc on a cylinder.
- Never use a leaking, corroded or damaged cylinder. Remove the cylinder from service and contact the supplier for return.

Attaching a Regulator

- Use safety glasses and goggles.
- Before attaching the regulator, perform a visual inspection of the regulator. Check the condition of the inlet and outlet, look for worn threads and inspect gauges for damage.
- Visually inspect the cylinder before use to detect for any damage, cracks, corrosion or other defects.
- Wipe the outlet with a clean, dry, lint free cloth. The threads and mating surfaces of the regulator and hose connections should also be cleaned before the regulator is attached. A connection problem caused by dirty or damaged threads could result in leaks when the cylinder is used.
- Always use a cylinder wrench or other tight fitting wrench to tighten the regulator nut and hose connections. Using an oversized wrench, adjustable wrench, pliers or a pipe wrench may damage the fittings and make it impossible to tighten them properly.
- Attach the proper regulator to the cylinder of compressed gas (see Figure 1). Do not use Teflon™ tape on fittings when the seal is made by metal-to-metal contact. Under no circumstances is grease or oil to be used on regulator or cylinder valves because these substances may cause an adverse, dangerous reaction within the cylinder gas.
- Check for leaks using the gas leak detector.

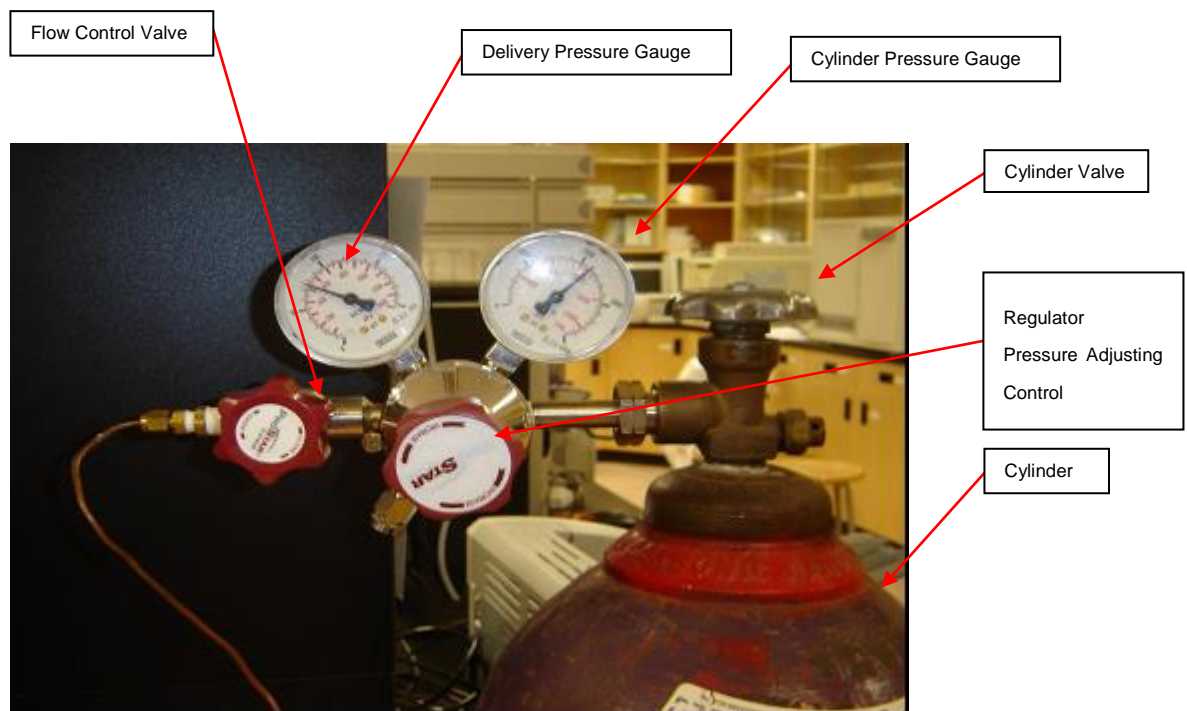


Figure1. Regulator attachment to compressed gas cylinder

5.2 Specific Gas Requirements

The following information regarding specific classes of gases is offered as additional requirements to be used in conjunction with the general usage requirements listed in preceding sections.

Flammable Gases

- Not more than 100 cubic feet of flammable gas can be used and stored (combined quantity) in a fire control area. In a laboratory 500 square feet or less, not more than 6 cubic feet, and larger laboratories, not more than 0.012 cubic feet per square feet of lab work area can be used and stored. In addition, lecture bottle cylinders must be limited to 25 (10 in instructional laboratories).
- 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 at least 18 inches above the tallest container, but not less than 5 feet and laterally not less than 18 inches beyond the sides of the containers and having a fire rating of at least ½ hour is the minimum separation requirement.
- Portable fire extinguishers (carbon dioxide or dry chemical type) must be available for fire emergencies where flammable gas is stored.
- Spark-proof tools should be used when working with flammable gas cylinders.
- "Flow" experiments with flammable gases are not to be left unattended; an explosive meter or combustible gas alarm must be used.
- In the event of an emergency involving a flammable gas, such as a gas leak, fire or explosion, personnel must immediately evacuate the area. Do not attempt to extinguish burning gas if the flow of product cannot be shut off immediately and without risk.
- All lines and equipment associated with flammable gas systems must be grounded and bonded.
- Acetylene should not be utilized in lines or hoses at a pressure exceeding 15 psi.
- Contact HSEO for additional information or concerns about flammable gas storage.

Asphyxiant Gases

- Do not store asphyxiant gases in areas without ventilation. This includes environmental chambers (e.g. cold boxes) that do not have a fresh air supply or exhaust system.
- Any gas that has the potential to displace oxygen in sufficient quantities can cause asphyxiation. Only persons trained, qualified and using a self-contained breathing apparatus (SCBA) with adequate back-up should respond to an inert gas leak or enter an area where an asphyxiant gas could be present. Shut off the source of the gas leak if there is no risk to personnel and ventilate the area. If a person has symptoms of asphyxiation, move the victim to fresh air and obtain proper medical attention.

Oxidizer Gas

- Not more than 1500 cubic feet of oxidizing gas can be used and stored (combined quantity) in a fire control area. In a laboratory 500 square feet or less, not more than 6 cubic feet, and larger laboratories, not more than 0.012 cubic feet per square feet of lab work area can be used and stored. In addition, lecture bottle cylinders must be limited to 25 (10 in instructional laboratories).

- All equipment used for oxidizing gases must be cleaned with oxygen-compatible materials free from oils, greases, and other contaminants (hydrocarbons and neoprene are not oxygen-compatible; PTFE Teflon is compatible. The equipment will state that it is oxygen compatible). Do not handle cylinders with oily hands or gloves.
- 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 ½ hour is the minimum separation requirement.

Corrosive Gas

- Not more than 810 cubic feet of corrosive gas can be used and stored (combined quantity) in a fire control area.
- Keep exposure to gas as low as possible. Use in fume hood or other vented enclosure when possible. Avoid contact with skin and eyes.
- Wear safety goggles when handling compressed gases which are corrosive.
- An emergency shower and eyewash must be installed within 50 feet where corrosive materials, including corrosive gases.
- An emergency response procedure must be in place and everyone working in the area must be trained on the procedures.
- Safety plugs in the valves of chlorine cylinders fuse at 157 degrees F. Care must be exercised to see that they are not exposed to steam, hot water, etc. which could produce this temperature. Chlorine leaks may be located using a cloth wet with aqua-ammonia which will produce white fumes (ammonia chloride) in the presence of chlorine. NOTE: This procedure may only be performed with appropriate respiratory protection. In order for any individual to wear a respirator, he/she must have written physician's approval, attend a respiratory protection training session, and pass a respirator fit test. Training and fit testing are provided by the HS.

Toxic and Highly Toxic Gas

- Not more than 1,620 cubic feet of toxic gas can be in storage and 810 cubic feet in use in a fire control area. Not more than 40 cubic feet of highly toxic gas can be in storage and 20 cubic feet in use in a fire control area. In a laboratory 500 square feet or less, not more than 0.3 cubic feet, and larger laboratories, not more than 0.0006 cubic feet per square feet of lab work area can be used and stored. In addition, lecture bottle cylinders must be limited to 25 (10 in instructional laboratories).
- Lecture bottle-sized cylinders for all gases that have a health hazard rating of 3 or 4 or a health hazard rating of 2 without physiological warning properties, must be kept in a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure. Larger cylinders of toxic or highly toxic gas must be stored in gas cabinets, exhausted enclosures or gas rooms.
- Toxic and highly toxic gases shall not be stored or used outside of academic or research laboratories.
- Keep exposure to gas as low as possible. Use in fume hood or other vented enclosure when possible. Avoid contact with skin and eyes.
- Wear safety goggles when handling compressed gases which are toxic or highly toxic.
- A gas detection system with visible and audible alarms to detect the presence of leaks, etc. must be installed for all toxic and highly toxic gases when the physiological warning

properties for the gas are at a level below the accepted permissible exposure limit or ceiling limit for the gas. Contact HS for specifics on installing the gas monitoring system.

- An emergency response procedure must be in place and everyone working in the area must be trained on the procedures.

Cryogenic

- Wear face shield and chemical safety goggles when dispensing from cylinder.
- Wear appropriate insulated gloves to protect from the extreme cold when handling cryogenic containers. Gloves need to be loose fitting so that they can be readily removed in the event liquid is splashed into them. Never allow an unprotected part of the body to touch uninsulated pipes or containers of cryogenic material.
- Keep liquid oxygen containers, piping, and equipment clean and free of grease, oil, and organic materials.
- Do not store cylinders in environmental chambers that do not have fresh air ventilation. A leak or venting from the container could cause an oxygen deficient atmosphere.
- Large stationary cryogenic systems and piping have additional requirements. Contact HSEO for guidance.
- First aid treatment for cold-contact burns.
- Remove any clothing not frozen to the skin that may restrict circulation to the frozen area. Do not rub frozen parts, as tissue damage may result. Obtain medical assistance as soon as possible.
- Place the affected part of the body in a warm water bath (not to exceed 40o C). Never use dry heat.

Pyrophoric Gas

- Not more than 250 cubic feet of pyrophoric gas can be in a storage area.
- Lecture bottle-sized cylinders for Pyrophoric (e.g. Silane) gases must be kept in a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure.
- Silane gas with a concentration of 2% or more by volume silane has additional safety requirements for flow control, exhausted enclosures or gas cabinets and emergency power. Contact HSEO for information.

5.3 Transporting Cylinders

- The cylinders' protective cap must be in place.
- Avoid dropping and striking cylinders together. The cylinder should not be lifted by the cap.
- Use a cradle for hoisting, never a lifting magnet or sling.
- Use a suitable hand truck with the cylinder firmly secured. Avoid dragging, sliding or rolling cylinders.
- Cylinders must be secured in a positive fashion with straps or chains while being transported and when in motor vehicles.

- Use the Freight Elevator when possible. If there is no Freight Elevator, do not use an elevator with people in it and do not allow other people to enter the elevator when transporting cylinders. When transporting Asphyxiant gas in elevators, send the cylinder up by itself and then follow in another elevator or stairs. This can only be done if the elevator can be made to not stop at any other floors before the cylinder is removed.

5.4 Storage

- Storage areas shall contain the appropriate safety signage.
- Storage areas shall be secured and only authorized persons will have access to compressed gases storage areas.
- Cylinder storage areas must be prominently posted with the names and hazard class of the gases to be stored.
- Cylinders not “in use” (“in use” means connected through a regulator to deliver gas to a laboratory operation, connected to a manifold used to deliver gas to a laboratory operation or a single cylinder secured alongside the cylinder as the reserve cylinder) must not be stored in the laboratory.
- When gases of different types are to be stored at the same location, cylinders should be grouped by type of gas and the groups arranged taking into account the type of gas contained (e.g., flammable gases may not be stored next to oxidizing gases). Empty cylinders should be stored separately from full cylinders.
- Storage rooms should be dry, cool, and well ventilated. Cylinders should not be stored at temperatures above 51 degrees C. (125 degrees F.) or near radiators or other sources of heat. Cylinders must be stored a minimum of 20 feet from incompatible materials and a minimum of 10 feet from combustible material.
- Cylinders stored outside must be protected against extremes of weather and combustible waste must be kept a minimum off 10 feet from the cylinders.
- Cylinders must be protected from any object that will produce a cut or other abrasion in the surface of the metal. Do not store near elevators or gangways, or in locations where heavy moving objects may strike or fall on them.
- All gas cylinders must be capped and secured when stored. Cylinders must be stored in the upright position, unless designed for use in the horizontal position. Each cylinder must be individually secured. Nesting of cylinders is not permitted. Cylinders shall always be secured to prevent them falling over. Chains or a clamp-plus-strap is an acceptable method of keeping cylinders upright. The chain or strap shall be placed above the midpoint of the cylinder to keep it from falling over.
- Do not store gas cylinders with pressure on the regulator.
- Storage, use and handling areas shall be secured against unauthorized entry or access to unauthorized personnel.

5.5 Functional Testing of Regulators

It is recommended that regulators be function tested every six months. Following, is a general procedure for function testing regulators.

- Close the regulator by turning the pressure adjusting screw counterclockwise until fully released.
- Close the cylinder valve. Ensure that lines leading from the regulator to equipment or apparatus are purged of pressure by opening the appropriate flow control valves.
- The regulator delivery pressure gauge should drop to a pressure reading of zero. Record the delivery pressure gauge reading. The cylinder pressure gauge will read full pressure. Record the initial high pressure.
- If the delivery pressure gauge does not read zero when all the pressure is removed, it may be damaged. Send regulators suspected of malfunction to the manufacturer for repair, or replace the regulator.
- Check the cylinder pressure gauge reading after at least 30 minutes. Record cylinder pressure gauge reading. Any pressure drop will indicate leakage. Send regulators suspected of malfunction to the manufacturer for repair, or replace the regulator.
- Release the pressure in the regulator by turning the pressure adjusting screw clockwise. After venting, close the regulator by turning the pressure adjusting screw counterclockwise.

5.6 Testing for Leaks

A leaking cylinder can pose a serious hazard to individuals working with the gas, and to the facility. Leak detection procedures should be implemented prior to the initial use of any system using compressed gas. Perform a leak test on a compressed gas system using the following procedure.

Testing for inert gas

- Prepare a soapy water solution. Ensure the solution to be used is not incompatible with the gas in the system.
- Pressurize the system.
- Apply the solution to all connections (e.g. cylinder valve, regulator connections, other connections) observing for the formation of bubbles. If bubbles formed, leak is present.
- Use gas leak detector equipment if available
- Inspect and secure connections that are observed to be leaking, and retest.
- If no bubbles are formed, the system is not leaking, and may be used. If a leak cannot be corrected, the system should not be used. Notify your supervisor.
- In instances where a cylinder valve is found to be leaking, the following should be adhered to. Never attempt to repair a cylinder valve.
- Contact the supplier and ask for response instructions. Contact HS at 4403 3999
For flammable or toxic gases, use gas leak detector equipment for leak test.

When gas leak is detected:

- Remove the gas cylinder to an isolated, well ventilated area, away from incompatible materials, only if safe to do so.
- Allow it to remain isolated until the gas has discharged, making certain that appropriate warning signs have been posted.
- If the material is toxic, remove the cylinder to an isolated, well-ventilated area, but only if this is possible while maintaining personal safety. Evacuate the building by pulling a fire alarm.

5.7 Disposal of Cylinders

- When feasible, QU shall purchase compressed gas only from manufacturers that will agree to take back the empty cylinder.
- Refillable cylinders shall be returned to the authorized supplier or directly to the vendor. If a refillable cylinder is encountered that does not have a manufacturer label, contact the HS for advice on disposal. Or the supplier/vendor shall be contacted to obtain guidelines for the shipment of cylinders to be returned.
- Manufacturer labels shall be maintained and empty cylinders shall be labeled as **“Empty”**.
- Appropriate identification of the contents of all cylinders is required and is the responsibility of the user.
- Close and tighten valves and replace safety caps on cylinders.
- Identify the gas that was in the container. Valves will be removed from empty nontoxic gas cylinders before disposal as metal scrap.
- Removal of cylinders that cannot be returned to the supplier/vendor or for disposal of orphaned cylinders shall be treated as hazardous waste. The following guidelines shall be used:
 - Laboratory In-charge shall properly store the hazardous waste at satellite accumulation area.
 - Laboratory In-charge shall prepare the Hazardous Waste Pickup Request Form, and shall be submitted to Environment Section for processing of waste disposal.
 - HSEO shall review the Hazardous Waste Pickup Request Form and conduct safety inspection on waste satellite accumulation area.
 - Upon verification and approval by HSEO, the accredited contractor shall be notified for pickup of hazardous waste.
 - Hazardous waste pickup request is process by HSEO during office hours, Sunday through Thursday, 8 AM to 2 PM.
 - Hazardous waste pick up is scheduled every Thursday starting at 9:00 AM.
 - In an emergency situation, the accredited contractor shall be asked to commenced packaging, manifesting, pick-up, transport, and final disposal activities within twelve (12) hours after notification by HSEO.
- Cylinders of hydrogen fluoride and hydrogen bromide should be returned to the supplier within two (2) years of the shipping date. Cylinders of corrosive or unstable gases should be returned to the supplier when the expiration date of the maximum recommended retention period has been reached. If no maximum recommended retention time is provided by the supplier, a 36 month (3 year) time limit should be used.

5.8 Inspection and Maintenance

Compression Units shall be inspected by a competent person at a minimum annually.

Gas cylinders shall be hydrostatically tested at a minimum every five years which shall be conducted by a qualified testing facility. The test date shall be stamped onto the cylinder each time the cylinder is tested.

Air Receiver shall be tested by a competent person or a skilled third party agency at a frequency defined by the applicable legal requirements, manufacturer recommendations and/or employer's inspection & maintenance scheme.

Pipework shall be tested by a competent person or a skilled third party agency at a frequency defined by the applicable legal requirements, manufacturer recommendations and/or employer's inspection & maintenance scheme.

Electronics shall be visually examined, function tested (to include protective devices), and continuity and resistance testing of any cables by the employer competent person or a skilled third party agency.

5.9 Emergency Response

Refer to ***QU HSMS - Emergency Management Procedure*** for requirements related to emergencies involving compressed gas cylinders include leaks, fire, explosions etc.

6 Training

6.1 General Worker

Employers shall ensure all relevant employees and contractors that perform tasks that work with or near compressed gasses receive training that includes at a minimum:

- physical hazards associated with compressed gases;
- design specification, capabilities and limitations of compressed gas storage systems and their uses at the work site;
- methods and procedures that will prevent exposure to compressed gases or hazards associated with compressed gases;
- the importance of control measures;
- safe work practices;
- required use, maintenance and storage of PPE;
- emergency response procedures;
- safe handling and storage;
- health hazards associated with compressed gases used at the work site;
- signs and symptoms of exposure to compressed gases used at the work site; and
- operator maintenance requirements for compressed gas systems.

6.2 Qualified Worker

Employers shall ensure managers and supervisors of operators of compressed gas systems requiring shall be trained on:

- requirements listed in Section 2(a);
- maintenance requirements of compressed gas system to ensure they are working appropriately and within specifications;
- how to recognize unsafe work practices when working with compressed gas; and
- how to identify when the compressed gas systems are not working appropriately.

6.3 Training Documentation

QU shall maintain a record of required training and attained competency with respect to hazardous materials for all persons handling or working in the vicinity of hazardous materials.

7 Document Control

This SOP is a controlled document. The controlled version of this SOP is located on the QU Documentation Management System.

Any printed copies of this controlled document are reference copies only. It is the responsibility of all of those with printed copies to ensure their copy is kept up to date.

Refer to ***QU HSMS – Document Control and Record Retention***.

8 References

UK HS HSG 39: Compressed Air Safety

OSHA Standards for General Industry 29 CFR 1910 - 1910.101 Compressed Gases (General Requirements)