

STANDARD OPERATING PROCEDURE

FOR COMPRESSED GAS CYLINDERS

Plant Ag SOP #	2002-2
Revision date:	26 Aug 2002
Reviewed by Env Health & Safety:	15 Aug 2002

I. ASSOCIATED RISKS

Compressed gas is any substance contained under pressure including dissolved gas or a gas liquified by compression or refrigeration that has a critical temperature of less than 50EC, an absolute vapour pressure of greater than 275.8 kPa at 21EC or 717 kPa at 54EC, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8EC.

Compressed gas cylinders pose significant hazards due to both their pressure and/or contents. These hazards can be roughly grouped into two categories:

Mechanical hazards:

- Breaking off a valve from a full cylinder is the ultimate accident and all operations should aim at absolutely avoiding this incident. A full standard sized compressed gas cylinder at a pressure of - 200 atm contains the kinetic energy equivalent to a small anti-tank weapon. Cylinders whose valves were accidentally broken off have been known to fly in excess of 500 m and penetrate concrete walls.
- Compressed gas cylinders are heavy and injury to hands, feet, and backs can occur with improper methods of moving cylinders.
- Threaded connections are typically made of brass and are designed to give gas-tight metal to metal seals. Since brass is a soft metal, these threads can be easily damaged if improperly installed resulting in loss of seal and potentially disastrous consequences.

Content hazards:

- Asphyxiation. All gasses available in compressed gas cylinders, with the exception of breathable air, will lead to death by asphyxiation if their concentration within any enclosed space, such as a laboratory, exceeds certain levels.
- Ignition and or explosion. Many gasses, in particular H₂ but also a variety of organic compounds such as ethylene, are flammable. Even a very small leak on an improperly installed gas-valve or otherwise compromised cylinder can lead to build-up of flammable, or worse, explosive gas/air mixtures within enclosed spaces.
- Poisoning. A variety of gasses available in compressed gas cylinders are highly toxic, for example CO and H₂S. Others are toxic as well as corrosive to equipment and tissue, in particular in the respiratory tract and the eyes. Examples of the latter class are Cl₂, NO_x, or SO₃.

Classification	Examples
1. Flammable	Hydrogen, acetylene, propane, methane, butane, ethane, ethylene, isobutane, silane, vinyl chloride
2. Inert	Helium, neon, nitrogen, carbon dioxide, air, nitrous oxide, sulphur hexafluoride
3. Toxic	Carbon monoxide, phosgene, nitric oxide, arsine, chlorine trifluoride, cyanogen, methyl bromide, nitrogen trioxide
4. Corrosive	Hydrogen chloride, boron trifluoride, ammonia, chlorine

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II. RISK MANAGEMENT

- 2.1 All compressed gas cylinders are to be clearly marked with either the chemical name or the trade name of the gas.
- 2.2 Cylinders must be stored in approved areas away from elevators, stairs, and building exits.
- 2.3 Approved storage areas must ensure cylinders are located and secured in a manner that will prevent damage to any cylinder and prevent unauthorized tampering/use.
- 2.3 All cylinders must be stored in an upright position and secured to a solid object at the top 1/3rd of the cylinder in a manner that will prevent the cylinder from being knocked over or from falling. Mechanisms for securing must be of noncombustible material or fire-resistive.
- 2.4 When cylinders are not in use, the protective cap must be installed hand tight.
- 2.5 Cylinders no longer in use for the operation or empty must be properly removed by the supplier.
- 2.6 Cylinders must be tagged or signed in a manner that will identify which cylinders are empty and which are full/partially full.
- 2.7 Movement, connection, disconnection, and use of compressed gas cylinders is only to be done by personnel who have been trained in the safe operating procedures of compressed gas cylinders and their contents.

III. OPERATOR INSTRUCTIONS

3.1 Training

- All operators must be WHMIS-trained and have successfully completed an authorised training session on the safe operating procedures of compressed gas cylinders. This training will include review of the standard procedure for compressed gas cylinders and hands-on assistance by an experienced compressed gas cylinder user.
- All users must be familiar with the properties of each gas they are using. A review of the MSD sheets is necessary.

3.2 Movement and storage

- Only trained personnel are authorized to move a compressed gas cylinder.
- Safety shoes, lab coats, and eye protection are to be worn during movement of compressed gas cylinders.
- Any gas cylinder that is being moved, however short the distance and irrespective of the content, must have a safety cap screwed over the valve on top of the cylinder.
- If a cylinder is to be moved more than 2 m this must be done using a cart specifically designed for this purpose and fitted with a securing chain. In the Crop Science building this cart can usually be found in the main floor supply room near the elevators.
- All cylinders must be stored in an upright position and secured to a table, lab bench, or wall at the top 1/3rd of the cylinder in a manner that will prevent the cylinder from being knocked over or from falling. Straps or chain holders for securing must be of noncombustible material or fire-resistive.
- Cylinders must be stored in approved areas away from elevators, stairs, and building exits. Approved storage areas must ensure cylinders are located and secured in a manner that will prevent damage to any cylinder and prevent unauthorized tampering/use. Avoid areas near heat ducts, direct sunlight, steam pipes, and heat releasing equipment such as autoclaves and ovens.
- All cylinders shall be labelled with the contents, name of the owner, and the date acquired.
- Corrosive gases should not be kept longer than 3 months. Return to the supplier even if there is gas remaining in the cylinder.

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- The location and type of individual cylinders in the laboratory should be indicated on a floor-plan posted on the outside of the laboratory entrance door.

3.3 Connecting/Changing cylinders

- Only trained personnel are authorized to connect/change a compressed gas cylinder.
- Never use a cylinder that cannot be identified positively.
- Never use excessive force when fitting a pressure-reducing diaphragm regulator to a cylinder.
- Choose the right regulator with the correct pressure output range for the intended application. Never use adapters for attaching regulators.
- Make sure the threads on both the regulator and the cylinder valve are clean and in good condition. Do not connect if either are not in good condition.
- Keep cylinders valves, regulators, couplings, hose and apparatus clean and free of oil and grease.
- The use of Teflon tape on the threaded connection is not recommended and unnecessary if the regulator and tank threads are in good condition.
- Hold the regulator so that the dials are vertical and connect the regulator to the cylinder valve by closing the thread finger-tight. The thread should move very easily, if it does not it is either damaged or you are not holding it at the correct angle. Use a wrench to tighten the connection with a maximum of one turn. Never use excessive force to tighten the connection.
- Leak check the connection using either commercially available Snoop or a mixture of water/isopropanol/dish soap.
- It is the individual researcher's/supervisor's responsibility that any used or stored gas cylinders, as well as feed lines originating from them are kept in good condition and tested for leakage on a regular basis.

3.4 Venting

- With the exception of N₂, Ar, He, and air, all gases originating from a compressed gas cylinder must ultimately be vented into a fume-hood. Due to the small gas volumes involved this stipulation is waived for flame ionization (FID) and thermal conductivity (TCD) detectors on gas chromatographs.
- Due to extreme fire hazard, liquid oxygen and flammable cryogenics such as liquid hydrogen shall only be used after consultation with Environmental Health and Safety Department.
- All open flame equipment requiring flammable gas delivery systems shall incorporate flash arresters in the gas lines.
- Toxic, flammable, and corrosive gases must be stored outside the building. Only such gases 'in service' may be kept in the laboratory.
- If CO is to be used on a regular basis in any given laboratory, an electronic CO sensor should be permanently installed and regularly tested. A written record of these tests must be kept.

3.5 Use

- All users must be familiar with the properties of each gas they are using. A review of the MSD sheets is necessary.
- Appropriate personal protective equipment for the gas involved shall be worn when using compressed gas cylinders. Eye protection is the minimum requirement for working with any compressed gas.
- Open cylinder valves slowly and directed away from your face.
- Never turn a gas cylinder off with the regulator. Close down flow at the main cylinder valve and let lines drain when you are finished using the gas system.

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- Do not drain tank completely. Air can be sucked back through the valve contaminating the cylinder creating an explosive mixture. Leave a minimum 25 psi in the tank.

3.6 Additional information.

- Consult the MSD sheets for information on the specific contents of a compressed gas cylinder.
- Further information is available from the University Safety Policy Manual, Policy 851.08.05

VI. CONTINGENCY PLAN

Leaking cylinder

- Close the main cylinder valve to shut off the gas flow.
- Do not extinguish a flame involving a highly combustible gas until the source of the gas has been shut off, otherwise, it can reignite, causing an explosion.
- Cylinders leaking at the cylinder control valve should be reported to emergency personnel (Ext. 2000).
- If a hazardous gas is released into an unvented enclosure and the gas supply cannot be promptly cutoff, activate the emergency evacuation procedure in the building.