

GUIDE TO LABORATORY SAFE PRACTICES MANAGING COMPRESSED GASES

Labeling & Storage

- Compressed gas cylinders should be labeled as to their contents. Note that the manufacturer label may not be adequate to describe the contents of the cylinder.
- Store cylinders so that their content labels are clearly visible.
- Store all cylinders in a dry, well-ventilated area away from extreme temperature changes, sources of ignition or heat, moisture, and mechanical shock.
- Keep incompatible classes of gases stored separately. Keep flammables away from reactives, which include oxidizers and corrosives. Gas cylinders of fuels (for example, hydrogen) should be separated from gas cylinders of oxidizers (for example, oxygen) by at least 20 feet or by a wall with a minimum fire rating of 2 hours.
- Always make sure that cylinders are secured to a permanent structural support and secured with a chain or a strap at two thirds of their height from the floor. Place a facilities service request using the Ready website tool at <https://ready.app.vanderbilt.edu/>
- For small cylinders or lecture bottles, utilize a stand or other appropriate mechanism to secure the cylinder to a stable surface.
- Segregate gas cylinder storage from the storage of other chemicals as much as possible.
- Cylinders that are in use must be secured individually so that no slippage or sliding occurs that could damage or alter the regulator.
- If cylinders must be ganged together for storage, only gang two cylinders together at a time, if possible.
- Cylinder carts are not a safe way of securing uncapped gases, even "only for a short time."
- Segregate empty cylinders from full cylinders and clearly mark the empty cylinders.

Usage

- Only Compressed Gas Association (CGA) standard combination of valves and fittings can be used in compressed gas installations.
- Gas lines and manifolds should be clearly marked with the identity of their contents and the direction of gas flow.
- When cylinders are no longer in use, shut the valves, relieve the pressure in the regulators, remove the regulators, and cap the cylinders.
- Make sure regulators are compatible with the gases they are being used with. Corrosive gases and carbon dioxide typically require regulators made of corrosive-resistant materials.
- Pressure regulators should be equipped with spring-loaded pressure relief valves to protect the low-pressure side. When used on cylinders of flammable, toxic, or otherwise hazardous gases, the relief valve should be vented to a hood or other safe location.
- Regulators used for corrosive gases should be removed immediately after use and flushed with dry air or nitrogen.
- Cylinder discharge lines should be equipped with approved check valves to prevent inadvertent contamination of cylinders that are connected to a closed system where the possibility of flow reversal exists.
- For small cylinders or lecture bottles, utilize a stand or other appropriate mechanism to secure the cylinder to a stable surface.

Transportation

- Cylinders must always be handled as high energy sources.
- Always transport gas cylinders on wheeled cylinder carts with retaining straps or chains.
- Always transport lecture cylinders individually or in an approved carrier for transporting multiple cylinders.

Potential Leaks

- Only trained and designated persons may change or hook up gas cylinders.
- The laboratory faculty member must review and approve any new gas cylinder installation.
- Gas cylinders, hoses, tubing, and regulators must be maintained in good condition and replaced immediately if they become damaged or worn.
- Do not lubricate gas cylinder fittings and do not force tight fits.
- Open valves slowly, and do not stand directly in front of the gauges in case the gauge face blows out.
- Corrosive, toxic, and flammable gases must be connected with one continuous tube from the regulator to the apparatus.
- Cylinders, connections, and hoses should be checked regularly for leaks using an appropriate gas detector (if applicable), soapy water, or a 50 percent glycerin-water solution, can be used to look for bubbles.
- When the gas to be used in a procedure is a flammable, oxidizing, or highly toxic gas, the system should first be checked for leaks using an inert gas before introducing the hazardous gas.
- Laboratory personnel should never attempt to repair a leak at the junction of the cylinder valve and the cylinder or at the safety device. Contact the manufacturer or supplier for assistance.
- If a leak at the cylinder valve handle cannot be remedied by tightening a valve gland or a packing nut, contact the manufacturer or supplier for assistance.
- Use of internal bleed-type regulators should be avoided.

Empty Cylinder Disposal

- Whenever possible, only purchase cylinders (including lecture cylinders) that can be returned to the distributor.
- If cylinders cannot be returned to the distributor (including lecture cylinders), contact EHSS for proper disposal.

SPECIAL REQUIREMENT FOR TOXIC GASES

Examples of highly toxic gases used at Vanderbilt University (list not inclusive):

- Arsine
- Boron trifluoride
- Carbon monoxide
- Chlorine
- Diborane
- Dichlorosilane

- Fluorine
- Hydrogen chloride
- Hydrogen cyanide
- Hydrogen fluoride
- Hydrogen selenide
- Hydrogen sulfide
- Nitrogen dioxide
- Nitric oxide
- Ozone
- Phosgene
- Phosphine
- Sulfur dioxide

Contact the EHS [Chemical Safety Team](#) to review plans for using highly toxic gases to ensure adequate safety measures are in place.

Engineering Controls and Requirements for Gas Use by Application

Engineering Controls

	<u>Class 1</u>	<u>Class 2</u>	<u>Class 3</u>	<u>Class 4</u>	<u>Class 5</u>
Gas Cabinet	--	X ¹	X	X	--
Interlocks	X ²	X ²	X ²	X ²	X ²
Emergency Off Button			X	X	
Equipment Enclosed and Ventilated	--	X ¹	X	X	X
Smoke Detection	--	X ²	X ²	X ²	X ²
Sprinkler Protection	--	X ³	X ³	X ³	X ³
Emergency Power to Exhaust Ventilation	--	--	X ⁴	X ⁴	X ⁴
Pneumatic Shutoff Valve	--	X ⁵	X	X	X
Scrubber	--	--	X ²	X ²	X ²
Vacuum Pump Purge and Interlock	--	--	X	--	--
Flow Restricting Orifice	--	X	X	X	X
Ventilation Alarms	--	--	X	X	X
Eyewash and Showers	--	--	--	X ⁶	X ⁶
Purge Panel	--	--	X	X	X
Gas Monitor	--	X ⁷	X ⁷	X ⁷	X ⁷
Piping and Fittings	X	X	X	X	X
Hardware	X	X	X	X	X

Classes

- **Class 1 Application: Use of Inert Gases**
Gases which are non-flammable and non-toxic, but which may cause asphyxiation due to displacement of oxygen in poorly ventilated spaces
- **Class 2 Application: Use of Flammable, Low Toxicity Gases**
Gases which are flammable (at a concentration in air of 13% by volume or have a flammable

range wider than 13% by volume), but act as non-toxic, simple asphyxiants (e.g. Hydrogen, Methane)

- **Class 3 Application: Use of Pyrophoric Gases and Liquids**
Gases or liquids which spontaneously ignite on contact with air at a temperature of 130 F or below.
- **Class 4 Application: Use of Corrosive, Toxic, and Highly Toxic Gases**
Gases which may cause acute or chronic health effects at relatively low concentrations in air
- **Class 5 Application: Use of Compressed Gases in Fume Hoods**

Notes

1. Not required if flow restricting orifice is installed in a cylinder valve. May be required for semiconductor applications.
2. Based on the outcome of hazard review
3. Required in lab and inside gas cabinet for new installations
4. For new installations
5. Typically not required, may be required for semiconductor applications
6. For corrosive gases
7. For gas monitoring consult EHSS for details and requirements.

TRAINING

- Cryogen Safety Training available in the Oracle Learn Environment
- Chemical & Physical Safety in a Laboratory also provides some information about compressed gases and liquids available in the Oracle Learn Environment