

Compressed Gas Cylinder Safety, Management and Disposal

Introduction

Compressed gas cylinders are necessary in many campus operations and research. Compressed gases expose users to both chemical and physical hazards. Gases contained within compressed gas cylinders can be toxic, flammable, oxidizing, corrosive, inert, or some combination thereof. Because the chemical is in gaseous form and pressurized, it can quickly contaminate a large area in the event of a leak in the cylinder, the regulator, or any part of the system after the regulator; therefore, familiarity with the chemical hazards of the gas is necessary. The gas can also be injected into the body through the skin if the gas is blown against the skin with sufficient pressure. In addition to the chemical hazards, there are hazards from the pressure of the gas and the physical weight of the cylinder. A gas cylinder falling over can break chemical containers and crush feet. The cylinder can itself become a rocket if the cylinder valve is broken off. Appropriate care in the handling and storage of compressed gas cylinders is essential.

This fact sheet contains recommendations on the rental and return of gas cylinders, the disposal of non-returnable cylinders, the basic measures necessary to use compressed gas cylinders safely, and the basic guidance on gas system safety. Gas specific safety information can be found in the cylinder labeling, in the Material Safety Data Sheet, and through the gas manufacturer or vendor. Additional references for compressed gas safety include the National Research Council's [Prudent Practices in the Laboratory](#) and the Compressed Gas Association's [Handbook of Compressed Gases](#).

Rental of refillable, returnable cylinders vs. purchasing non-refillable, non-returnable cylinders

1. There are two types of cylinders used on campus:
 - **Refillable gas cylinders** supplied by gas vendors which are generally large and have an average of 200 cubic feet of compressed gas in them.
 - **Non-refillable gas cylinders** such as lecture bottles or disposable cylinders.
2. Refillable gas cylinders usually are provided on a rental basis from a gas vendor or campus unit. These cylinders are owned by the gas vendor and must be returned to them when they are empty or when partially filled and the gas is no longer in use. The rental and return of refillable gas cylinders to gas vendors or campus units is the recommended practice for the management of cylinders.

Note: The term "gas vendor" as used in this fact sheet refers to the gas company that provided the refillable, returnable cylinders for use on campus. For most of these cylinders, that would be the campus contracted gas vendor S.J. Smith (valid until 6/30/2007).

3. **Lecture bottles are non-refillable gas cylinders** that are purchased outright from the gas vendor and become the University's responsibility to properly dispose. They are essentially disposable gas cylinders with disposal cost that can range from \$0 (non-hazardous gases only) to over \$1000, even if empty. One of the primary reasons non-refillable lecture bottles are purchased and used is that they are small (usually 12-15 inches long and 2 inches in diameter, but can vary) and portable. Most gas vendors are able to provide a complete line of small quantity gases for rent in refillable, returnable cylinders which are generally about 20 inches long and 4 inches in diameter. These refillable, returnable cylinders are just as portable as lecture bottles and almost always cost less than the same product delivered in a lecture bottle. The cylinders contain more product than lecture bottles and may be returned to the gas vendor for free even if they are not empty. The Division of Research Safety discourages the purchase and use of lecture bottles if the gas is available for rental in other cylinder sizes. Dispose of lecture bottles through



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the Division of Research Safety. See the compressed gas cylinder disposal procedures at the end of the fact sheet and follow the disposal procedures provided for non-refillable gas cylinders.

4. **Disposable cylinders** - while certain gases (i.e. propane, butane) are sold in "disposable" cylinders, these cylinders should be disposed of through the Division of Research Safety. See the compressed gas cylinder disposal procedures at the end of the fact sheet and follow the disposal procedures provided for non-refillable gas cylinders.

General Requirements

1. Contents of the gas cylinder should be clearly identified. Color coding is not a reliable means of identification. Do not deface or remove any markings, tags or stencil marks used for identification of contents attached by the gas vendor. Cylinders which do not bear a legibly written, stamped, or stenciled identification of the contents should not be used: they should be segregated and the gas vendor should be contacted for removal.
2. Caps used for valve protection should be kept on the cylinder except when the cylinder is in use. A cylinder's cap should be screwed all the way down on the cylinders neck and should fit securely. The cap is for valve protection only.
3. Leaking Cylinders
 - **Poisonous gas** cylinders, regardless of size, should only be opened while in a chemical fume hood or appropriate gas cabinet. In extenuating circumstances alternate ventilation may be used only with prior review and approval of the Division of Research Safety. If there is a circumstance where it is possible that a poison gas could be entering the room air, immediately leave the room, close the door(s), activate the nearest fire alarm pull station, evacuate the area and call 9-911 from a safe place to report the emergency. Be sure to meet the Fire Department at the main entrance to the building to explain the situation. If the cylinder is rented, the gas vendor should be contacted for disposal of the cylinder once the emergency situation is stabilized. If the cylinder is a lecture bottle or disposable cylinder, submit a chemical waste pickup request to the Division of Research Safety for removal.
 - If a cylinder containing **flammable** or **oxidizing gas** is leaking, follow the same steps as above, but turn off all sources of ignition in the room prior to leaving if the shutoffs are accessible and isolated from the leak or are explosion proof. Never attempt to extinguish a fire involving flammable gas without shutting off the gas supply; explosive atmospheres could be created.
 - If the leaking cylinder contains an **inert gas**, place the cylinder in a well-ventilated location, preferably an outdoor cylinder storage area. If the cylinder is rented, the gas vendor should be contacted for removal of the cylinder. If the cylinder is a lecture bottle or disposable cylinder, submit a chemical waste pickup request to the Division of Research Safety for removal.
4. If a cylinder or valve is noticeably corroded, the gas vendor should be contacted and the vendor's instructions followed. Any other damage that might impair the integrity of the cylinder should be called to the attention of the gas vendor before the cylinder is returned.
5. Components of gas systems should be labeled to avoid any confusion.
6. The practice of transferring compressed gases from one commercial cylinder to another is not permitted. Absolutely no refilling of cylinders that were purchased from a commercial gas vendor.



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Moving and Transporting Cylinders

1. Always use a suitable cylinder cart for transporting cylinders, with the cylinder securely chained or strapped to the cart. Do not roll or drag a cylinder to move it or allow cylinders to strike each other or any other surface violently.
2. Protective valve caps must be secured when moving cylinders. Avoid lifting or moving the cylinder by the cap.
3. Ropes or slings should not be used to suspend cylinders unless the gas vendor has made provisions for such lifting and attachment points are provided on the cylinder.

Storing Cylinders

1. All cylinder storage areas must be prominently marked with the hazard class or the name of the gases to be stored; e.g. "Flammable Gas Storage Area", and "No Smoking" signs posted where appropriate.
2. Always secure gas cylinders, including lecture bottles, upright (with valve end up) to a wall, bench top, cylinder rack or post, unless the cylinder is specifically designed to be stored otherwise. Specially designed cylinder clamps can be purchased for securing a cylinder against a bench top. Do not store lecture bottles in cabinet drawers on their side.
3. Where gases of different types are stored at the same location, cylinders (empty or full) should be grouped by the type of gas; e.g., flammable, oxidizer, toxic or corrosive. Inert gases can be stored with any other type of gas.
4. To avoid confusion, full cylinders should be stored separately from empty cylinders. Cylinders should be used by the "first in, first out" guideline.
5. Cylinders should be stored in a well-ventilated area away from sparks, flames or any source of heat or ignition. Cylinders may be stored outside on a slab, however, where extreme temperatures prevail, cylinders should be stored so that they are protected from the direct rays of the sun. Do not expose cylinders to temperatures above 125 degrees F.
6. Cylinders should not be exposed to continuous dampness or stored near salt or other corrosive chemicals or fumes. Corrosion may damage cylinders and cause their valve protection caps to stick.
7. Avoid prolonged storage of cylinders in corridors.
8. Never store cylinders in elevator lobbies, stair towers or any other location which could obstruct the safe exit pathway of the building occupants.

General Use Precautions

1. Do not use compressed gas cylinders for any purpose other than the transportation and supply of gas.
2. Never tamper with or attempt to repair or alter cylinders, regulators or any pressure relief devices. Return cylinders to the gas vendor for all repairs. Have regulators checked and cleaned periodically by trained service personnel.
3. Do not attempt to remove a stuck cylinder cap by using a lever in the cap ports. The lever may accidentally open the valve when the cap turns.
4. Do not place cylinders where they might become part of an electric circuit or allow them to come into contact with an electrically energized system.
5. Use pressure regulators that are equipped with pressure relief devices.

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Utilizing Compressed Gases

1. Before using the gas, read all label information and the data sheets associated with the use of that particular gas.
2. Always use the proper regulator for the gas in the cylinder. Always check the regulator before attaching it to a cylinder. If the connections do not fit together readily, the wrong regulator is being used. Do not force connections to fit, as you may permanently damage the threads.
3. The threads and mating surfaces of the regulator and hose connections should be cleaned before the regulator is attached. Wipe the outlet with a clean, dry, lint-free cloth. Particulates can clog the regulator filter (if so equipped) or cause the regulator to malfunction.
4. Attach the regulator securely, with the secondary valve closed and with the regulator flow backed off (counterclockwise) before opening the cylinder valve.
5. Do not permit oil or grease to come in contact with cylinders or their valves, especially cylinders containing oxidizing gases (See the section on Special Precautions for Using Oxygen and Oxidizing Gases.)
6. Always use a cylinder wrench or other tightly fitting wrench to tighten the regulator nut and tube connections. When working with tubing or tube fittings, where turning a wrench could put torque on weaker system parts, use a second wrench in a suitable location to counter the torque.
7. Teflon tape should only be used on tapered pipe threads where the seal is made at the threads, not on cylinder connections or tube fitting connections, all which have metal-to-metal-face seals or gasketed seals.
8. When opening a cylinder valve, open the valve slowly. Point the valve opening away from yourself and other persons. Never use a wrench or hammer to open or close a hand wheel-type cylinder valve. If the valve is frozen and cannot be operated by hand, return the cylinder to the gas vendor.
9. Use "Snoop", soapy water or leak detection equipment to ascertain that there are no leaks in the gas transport system.
10. Before a regulator is removed from a cylinder, close the cylinder valve and release all pressure from the regulator.
11. Never completely empty a rented gas cylinder, rather discontinue use of the cylinder when it has at least 25 psi remaining. Mark the cylinder so that others know that it is nearly empty; e.g., write "MT" on a piece of tape and stick it on the cylinder in such a way that the tape will not come off unless intentionally removed. Verify that the valve is closed and secure the cylinder valve protective cap and outlet cap or plug, if used.
12. Utilize pressure relief devices; e.g., pressure relief valves and rupture discs where appropriate to protect against the over pressurizing of any element of the compressed gas system that cannot safely withstand full cylinder pressure.
13. Be sure to use valves, tubing and tube fittings that are designed for the application. If in doubt, contact the manufacturer or distributor.
14. Where there is any chance for equipment malfunction, inspect the condition of the equipment at appropriate intervals.

Special Precautions for Using Flammable Gases

In addition to the above guidelines, the following measures should be taken when handling flammable gases.

1. Cylinders containing flammable gases (empty or full) should be separated from cylinders containing oxidizing gases by a minimum distance of 20 feet or by a barrier at least 5 feet high which has a



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- fire-resistance rating of at least one-half hour; e.g., a concrete block wall.
2. Do not store flammable gases near unprotected electrical connections, heat sources or any source of ignition.
 3. Storage of flammable gases in a ventilated, fire resistant enclosure is recommended; e.g., an approved gas cabinet or chemical fume hood. If this is not possible, flammable gas cylinders should be stored in a well-ventilated space.
 4. The quantity of flammable gases in a laboratory should be kept to a minimum. A maximum of three full-size cylinders of flammable gas are permitted in one laboratory.
 5. The use of flow restrictors or surge protectors on flammable gas cylinders is recommended, in order to prevent a sudden large flow of gas if a rupture or other unexpected release happens in the system.
 6. There may be circumstances where using a pure flammable gas may pose unacceptable risks. Under these circumstances, it may be necessary to use the flammable gas in a mixture with an inert gas; i.e., to lower the flammability of the gas e.g., 1% hydrogen in 99% argon. If in doubt, contact the Division of Research Safety.

Special Precautions for Using Poison Gases

In addition to the general guidelines, the following measures should be taken **when handling poison gases**:

1. Poison gases must be stored in a ventilated enclosure; e.g., an approved gas cabinet or a chemical fume hood.
2. Gas detection systems may be required in laboratories utilizing poison gases. Contact the Division of Research Safety for information.
3. The quantity of poison gas in a laboratory should be kept to a minimum.
4. Flow restrictors are required on most poison gas cylinders.
5. Ensure that pressure-relief devices vent directly to a laboratory exhaust system.

Special Precautions for Using Oxygen and Oxidizing Gases

In addition to the general guidelines, the following measures should be taken when handling oxidizing gases:

1. Do not permit oil or grease to come in contact with compressed oxidizing gases. Regulators and tubing used with oxidizing gases must be specially cleaned to remove oil and other reducing agents. Explosions may occur when pressurized oxidizers come into contact with grease or oil.
2. Cylinders containing oxygen or oxidizing gases (empty or full) should be separated from cylinders containing flammable gases 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; e.g., a concrete block wall.
3. Do not store oxidizing gases near flammable solvents, combustible materials or near unprotected electrical connections, heat sources or sources of ignition.

Special Precautions for Using Corrosive Gases

In addition to the general guidelines, the following measures should be taken when handling corrosive gases:

1. Cylinders containing corrosive chemicals should be periodically checked to ensure that the valve has not corroded. If a cylinder or valve is noticeably corroded, the gas vendor should be contacted



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and the gas vendor's instructions followed. Any other damage that might impair the integrity of the cylinder should be called to the attention of the gas vendor before the cylinder is returned.

2. The user should be cautious if flow does not immediately start when a valve is opened slightly, as there could be a plug in the valve. If there is a plug in the valve and the valve is opened more, the plug could clear suddenly, with unexpected excessive flow.

Other information about compressed gas safety can be obtained from the Division of Research Safety at (217) 333-2755 or [via e-mail](mailto:css@illinois.edu) at css@illinois.edu.

Compressed Gas Cylinder Disposal or Return

There are two types of gas cylinders found on campus; **refillable** and **non-refillable** (e.g. lecture bottles, disposable gas cylinders). These two types of gas cylinders have different methods used to properly manage their removal from campus laboratories and workplaces.

1. **Refillable** gas cylinders are generally large and have an average of 200 cubic feet of compressed gas in them. These cylinders are owned by the gas vendor and must be returned to them when they are empty or when partially filled and the gas is no longer required. If the cylinder was rented from a campus unit, contact the unit for cylinder return procedures. If the cylinder was rented from a gas vendor follow the cylinder return procedures as documented in the rental plan.
2. **Non-refillable** gas cylinders (e.g. lecture bottles, disposable gas cylinders) must be managed as a potential hazardous waste, as they are purchased outright. Examples of disposable gas cylinders are cylinders of propane, butane, helium, or calibration gases. When a non-refillable gas cylinder is ready to be disposed of follow the procedures listed in [Chapter 7 of the University of Illinois at Urbana-Champaign Chemical Waste Management Guide](#). Indicate on the non-refillable gas cylinder whether it is empty or still contains product above 1 atmosphere of pressure.

Please note that the Division of Research Safety may refuse to pickup for disposal non-refillable gas cylinders for the following reasons: the contents are not identified, valves are corroded, and cylinder is in exceedingly poor condition.

Gas Categories

Corrosive - Gases that corrode material or tissue with which they come in contact, or do so in the presence of water, are classified as corrosive. They can also be reactive and toxic and/or flammable or an oxidizer.

Flammable - Gases that, when mixed with air at atmospheric temperature and pressure, form a flammable mixture at 13% or less by volume, or have a flammable range in air of greater than 12% by volume regardless of the lower flammable limit, are classified as flammable. They can be high-pressure, toxic, and reactive and displace oxygen in air. A change in temperature, pressure or oxidant concentration may vary the flammability range considerably.

Inert - Gases that do not react with other materials at ordinary temperature and pressure are classified as inert. They are colorless and odorless, as well as nonflammable and nontoxic. The primary hazard of these gases is pressure. These gases are often stored at pressures exceeding 2,000 psi. Also, they can displace the amount of oxygen necessary to support life when released in a confined place. Use of adequate ventilation and monitoring of the oxygen content in confined places will minimize the danger of asphyxiation.



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Oxidizer - Gases that do not burn but will support combustion are classified as oxidants. They can be high-pressure, toxic and reactive, and can displace breathing oxygen from air.

Toxic - Gases that may produce lethal or other harmful effects on humans are classified as toxic. They can be high pressure, reactive, nonflammable or flammable, and/or oxidizing in addition to their toxicity. The degree of toxicity and the effects will vary depending on the gas.

Characteristics of Specialty Gases

A chart of the characteristics of specialty gases is listed on the next page.

- (1) Flammable limits are at normal atmospheric pressure and temperature.
- (2) Corrosive in presence of moisture.
- (3) Toxic. It is recommended that the user be thoroughly familiar with the toxicity and other properties of this gas.



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Gas	Flammable Limits in Air (Vol. %) (1)	Oxidizer	Inert	Corrosive	Toxic
Acetylene	2.5 - 100				
Air		X			
Ammonia				X	
Argon			X		
Arsine	5.1 - 78				-3
Boron Trichloride				X	X
Boron Trifluoride		X		X	-3
1,3-Butadiene	2.0 - 11.5				
Butane	1.8 - 8.4				
Butenes	1.6 - 10				
Carbon Dioxide			X		
Carbon Monoxide	12.5 - 74				X
Chlorine		X		-2	-3
Diborane	0.8 - 98				-3
Dichlorosilane	4.1 - 98.8			X	X
Dimethylamine	2.8 - 14.4			X	
Ethane	3.0 - 12.4				
Ethylene	2.7 - 36				
Ethylene Oxide	3.6 - 100				X
Fluorine		X			-3
Halocarbon-13 (Chlorotrifluoromethane)			X		
Helium			X		
Hydrogen	4.0 - 75				
Hydrogen Bromide				-2	-3
Hydrogen Chloride				-2	-3
Hydrogen Fluoride				X	-3
Hydrogen Sulfide	Apr-44			-2	-3
Isobutane	1.8 - 9.6				
Iso-Butylene	1.8 - 9.6				
Krypton			X		
Methane	5.0 - 15.0				
Methyl Chloride	10.7 - 17.4				
Monomethylamine	4.9 - 20.7			X	
Neon			X		
Nitric Oxide		X		-2	-3
Nitrogen			X		
Nitrogen Dioxide		X		-2	-3
Nitrogen Trifluoride		X			
Nitrous Oxide		X			
Oxygen		X			
Ozone		X			
Phosgene					-3
Phosphine	1.6 - 99				-3
Propane	2.1 - 9.5				
Propylene	2.0 - 11				
Silane	1.5 - 98				
Sulfur Dioxide				-2	-3
Sulfur Hexafluoride			X		
Sulfur Tetrafluoride				X	-3
Trimethylamine	2.0 - 12.0			X	
Vinyl Chloride	3.6 - 33				
Xenon			X		



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Questions?

Contact the Division of Research Safety, Chemical Safety Section (333-2755 or [via e-mail](mailto:css@illinois.edu) at css@illinois.edu) or visit our web site: <http://www.drs.illinois.edu/css/>.

Other Chemical Safety Fact Sheets are available from the Chemical Safety Section at our web site: <http://www.drs.illinois.edu/css/factsheets/>.

