



INDIANA UNIVERSITY

OFFICE OF THE EXECUTIVE VICE PRESIDENT
FOR UNIVERSITY ACADEMIC AFFAIRS

University Environmental Health and Safety

Compressed Gas Cylinder Safety Program

October 23, 2017

1.0 INTRODUCTION

1.1 Purpose

Indiana University Environmental Health and Safety (IUEHS) has developed this Program to cover general procedures for the safe handling and storage of all compressed gas cylinders and provide recommended safe practices for the handling, storage and transport of cylinders.

1.2 Scope

This Program applies to all Indiana University faculty and staff that use, handle, store or transport compressed gas cylinders.

2.0 AUTHORITY AND RESPONSIBILITY

2.1 **University Environmental Health and Safety (IUEHS)** shall be responsible for:

- 2.1.1 Developing the written Compressed Gas Cylinder Safety Program and revising the Program as necessary;
- 2.1.2 Developing a training program on the safe handling, use, storage, and transportation of compressed gas cylinders; and
- 2.1.3 Conducting routine inspections to ensure the proper storage and use methods are used.

2.2 **Departments** shall be responsible for:

- 2.2.1 Understanding and complying with the requirements of this Program;
- 2.2.2 Ensuring the proper handling, use, storage, and transportation of compressed gas cylinders according to this Program;
- 2.2.3 Training employees on the safe use, handling, storage, and transportation of compressed gas cylinders; and
- 2.2.4 Contacting IUEHS if assistance is needed.

2.3 **Employees** shall be responsible for:

- 2.3.1 Completing training as necessary;
- 2.3.2 Complying with the procedures outlined in this Program; and
- 2.3.3 Informing their supervisor of any problems, defective equipment, or lack of proper storage space for compressed gas cylinders used by them.

3.0 ELEMENTS OF THE PROGRAM

3.1 Inspection

When a gas cylinder is received, it shall be inspected by the user for the following:

- 3.1.1 A stamped hydrostatic test date within the last five years;
- 3.1.2 A stenciled or labeled identification of its contents;
- 3.1.3 Presence of a valve protection cap; and
- 3.1.4 Signs of damage or leakage.

If the test date, identification, markings or cap are not in order, if the cap is rusted or inoperable, or if the cylinder is damaged it shall be rejected.

3.2 Labeling

All compressed gases received, used or stored must be labeled according to the United States Department of Transportation (DOT) and the Occupational Safety and Health Agency (OSHA) Hazard Communication regulations. Each cylinder must be marked by label or tag with the name of its contents. Such identification shall be stenciled or stamped on the cylinder or placed on a label. Do not accept cylinders without the appropriate labels. The primary identifier of cylinder contents is the label.

Never rely on the color of the cylinder for identification. Cylinder colors may vary depending on the supplier. Labels on caps have little value because caps are interchangeable.

All gas lines leading from a compressed gas supply shall be clearly labeled to identify the gas.

When a cylinder becomes empty, it must be marked EMPTY and stored apart from full cylinders while waiting to be removed.

Storage areas shall be prominently posted with the hazard class or the name of the gases stored.

3.3 General Precautions

There are two types of hazards associated with the use, storage and handling of compressed gas cylinders: the chemical hazard associated with the cylinder contents (corrosive, toxic, flammable, etc.) and the physical hazard represented by the presence of a high pressure vessel.

Compressed gas cylinders shall only be handled by those familiar with the hazards and who understand how to safely handle transport and store compressed gas cylinders. Safety Data Sheets (SDS) must be obtained and maintained for all compressed gases. Before using any compressed gas, be familiar with the respective Safety Data Sheet (SDS) for the gas being used.

When using compressed gas cylinders, the following precautions shall be followed at all times:

- 3.3.1 Only properly trained employees shall handle and/or use compressed gas cylinders;
- 3.3.2 Cylinders shall not be used as rollers, supports, or for any purpose other than to contain and use the contents as received;
- 3.3.3 Employees and other personnel shall keep all open flames and heat sources away from medical oxygen tanks, oxygen machines or concentrators, and oxygen tubing;
- 3.3.4 Repair or alteration of compressed gas cylinders is prohibited;
- 3.3.5 Cylinders shall not be placed where they might become part of an electrical circuit. When compressed gas containers are used in conjunction with electric welding, they shall not be grounded or used for grounding;
- 3.3.6 Compressed gas containers shall not be exposed to temperature extremes;
- 3.3.7 If compressed gas containers have been exposed to fire, contact the supplier immediately;
- 3.3.8 All tubing shall be periodically checked for integrity. If tubing is damaged, cracked, or missing, it shall be removed from service until properly repaired or replaced;
- 3.3.9 When a container or valve is noticeably corroded, dented, cut, damaged, or involved in an accident, notify the supplier;
- 3.3.10 Gases are not to be transferred from one vessel to another (except dry ice and cryogenic materials). Do not try to refill a compressed gas cylinder; and
- 3.3.11 Disposable gas cylinders, including lecture bottles, shall not be refilled. It is against US DOT regulations to refill or reuse a disposable gas cylinder.

3.4 Safe Handling of Containers

When handling and transporting compressed gas cylinders, the following shall be followed at all times:

- 3.4.1 Move cylinders using a suitable hand truck or cart;
- 3.4.2 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;
- 3.4.3 An upright position shall include conditions where the cylinder is inclined as much as 45 degrees from the vertical;
- 3.4.4 Never drop, bang, or strike cylinders against each other or other objects;
- 3.4.5 Regulators shall be removed and valve protection caps put in place before the cylinder is moved;
- 3.4.6 Do not lift or move the cylinder by the cap;
- 3.4.7 Do not subject cylinders to rough handling or abuse;
- 3.4.8 Only one cylinder shall be handled at a time unless a two cylinder cart is used and each cylinder is restrained by its own chain; and
- 3.4.9 Cylinders shall only be transported in freight/cargo elevators when they are available. Passenger elevators shall only be used when freight/cargo elevators are not present in the building.

3.5 Valve Protection Caps and Regulators

- 3.5.1 Valve protection caps for a cylinder shall always be in place and hand tight except when cylinders are secured, in use, or connected for use;
- 3.5.2 Never force a cap. The cap shall only be hand tight;
- 3.5.3 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 a likelihood of damage;
- 3.5.4 Never use a cylinder without a regulator;
- 3.5.5 Regulators are gas specific and are generally not interchangeable. Make sure that the regulator and valve fittings are compatible;
- 3.5.6 After attaching the regulator, and before the cylinder valve is opened, check the adjusting screw of the regulator to see that it is released. Never permit the gas to enter the regulator suddenly;
- 3.5.7 Never try to stop a leak between a cylinder and regulator by tightening the union nut unless the valve has been closed first; and
- 3.5.8 Never use adapters to fit valves to cylinders or regulators to valves.

3.6 Storage

Because of the high internal pressure in compressed gas cylinders, they can become projectiles if stored in a manner that could damage the valve. Leaking cylinders can also cause an atmospheric hazard or create an oxygen deficient atmosphere. Due to the hazards associated with compressed gas cylinders, the following rules for storing compressed gas cylinders shall be followed at all times:

3.6.1 General Storage Requirements

- 3.6.1.1 All cylinder storage areas must be prominently marked with the hazard class or the name of the gasses to be stored, e.g. Flammable Gas Storage Area, and "No Smoking" signs posted where necessary;
- 3.6.1.2 Always secure gas cylinders upright (with valve end up) to a wall, cylinder hand truck, cylinder rack or post, or laboratory bench unless the cylinder is specifically designed to be stored otherwise. An upright position shall include conditions where the cylinder is inclined as much as 45 degrees from the vertical. If being secured to a laboratory bench, cylinder bench clamps can only be attached to a bench that is adequate to support the weight of the cylinder.;
- 3.6.1.3 Cylinders with a water volume less than 1.3 gallons (5 L) are allowed to be stored in a horizontal position;
- 3.6.1.4 A chain, bracket, or other restraining device shall be used at all times to prevent cylinders from falling;
- 3.6.1.5 Where gases of different types are stored at the same location, cylinders (empty or full) shall be grouped by the type of gas, e.g., flammable, oxidizer or corrosive. Inert gases can be stored with any other type of gas;
- 3.6.1.6 Full cylinders shall be stored separately from empty cylinders. Cylinders shall be used by the "first in, first out" guideline;
- 3.6.1.7 Cylinders shall be stored in a well-ventilated area away from sparks, flames or any source of heat or ignition;
- 3.6.1.8 Cylinders containing flammable gases such as hydrogen or acetylene must not be stored in close proximity to open flames, areas where electrical sparks are generated, or where other sources of ignition might be present;

- 3.6.1.9 Oxygen cylinders, full or empty, shall never be stored in the same vicinity as flammable gases. The proper storage of oxygen cylinders requires a minimum of 20 feet between flammable gas and oxygen cylinders or the areas need to be separated, at a minimum, by a firewall 5 feet high with a fire rating of at least ½ hour;
- 3.6.1.10 Restraints must be fastened on the upper half of the cylinder – above the center of gravity;
- 3.6.1.11 Greasy and oily materials must never be stored around oxygen cylinders and fittings must never be greased or oiled;
- 3.6.1.12 Storage areas should be dry, well-drained, ventilated, and fire-resistant;
- 3.6.1.13 Cylinders may be stored outside on a slab, however, where extreme temperatures prevail; cylinders shall be stored so that they are protected from the direct rays of the sun. Do not expose cylinders to temperatures above 125 degrees F.
- 3.6.1.14 Cylinders shall not be exposed to continuous dampness, stored near salt or other corrosive chemicals or fumes. Corrosion may damage cylinders and cause their valve protection caps to stick. Cylinders containing corrosive chemicals shall be periodically checked to ensure that the valve has not corroded; and
- 3.6.1.15 Never store cylinders in elevator lobbies, corridors, stairways, paths of egress or any other location which could obstruct the safe exit pathway of the building occupants.

3.6.2 **Oxygen-Fuel Welding Gas Storage**

- 3.6.2.1 Cylinders shall be kept away from radiators and other sources of heat;
- 3.6.2.2 Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, at least 20 feet from highly combustible materials such as oil or excelsior;
- 3.6.2.3 Cylinders shall be stored in definitely assigned places away from elevators, stairs, or gangways;
- 3.6.2.4 Assigned storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or subject to tampering by unauthorized persons;
- 3.6.2.5 Cylinders shall not be kept in unventilated enclosures such as lockers and cupboards;
- 3.6.2.6 Empty cylinders shall have their valves closed;
- 3.6.2.7 Valve protection caps, where cylinder is designed to accept a cap, shall always be in place, hand-tight, except when cylinders are in use or connected for use;
- 3.6.2.8 Fuel-gas cylinder storage inside a building, except those in actual use or attached ready for use, shall be limited to a total gas capacity of 2,000 cubic feet or 300 pounds of liquefied petroleum gas;
- 3.6.2.9 For storage in excess of 2,000 cubic feet total gas capacity of cylinders or 300 pounds of liquefied petroleum gas, a separate room or compartment shall be provided, or cylinders shall be kept outside or in a special building;
- 3.6.2.10 Acetylene cylinders shall be stored valve end up;
- 3.6.2.11 Oxygen cylinders shall not be stored near highly combustible material, especially oil and grease; or near reserve stocks of carbide and acetylene or other fuel-gas cylinders, or near any other substance likely to cause or accelerate fire; or in an acetylene generator compartment;

- 3.6.2.12 Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), by a minimum distance of 20 feet or by a noncombustible barrier at least 5 feet high having a fire-resistance rating of at least ½ hour; and
- 3.6.2.13 Oxygen and acetylene may be stored together if it is reasonably anticipated that the gas will be used in the next 24 hours.

3.7 Compressed Gas Emergency Procedures

In the event of a leaking compressed gas cylinder follow the procedures identified in IU's Emergency Procedures Handbook.

3.8 Disposal of Cylinders

When disposing or returning gas cylinders the following shall apply:

- 3.8.1 Close and tighten valves and replace valve caps on cylinders when they are empty;
- 3.8.2 Contact the supplier/vendor to obtain guidelines for the shipment of cylinders to be returned;
- 3.8.3 Contact IUEHS for your respective campus for the disposal of empty compressed gas cylinders; and
- 3.8.4 Cylinders with hydrogen fluoride, hydrogen bromide, or liquid hydrogen cyanide shall be returned to the vendor within two (2) years of the shipping date. Cylinders of corrosive or unstable gases shall be returned to the vendor when the expiration date or the maximum recommended retention period has been reached. If no maximum recommended retention time is provided by the vendor, a 36 month (3 year time limit) shall be used unless approved of by IUEHS for the respective campus.

3.9 Specific Gases Handling Procedures

3.9.1 *Flammable Gases*

The following information applies to the use and handling of flammable gases. Some common examples of flammable gases include acetylene, hydrogen, methane, propane and isobutane.

- 3.9.1.1 Flammable gases must be stored in well-ventilated areas away from flammable liquids, combustible materials, oxidizers, open flames, sparks or other sources of heat or ignition;
- 3.9.1.2 A portable fire extinguisher (carbon dioxide or dry chemical powder type) must be available for fire emergencies where flammable gas is stored;
- 3.9.1.3 "Flow" experiments with flammable gases are not to be left unattended; an explosimeter or combustible gas alarm must be used;
- 3.9.1.4 Spark-proof tools shall be used when working with flammable gas cylinders;
- 3.9.1.5 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 without risk;
- 3.9.1.6 All lines and equipment associated with flammable gas systems must be grounded and bonded; and

3.9.1.7 Acetylene shall not be utilized in lines or hoses at a pressure exceeding 15 psi.

3.9.2 **Oxidizing Gases**

3.9.2.1 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 must state that it is oxygen compatible). Do not handle the cylinder with oily hands or gloves;

3.9.2.2 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 and having a fire rating of at least ½ hour is the minimum separation requirement; and

3.9.2.3 Oxygen and acetylene may be stored together if it is reasonably anticipated that the gas will be used in the next 24 hours.

3.9.3 **Corrosive Gases**

The following information is provided for corrosive gases. Examples include chlorine, hydrogen chloride, fluorine, hydrogen fluoride, hydrogen sulfide, carbon monoxide and carbon dioxide.

3.9.3.1 Keep exposure to gas as low as possible. Use in a fume hood or other vented enclosure when possible. Avoid contact with skin and eyes;

3.9.3.2 Wear safety goggles when handling compressed gas cylinders that contain corrosives;

3.9.3.3 An emergency shower and eyewash must be installed within 10 seconds where corrosive materials, including corrosive gases, are used; and

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

3.9.4 **Toxic and Highly Toxic Gases**

In addition to the general guidelines, the following measures shall be taken when handling toxic and highly toxic gases:

3.9.4.1 Toxic and highly toxic gases shall not be stored or used outside of laboratories;

3.9.4.2 Large cylinders of toxic and highly toxic gases must be stored in gas cabinets, exhausted enclosures, or gas rooms;

3.9.4.3 Keep exposure to toxic and highly toxic gases as low as possible. Use in a fume hood or other vented enclosure when possible. Avoid contact with skin and eyes;

3.9.4.4 A gas detection system with visible and audible alarms to detect the presence of leaks must be installed for all toxic and highly toxic gases that exceeds the maximum allowable quantities;

3.9.4.5 Contact IUEHS for your respective campus if assistance is needed or specifics on gas monitoring system requirements and maximum allowable quantity limits; and

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

3.9.5 **Asphyxiant Gases**

- 3.9.5.1 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;
- 3.9.5.2 An oxygen detection device must be present when the calculated oxygen concentration is less than 18% if the full contents of the cylinder were released; and
- 3.9.5.3 Any gas that has the potential to displace oxygen in sufficient quantities can cause asphyxiation. Only persons trained and qualified in the use of a self-contained breathing apparatus (SCBA) with adequate back-up shall 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.

3.9.6 **Cryogenic Liquids**

Cryogenic liquids and their boil-off vapors rapidly freeze human tissue and cause embrittlement of many common materials which may crack or fracture under stress. All cryogenic liquids produce large volumes of gas when they vaporize (at ratios of 600:1 to 1440:1, gas: liquid) and may create oxygen-deficient conditions. Examples of common cryogenic liquids include liquid nitrogen, oxygen, hydrogen, and helium. The following information applies to the use and handling of cryogenics:

- 3.9.6.1 Wear face shield and chemical safety goggles when dispensing from cylinder or dewar;
- 3.9.6.2 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;
- 3.9.6.3 Keep liquid oxygen containers, piping, and equipment clean and free of grease, oil, and organic materials;
- 3.9.6.4 Do not store cylinders or dewars in environmental chambers that do not have fresh air ventilation. A leak or venting from the container could cause an oxygen deficient atmosphere; and
- 3.9.6.5 First aid treatment for cold-contact burns:
 - 3.9.6.5.1 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;
 - 3.9.6.5.2 Place the affected part of the body in a 100-105°F warm water bath (not to exceed 44°C or 112°F); and
 - 3.9.6.5.3 Never use dry heat.

3.9.7 Oxygen

Every user should understand that oxygen can be dangerous if not used correctly. Oxygen makes things burn more easily and can even explode. Following these safety guidelines will help reduce the potential risks associated with oxygen.

3.9.7.1 OXYGEN IS NOT COMPRESSED AIR, IT IS OXYGEN;

3.9.7.2 Keep oxygen tanks (cylinders) away from all heat sources, including radiators, heat ducts, stoves, fireplaces, matches, and lighters;

3.9.7.3 Do not permit open flames, sparks, or burning material in the area where oxygen is being used;

3.9.7.4 Keep oxygen cylinders secure at all times;

3.9.7.5 Oxygen can ignite organics such as grease (without a flame);

3.9.7.6 Never use oxygen as a substitute as a “compressed air” to run pneumatic tools, in oil heating burners, to start internal combustion engines, to blow out pipelines, or to create pressure for ventilation;

3.9.7.7 Oxygen cylinder valves should be opened all of the way during use; and

3.9.7.8 Do not smoke when oxygen or fuel gases are present. Smoking can cause a fire or explosion.

4.0 TRAINING

All employees affected by this policy shall be trained in compressed gas cylinder safety. The training shall include:

4.1 Cylinder identification;

4.2 Cylinder inspection;

4.3 Cylinder handling, storage and use; and

4.4 Cylinder transportation.

5.0 REFERENCES

- [OSHA 29 CFR 1910.101](#)
- Compressed Gas Association – “Safe Handling of Compressed Gases in Containers”, 11th Edition, CGA P-1-2008;
- International Fire Code 2012 IFC Sec. 3505.6

6.0 REVISIONS

Revised: October 23, 2017

APPENDIX A: GLOSSARY

Asphyxiant gas: A gas, usually inert, that may cause suffocation by displacing the oxygen in the air necessary to sustain life, or is labeled by the DOT as Division 2.2.

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 vapor 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 labeled 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 psia, or which the DOT requires the Division 2.2 label for non-flammable, non-poisonous compressed gas-including compressed gas, liquefied gas, pressurized cryogenic gas, compressed gas in solution, asphyxiant gas and oxidizing gas.

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 greater than 12 percent by volume, regardless of the lower limit; or, one for which the DOT requires their red flammable gas label or is labeled as Division 2.1.

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 or is labeled by the DOT as Division 2.2 and Division 5.1 (Oxidizer).

Toxic gas: A gas that has a median lethal concentration in air of 2,000 parts per million or less by volume of gas; or, gas which the DOT requires the white poison label or is labeled as Division 2.3 "Gas poisonous by inhalation" because it is known to be so toxic to humans as to pose a hazard to health during transportation; or a gas that has an NFPA Health Hazard Rating of 3 (Toxic) or 4 (Highly Toxic).