OES Compressed Gas Plan



# Contents

# PURPOSE 3

# SCOPE 3

# RESPONSIBILITY 3

# DEFINITIONS 4

# INSPECTION 5

# LABELING 6

# GENERAL PRECAUTIONS 6

# SAFE HANDLING OF CONTAINERS 8

# VALVE PROTECTION CAPS AND REGULATORS 9

# STORAGE 9

# EMERGENCY PROCEDURES 13

# DISPOSAL OF CYLINDERS 14

# SPECIFIC GASES HANDLING PROCEDURES 15

# TRAINING 20

# REFERENCES 20

# POINT OF CONTACT 20

# OES Compressed Gas Plan

## ****1.0 Purpose****

The purpose of this written plan is to educate students, staff, and faculty of the hazards associated with compressed gases. Furthermore, it will cover the recommended safe practices for proper handling, usage, storage, and transportation of compressed gases.

**2.0 Scope**

This plan applies to all University Faculty and Staff that use, handle, store or transport compressed gas cylinders.

**3.0 Responsibility**

**A. Office of Occupational & Environmental Safety**

1. Developing the written Compressed Gas Cylinder Safety Program and

revising the Program as necessary.

1. Developing a training program on the safe handling, use, storage, and transportation of compressed gas cylinders.
2. Conducting routine inspections to ensure the proper storage and methods are used.

**B. Departments**

1. Understanding and complying with the requirements of this program.
2. Ensuring the proper handling, use, storage, and transportation of

compressed gas cylinders according to this Program.

1. Training employees on the safe use, handling, storage, and transportation of compressed gas cylinders.
2. Contacting OES if assistance is needed.

**C. Employees**

1. Completing training as necessary.
2. Complying with the procedures outlined in this Program.
3. Informing their supervisor of any problems, defective equipment, or lack of proper storage space for compressed gas cylinders used by them.

**4.0 Definitions**

**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

(non-flammable, non-poisonous compressed gas).

**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 (Toxic Gas) and Division 8 (Corrosive Substances).

**Cryogenic fluid:** A refrigerated, liquefied gas having a boiling point colder than -90

°C (130 °F) at 14.7 psi, or which the DOT requires the Division 2.2 label for nonflammable, 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

(Flammable Gases).

**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 (non-flammable, non-poisonous compressed gas) 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).

**5.0 Inspection**

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

1. A stamped hydrostatic test date within the last five years
2. A labeled identification of its contents
3. Presence of a valve protection cap
4. Signs of damage or leakage.

**6.0 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 should be

stenciled or stamped on the cylinder or placed on a label. Do not accept cylinders

without the appropriate or non-legible labels. The primary identifier of cylinder

contents are 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.

**7.0 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:

1. Only properly trained employees shall handle and/or use compressed gas

cylinders.

1. Cylinders shall not be used as rollers, supports, or for any purpose other than

to contain and use the contents as received.

1. Employees and other personnel shall keep all open flames and heat sources

away from medical oxygen tanks, oxygen machines or concentrators, and

oxygen tubing.

1. Repair or alteration of compressed gas cylinders is prohibited.
2. 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.

1. Compressed gas containers shall not be exposed to temperature extremes.
2. If compressed gas containers have been exposed to fire, contact the supplier

immediately.

1. All tubing shall be periodically checked for integrity. If tubing is damaged,

cracked, or missing, it shall be removed from service until properly repaired

1. or replaced.
2. When a container or valve is noticeably corroded, dented, cut, damaged, or

involved in an accident, notify the supplier.

1. Gases shall not be transferred from one compressed gas cylinder to another.
2. Disposable gas cylinders, including lecture bottles, shall not be refilled. It is

against US DOT regulations to refill or reuse a disposable gas cylinder.

**8.0 Safe Handling of Containers**

When handling and transporting compressed gas cylinders, the following shall be

followed at all times:

1. Move cylinders using a suitable hand truck or cart.
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.

1. An upright position shall include conditions where the cylinder is inclined as

much as 45 degrees from the vertical.

1. Never drop, bang, or strike cylinders against each other or other objects.
2. Regulators shall be removed, and valve protection caps put in place before

the cylinder is moved.

1. Do not lift or move the cylinder by the cap.
2. Do not subject cylinders to rough handling or abuse.
3. 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.

**9.0 Valve Protection Caps and Regulators**

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.

2. Never force a cap. The cap shall only be hand tight.

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.

4. Never use a cylinder without a regulator.

5. Regulators are gas specific and are generally not interchangeable. Make sure

that the regulator and valve fittings are compatible.

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.

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

8. Never use adapters to fit valves to cylinders or regulators to valves.

**10.0 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 storage should always be followed:

**A. General Storage**

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.

1. 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.

1. Cylinders with a water volume less than 1.3 gallons can be stored

in a horizontal position.

1. A chain, bracket, or other restraining device shall always be used to

prevent cylinders from falling.

1. 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.

1. Full cylinders shall be stored separately from empty cylinders. Cylinders

should be used by the "first in, first out" guideline.

1. Cylinders shall be stored in a well-ventilated area away from sparks, flames or

any source of heat or ignition.

1. Cylinders containing flammable gases such as hydrogen or acetylene must

be stored at least 20 feet from highly combustible materials.

1. 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.

1. Restraints must be fastened on the upper half of the cylinder – above the

center of gravity.

1. Greasy and oily materials must never be stored around oxygen cylinders and

fittings must never be greased or oiled.

1. Storage areas should be dry, well-drained, ventilated, and fire-resistant.
2. 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.

1. Cylinders should 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.

1. 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.

**B. Oxygen-Fuel Welding Gas Storage**

1. Cylinders shall be kept away from radiators and other sources of heat.

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. Cylinders shall be stored in specifically assigned places away from elevators,

stairs, or gangways.

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.

5. Cylinders shall not be kept in unventilated enclosures such as lockers and

cupboards.

6. Empty cylinders shall have their valves closed.

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.

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.

1. 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.

1. Acetylene cylinders shall be stored valve end up.
2. 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.

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.

13. Oxygen and acetylene may be stored together on a cart if it is reasonably

anticipated that the gas will be used in the next 24 hours.

**11.0 Emergency Procedures**

If a compressed gas cylinder or gas piping is leaking, or is suspected of leaking, or if

there is any other known or suspected gas release, and a person knowledgeable

about the source decides that it is hazardous to them or to other building occupants,

the following steps should be taken:

1. Contact the University Fire Department and be prepared to provide

the following information:

a) Building name

b) Floor and room number

c) Specific chemical name of involved gas

d) Source of the gas

2. Immediately notify building occupants to evacuate the area using general

evacuation procedures and ensure accountability of all personnel.

**12.0 Disposal of Cylinders**

1. Close and tighten valves and replace valve caps on cylinders when they are

empty.

2. Contact the Clemson University contracted gas supplier/vendor to request vendor pickup. The supplier/vendor, in most cases, will pick up any unused or empty tanks that they supply.

3. Any empty or unused lecture bottles or other cylinders not purchased via the contracted vendor must be declared to OES Hazardous Waste for proper disposal as Hazardous Waste. These bottles or cylinders should have the valves tightened, the valve cap replaced and labeled as hazardous waste.

4. Cylinders with hydrogen fluoride, hydrogen bromide, or liquid hydrogen

cyanide should 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 OES.

**13.0 Specific Gases Handling Procedures**

**A. 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.

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.

2. A portable fire extinguisher (carbon dioxide or dry chemical powder type)

must be available for fire emergencies where flammable gas is stored.

3. “Flow” experiments with flammable gases are not to be left unattended; an

explosimeter or combustible gas alarm must be used.

4. Spark-proof tools shall be used when working with flammable gas cylinders.

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.

6. All lines and equipment associated with flammable gas systems must be

grounded and bonded; and

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

psi.

**B. Oxidizing Gases**

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.

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.

3. Oxygen and acetylene may be stored together if it is reasonably anticipated

that the gas will be used in the next 24 hours.

**C. 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.

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.

2. Wear safety goggles when handling compressed gas cylinders that contain

corrosives.

3. An emergency shower and eyewash must be installed within 10 seconds

where corrosive materials, including corrosive gases are used.

4. An emergency response procedure must be in place and everyone working

in the area must be trained on the procedure.

**D. Toxic and Highly Toxic Gases**

1. Toxic and highly toxic gases shall not be stored or used outside of

laboratories.

2. Large cylinders of toxic and highly toxic gases must be stored in gas cabinets,

exhausted enclosures, or gas rooms.

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.

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 exceed the

maximum allowable quantities.

5. Contact OES if assistance is needed or specifics on gas monitoring system

requirements and maximum allowable quantity limits.

6. An emergency response procedure must be in place and everyone working

in the area must be trained on the procedure.

**E. Asphyxiant Gases**

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.

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.

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.

**F. 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:

1. Wear face shield and chemical safety goggles when dispensing from a

cylinder or dewar.

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. Keep liquid oxygen containers, piping, and equipment clean and free of

grease, oil, and organic materials.

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.

First aid treatment for cold-contact burns:

5. 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.

6. Place the affected part of the body in a 100-105°F warm water bath (not to

exceed 44°C or 112°F); and

7. Never use dry heat.

**G. 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.

1. OXYGEN IS NOT COMPRESSED AIR.

2. Keep oxygen tanks (cylinders) away from all heat sources, including radiators,

heat ducts, stoves, fireplaces, matches, and lighters.

3. Do not permit open flames, sparks, or burning material in the area where

oxygen is being used.

4. Keep oxygen cylinders secure at all times.

5. Oxygen can ignite organics such as grease (without a flame).

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.

7. Oxygen cylinder valves should be opened all the way during use.

8. Do not smoke when oxygen or fuel gases are present. Smoking can cause a

fire or explosion.

**14.0 Training**

All employees affected by this program shall be trained in compressed gas cylinder

safety. The training can be found at <https://clemson.bioraft.com/rafttraining/course/872>

**15.0 References**

OSHA 29 CFR 1910.101:

<https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9747>

Compressed Gas Association:

<https://www.cganet.com/>

International Fire Code 2012 IFC Sec. 3501:

<https://up.codes/viewer/georgia/ifc-2012/chapter/35/welding-and-other-hot-work#35>

**16.0 Point of Contact**

For any questions, comments, or matters pertaining to this written plan, please contact [oeshelp@clemson.edu](mailto:oeshelp@clemson.edu).