THE OHIO STATE UNIVERSITY

Compressed Gas Safety Program

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1.0 Introduction

1.1 It is the policy of The Ohio State University (OSU) to take precautions to eliminate potential hazards in the workplace. The purpose of this Compressed Gas Safety Program is to provide the hazards associated with compressed gases and outline the steps to take to ensure employees who work with, or around compressed gases are not exposed to hazards; and to provide procedures for common compressed gas work duties to minimize exposure in accordance with the OSHA Hazardous Materials, Compressed Gas standards (29 CFR 1910.101); Department of Transportation Hazardous Materials Regulations; and Compressed Gas Association (CGA) guidelines.

1.2 Compressed gas cylinders can present a variety of hazards due to their pressure and/or contents. This program covers requirements which must be followed for the use of all compressed gases. In addition, this program covers steps to take for hazardous compressed gases including controls, work practices, leak testing and the use of personal protective equipment. The OSU Compressed Gas Safety Program outlines acceptable storage, use and handling of gases in pressurized portable containers.

2.0 Responsibilities

2.1 Environmental Health & Safety

2.1.1 Environmental Health & Safety (EHS) provides program oversight and consultation to OSU work groups regarding potential risks, exposure prevention and training relating to compressed gas exposures.

2.1.2 Provide training and recommendations for departments utilizing compressed gases.

2.2 OSU Department (Facilities Operations & Development (FOD); Athletics; OSU Medical Center (OSUMC); Student Life; et. al.)

2.2.1 Each department with responsibilities for purchasing and/or using compressed gases should:

2.2.1.1 Ensure the applicable components of the Compressed Gas Safety Program are available to all affected employees.

2.2.1.2 Provide applicable training to employees expected to work in, or with, building materials where there is a potential risk for compressed gas exposure.

2.3 Supervisors

2.3.1 OSU employees who supervise personnel with responsibilities to work in areas where there is a risk of exposure to compressed gases, must ensure employees are properly trained on the applicable contents of the Compressed Gas Safety Program and are provided appropriate personal protective equipment (PPE) when conducting such work.

2.4 Authorized Person

2.4.1 Employees working in areas where there is an identified risk of compressed gas must be properly trained on all applicable elements of the OSU Compressed Gas Safety Program; and be provided and utilize the appropriate PPE for the task being performed.

3.0 Definitions

3.1 The following definitions are provided to allow for a better understanding of the OSU Compressed Gas Safety Program.

Authorized person:	An employee who has received proper training and PPE to safely work with compressed gases.
Compressed Gas:	Any gas or mixture of gases in a container having a pressure exceeding 40 psi at 70^0F; or regardless of the pressure at 70^0F, having a pressure exceeding 104 psi at 130^0F; or any liquid having an absolute vapor pressure exceeding 40 psi at 100^0F. Compressed gases can be toxic, flammable, oxidizing, corrosive or inert. In the event of a leak, inert gases can quickly displace air in a large area creating an oxygen-deficient atmosphere, toxic gases can create poison atmospheres and flammable or reactive gases can result in fire and exploding cylinders.
Cylinder:	Generally, a compressed gas container having a maximum water capacity of 1,000 pounds or approximately equivalent to 120 gallons.
Flammable Limits:	The concentration of flammable vapor in air, oxygen, or other oxidants that will propagate flame upon contact with an ignition source. The lower explosive limit (LEL) is the concentration below which a flame will not propagate; the upper explosive limit (UEL) is the concentration above which a flame will not propagate.
Ignition source:	Anything that provides heat, sparks, or flame sufficient to cause combustion or explosion.
Inert gas:	Gases that do not readily react with other chemicals.
Pressure Regulator:	A device used to prevent the pressure from rising above a predetermined maximum, thereby, preventing rupture of a normally charged cylinder when subjected to a standard fire test.
Restrictive Flow Orifice:	A safety device placed in the outlet of a cylinder valve that is intended to limit the release rate of a hazardous gas in the event of unplanned opening of the valve, or failure of the system.
Valve Protection Cap:	A rigid removable cover provided for container valve protection during handling, transportation and storage.

4.0 Personal Protective Equipment

4.1 The general requirements for the use of personal protective equipment (PPE) while handling or using compressed gases include, but are not limited to the following.

4.1.1 Eye protection – required any time compressed gases are handled or used.

4.1.2 Foot protection – required when moving or handling compressed gas cylinders

4.1.3 Hand and body protection – to protect against cold exposure, corrosives and pinch points

4.1.4 Respiratory protection – may be required depending on the type of gas being used and the procedures being used with the gas.

5.0 Inspection Procedures

5.1 Compressed gas cylinders should be inspected as necessary to ensure they are fit for use. Compressed gas cylinders should be visually inspected at the time of delivery and as necessary thereafter, depending on the manufacturer's recommendations.

5.2 Inspections of cylinders should be conducted in accordance with the following applicable standards:

5.2.1 49 CFR 171-179 – Department of Transportation Hazardous Materials Regulations

5.2.2 Compressed Gas Association (CGA) Pamphlet C-6-1968 – Standards for Visual Inspection of Steel Compressed Gas Cylinders)

5.3 If a cylinder is found to be unfit for use, it must be taken out of service and returned to the manufacturer for repair or disposal.

6.0 Handling Procedures

6.1 Compressed gas cylinders are considered to be handled when an OSU staff/faculty member performs tasks including filling, changing gas service, maintaining and moving cylinders, connecting cylinders.

6.2 Compressed gas cylinders should be handled only by employees familiar with the hazards and who can demonstrate safety precautions working with cylinders. Compressed gas cylinders are heavy and awkward to move. Improper handling can result in injuries. Other hazards such as fire, explosion, chemical burns, poison and cold burns can occur due to mishandling.

6.3 The following precautions must be taken when handling compressed gas cylinders.

6.3.1 Wear the appropriate PPE as mentioned in section 4.0 of this program.

6.3.2 Cylinders must always be transported on wheeled cylinder carts with retaining straps or chains.

6.3.3 Do not drag a cylinder over a few feet necessary to position the cylinder. Rolling short distances is permitted only along the bottom rim.

6.3.4 Compressed gas cylinders must be transported with protective caps in place. Do not lift the cylinder by the protective cap

6.3.5 Avoid dropping the cylinder; do not tamper with pressure-relief devices or remove any labeling or shipping hazard labels.

6.3.6 Do not allow grease or oil to come in contact with oxygen cylinder valves, regulator, gauges or fittings. Oxygen cylinders and apparatus must be handled with clean hands and tools.

6.3.7 Open cylinder valves slowly, directed away from your face.

6.3.8 Do not attempt to refill compressed gas cylinders unless fully trained to do so.

7.0 Storage Procedures

7.1 Compressed gas cylinders must be properly stored to prevent injury in the case of a container breech.

7.2 The following precautions must be taken during the storage of compressed gas cylinders.

7.2.1 Signage is required at compressed gas cylinder storage location including:

7.2.2 Cylinders must be stored in a cool, dry, well ventilated area.

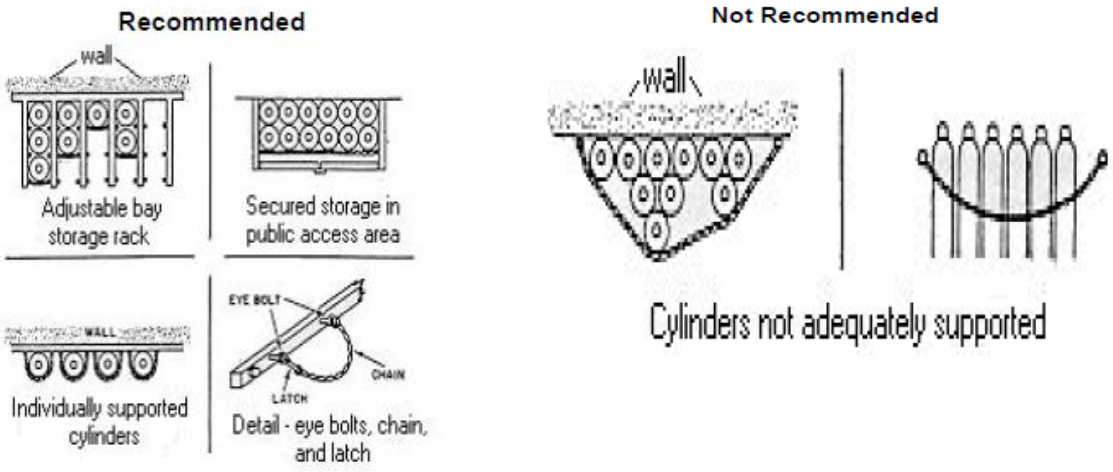
7.2.3 Cylinders must be stored upright, with caps in place, and secured by chains, straps or in racks to prevent falling/tipping.

7.2.3.1 Cylinders must be secured in one or more of the following methods.

7.2.3.1.1 By a noncombustible, two-point restraint system (chain) that secures the cylinder. Nesting of cylinders is not an approved method that can be used to secure cylinders. Individual cylinders can use a bracket or saddle for support means.

7.2.3.1.2 By a noncombustible rack, framework, cabinet, approved strapping device, security to a cylinder cart or other substantial means that prevents the cylinder from falling.

7.2.3.1.3 Straps must surround the cylinder approximately ½ to 1/3 of the height of the cylinder measured from the floor.



7.2.4 Segregate cylinders in storage by contents. For example, flammable gases must be stored separately from oxidizing gases by a distance of 20 feet or a 5 foot high, one-hour fire rated wall.

7.2.5 Do not expose cylinders to corrosive materials such as corrosive gas or other combustible materials.

7.2.6 Segregate full and empty cylinders; use the first in first out inventory control method.

7.2.7 Store cylinders away from heavily trafficked areas and emergency exits.

7.2.8 Visually inspected stored cylinders on a routine basis to identify problems before an emergency occurs.

7.2.9 All cylinder storage areas, outside or inside, must be protected from extreme heat and cold and from access by unauthorized personnel. Prevent indoor or outdoor temperatures from exceeding 125^0F.

7.2.10 Cylinders should be labeled full or empty when in storage.

8.0 Usage Procedures

8.1 The following precautions must be used to prevent injuries caused by the improper use of compressed gases and cylinders.

8.1.1 Know and understand the hazards associated with the gases and equipment being used.

8.1.2 Use only regulators approved for the gases and cylinders in use.

8.1.3 Never mix gases in a cylinder

8.1.4 Do not allow cylinders to become part of an electrical circuit

8.1.5 Use non-sparking tools (brass) when working with flammable/explosive materials.

8.1.6 Prevent sparks and flames from contacting cylinders

8.1.7 Do not discharge the contents from any gas cylinder directly towards people.

8.1.8 Open cylinder valves slowly and carefully after the cylinder has been connected.

8.1.9 Never use compressed gases in a confined space.

8.1.10 Never work alone when using a compressed gas

8.1.11 Never use compressed gas to dust off equipment or clothing.

9.0 Tubing and Piping Connections

9.1 Hazardous gases must be dispensed using systems that are properly designed and compatible with the gas in use. Tubing and piping must be burst resistant with a burst pressure twice the maximum pressure on the second stage regulator.

9.2 The following should be followed in regards to tubing and piping for compressed gas use.

9.2.1 Hard piping is the preferred method of piping for compressed gas use. Piping should be copper or stainless steel. Cast iron is not acceptable for use with compressed gases. Flexible tubing can be used in approved applications.

9.2.1.1 When flexible tubing must be used, select tubing compatible with the gas in use. Flexible tubing is not for use with highly toxic gases. Flexible tubing can only be used within “line of sight”. Do not run flexible tubing through walls, ceiling spaces, doorways or other non-visible pathways.

9.2.1.2 Always clamp flexible tubing connections. Use a clamp approved for the maximum allowable pressure that the connection is subject to. Never use wire, which may cut the tubing.

9.2.1.3 Flexible tubing deteriorates with age or exposure to chemicals or UV light. Inspect tubing regularly and replace when wearing is noticed.

9.2.2 Do not use Teflon tape on pipe threads where the seal is made at the threads. Compressed gas connections have metal to metal seals or gasket seals.

9.2.3 Leak-check tubing or piping connections when using hazardous gas.

9.2.4 Secure and support tubing or piping to keep it in place and to prevent injuries from whipping if the connection fails under pressure.

10.0 Regulators and Valves

10.1 Regulators reduce high pressure gas on a cylinder to a lower usable level. Regulators provide additional safety measures by preventing fire/explosions and exposure to chemicals or cold burns.

10.1.1 Ensure the appropriate regulator is selected for the compressed gas in use. It must be compatible and operate at the appropriate pressures.

10.2 Most compressed gas cylinders will be equipped with a valve to release gas from the cylinder. The cylinder valve is the most vulnerable part of the compressed gas cylinder. Leaks can also occur at the valve, cylinder stem and the hose connection.

10.2.1 Check valves are mechanical valves that permit gases and liquids to flow in only one direction, preventing reverse flow. Common types of valves include check, ball, disk, butterfly, gas, diaphragm, needle and solenoid and can be constructed of plastic, stainless steel, or other material. Ensure the proper check valve is selected for the compressed gas in use and the operations taking place.

10.2.1.1 If a valve becomes noisy or hard to turn, the cylinder should be taken out of service, capped and repaired before put back into use.

10.2.2 A flash arrestor prevents ignition sources from reaching regulator and cylinder for flammables

10.2.3 Excess flow valves restrict flow in the event of a gas line break

11.0 Other Considerations for Compressed Gas Cylinders

11.1 Restrictive Flow Orifices (RFOs): Used in conjunction with high purity, highly hazardous or pyrophoric compressed gas applications to limit the potential danger of an uncontrolled flow from a compressed gas cylinder. An RFO can cut the flow rate by a factor of 100 to add an extra level of safety in the event of an uncontrolled release.

11.2 Rupture Disc: A non-reclosing pressure relief device that protects a pressure vessel, such as a compressed gas cylinder from over pressurization or potentially damaging vacuum conditions. A rupture disc is designed to provide a leak-tight seal within a pipe or vessel, until the internal pressure rises to a predetermined level. At that point the rupture disc bursts preventing damage to the equipment from overpressure.

11.3 Compressed gas users must be informed and knowledgeable of the types of gases being used, the hazards associated with those gases, and the necessary safety components required for their use at all times.

12.0 Compressed Gas Types

12.1 Inerts

12.1.1 Inert gases such as Nitrogen is a gas that makes up 78% of the atmosphere, is a dry, colorless and odorless gas; it is nonflammable and noncorrosive. Inert gases can displace oxygen in an enclosed space.

12.1.2 Inert gases can be vented in occupied spaces if adequate ventilation is supplied to the area. This includes hallways and loading docks.

12.2 Oxidizers:

12.2.1 Oxidizing gases such as compressed oxygen or nitrous oxide, while not combustible, will cause many materials to burn violently.

12.2.2 Never use grease, solvents, or other flammable material on an oxygen valve, regulator or piping.

12.3 Flammables:

12.3.1 Flammable gases such as propane, hydrogen, and acetylene always have a red Flammable Gas label. Do not use the color of the cylinder as an indicator of hazard type.

12.3.2 Users should be knowledgeable of the flammable range of flammable gases. For example, Hydrogen Lower Flammable Limit (LFL) = 4%; Upper Flammable Limit (UFL) = 75%.

12.3.3 Users must know the auto-ignition temperature for flammable gases in use and ensure temperatures do not reach this point.

12.3.4 Flammable gases must be segregated from oxidizing gases.

12.4 Pyrophoric gases:

12.4.1 Pyrophoric gases, such as arsine, silane, phosgene, etc. must be stored in a suitable exhausted location or ventilated cylinder storage cabinet.

12.4.2 If a pyrophoric cylinder is found leaking, the area must be evacuated and emergency services utilized.

12.5 Toxic gases:

12.5.1 Toxic gas use should be done in conjunction with area air monitoring to ensure detection of leaks/releases of toxic gases.

12.5.2 Toxic gas use is approved only in well ventilated applications.

12.5.3 Respirator use may be necessary when toxic gases are used in a process. Contact OSU EHS for a hazard assessment of toxic gas use.

13.0 Emergency Procedures

13.1 Emergencies involving compressed gas cylinders may arise due to fire threatening the cylinder; toxic gas leaks; inert gas leaks resulting in low oxygen within a room; or unplanned chemical or other reaction.

13.1.1 Most leaks occur at the valve and valve stem fittings, typically due to dirt/debris in the fitting. For small leaks, tighten fittings to attempt to rectify the problem. If leaks do not stop, remove the cylinder from service and properly repair.

13.2 If a cylinder is involved in an emergency, such as a fire, evacuate the area; do not attempt to move cylinders during an emergency; and notify emergency responders of cylinder location and contents.

14.0 Training and Recordkeeping

14.1 Training: All employees who handle compressed gas cylinders should receive Compressed Gas Cylinder safety training initially and any time there are changes to the program.

14.2 Recordkeeping: Supervisors are responsible for maintaining an inventory of compressed gases at all times.

Appendix A – Compressed gas cylinder inspection checklist

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Compressed Gas Cylinder Inspection Checklist

This checklist covers regulations issued by the U.S. Department of Labor, OSHA under the General Industry standard 29 CFR 1910.101. It applies to the handling, storage, and use of compressed gases in cylinders or portable tanks. The regulations cited apply only to private employers and their employees, unless adopted by a state agency and applied to other groups such as public employees.

The OSHA standard adopts by reference the Compressed Gas Association's (CGA) Pamphlets C-6-1986, C-8-1962, and P-1-1965.

Inspection Item	Regulatory Reference	Yes	No
Are cylinders stored in upright positions and immobilized by chains or other means to prevent them from being knocked over?	CGA 3.4.4 and 29 CFR 1910.101(b)		
Are cylinders stored away from highly flammable substances such as oil, gasoline, or waste?	CGA 3.3.6		
Are cylinders stored away from electrical connections, gas flames or other sources of ignition, and substances such as flammable solvents and combustible waste material?	CGA 3.5.1		
Are flammable gases separated from oxidizing gases in storage areas? Note: Acetylene and propane cylinders should be separated from oxygen cylinders when not in use.	CGA 3.3.3		
Are oxygen and fuel gas cylinders separated by a minimum of 20 feet or a fire rated partition when in storage?	CGA 3.5.3		
Are storage rooms for cylinders dry, cool, and well- ventilated? Note: The storage rooms should be fire resistant and the storage should not be in subsurface locations. Cylinders should be stored in secure areas at temperatures below 125°F, away from radiators or other sources of heat.	CGA 3.3.5		
Are cylinders stored away from incompatibles, excessive heat, continuous dampness, salt or other corrosive chemicals, and any areas that may subject them to damage?	CGA 3.3.7 and 29 CFR 1910.101(b)		
Is the storage area permanently posted with the names of the gases stored in the cylinders?	CGA 3.3.2 and 29 CFR 1910.101(b)		
Do all compressed gas cylinders have their contents and precautionary labeling clearly marked on their exteriors?	29 CFR 1910.101(b)		
Are all compressed gas cylinder valve covers in place when cylinders are not in use?	29 CFR 1910.101(b)		
Are all compressed gas cylinders stored so they do not interfere with exit paths?	29 CFR 1910.101(b)		
Do all compressed gas cylinders have safety pressure relief valves?	29 CFR 1910.101(c)		
Are cylinders always maintained at temperatures below 125°F?	CGA 3.1.12		
Are safety relief devices in the valve or on the cylinder free from any indication of tampering?	CGA 3.1.14		
Is repair or alteration to the cylinder, valve, or safety relief devices prohibited? Note: All alterations and repairs to the cylinder and valve must be made by the compressed gas vendor. Modification of safety relief devices beyond the tank or regulator should only be made by a competent person appointed by management.	CGA 3.1.15		
Is painting cylinders without authorization by the owner prohibited?	CGA 3.1.20		
Are charged or full cylinders labeled and stored away from empty cylinders?	CGA 3.3.4 and 29 CFR 1910.101(b)		

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Are all compressed gas cylinders regularly inspected for corrosion, pitting, cuts, gouges, digs, bulges, neck defects and general distortion?	29 CFR 1910.101(a)
Are cylinder valves closed at all times, except when the valve is in use?	CGA 3.1.15
Are compressed gas cylinders always moved, even short distances, by a suitable hand truck?	CGA 3.2.6
Is using wrenches or other tools for opening and closing valves prohibited?	CGA 3.4.9
Are suitable pressure regulating devices in use whenever the gas is emitted to systems with pressure-rated limitations lower than the cylinder pressure?	CGA 3.4.5
Are all compressed gas cylinder connections such as pressure regulators, manifolds, hoses, gauges, and relief valves checked for integrity and tightness?	29 CFR 1910.101(a)
Are all compressed gas cylinders regularly subjected to leak detection using an approved leak detecting liquid? Note: Ordinary soap solution may contain oils that are unsafe when used with oxygen cylinders. Leak detection liquids are available from commercial welding supply houses.	29 CFR 1910.101(a)
Are procedures established for when a compressed gas cylinder leak cannot be remedied by simply tightening the valve? The procedures should include the following: **1. Attach tag to the cylinder stating it is unserviceable.** **2. Remove cylinder to a well ventilated out of doors location.** **3. If the gas is flammable or toxic, place an appropriate sign at the cylinder warning of these hazards.** **4. Notify the gas supplier and follow his/her instructions as to the return of the cylinder**	CGA 3.1.6
Are employees prohibited from using compressed gases (air) to clean clothing or work surfaces?	29 CFR 1910.101(b)