ENVIRONMENTAL HEALTH & SAFETY

COMPRESSED AIR and GAS CYLINDER SAFETY PROGRAM

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UNM's Commitment to Safety

Safety is a core value of the University of New Mexico. UNM is committed to creating and fostering a culture of safety within the community. To learn more visit https://ehs.unm.edu/culture-of-safety.html.

Acronyms & Definitions

Compressed Gas	Any gas or mixture of gases in a container having a pressure exceeding 40 pounds per square inch absolute (); the pressure is relative to a vacuum as opposed to ambient atmospheric pressure.
Cylinder	A pressure vessel used to store gases at pressures above atmospheric pressure
psig	The measurement of pressure relative to ambient atmospheric pressure and is quantified in pounds per square inch gauge.
Pressure Regulator	A mechanical device designed to regulate system flow pressure in response to upstream or downstream pressure changes.
Valve Protection Cap	A rigid, removable cover that protects the valve during handling, transportation and storage of a compressed gas cylinder.
CFR	Code of Federal Regulations
EOHS	Employee Occupational Health Services
OSHA	Occupational Safety & Health Administration
PPE	Personal Protective Equipment
ppm	Parts per million
MAQ	Maximum Allowable Quantity – of a hazardous material as the amount of the material that can be stored, used, dispensed, or handled within a Control Area.
Control Area	A building or portion of a building or outdoor area within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the MAQ.

Hazardous Material	A chemical or substance that is classified as a physical hazard material or a health hazard material, whether the chemical or substance is in usable or waste condition
EHS	Environmental Health & Safety
SDS	Safety Data Sheet
SOP	Standard Operating Procedures

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Compressed Air and Gas Cylinder Safety Program

This document establishes University of New Mexico's written program for compressed air and gas cylinder safety. The purpose of this program is to identify work activities and personnel with potential for exposure to compressed air and gas cylinders, and to ensure that they are handled safely.

1. Scope

This safety program applies to all occupational or research use of compressed air and gas cylinders at the University of New Mexico (UNM) campuses or properties and by UNM employees, students or contractors completing scopes of work for UNM.

2. Responsibilities

2.1. Environmental Health & Safety (EHS) is responsible for:

- Preparing, reviewing and periodically revising this program.
- Monitoring compliance with this program.
- Providing general compressed gas safety training.
- Reviewing and approving procedures for all controlled, highly toxic, or highly hazardous gases.
- Determining health hazard classifications for previously unlisted gases, including acute and chronic toxicity, carcinogenicity, flammability, pyrophoricity and corrosivity.
- Conducting exposure assessments and evaluating exposure control measures.
- Providing or coordinating emergency response for chemical spills.
- Investigating accidents.
- Maintaining employee occupation exposure assessment records.

2.2. Deans, Directors, and Department Heads are responsible for:

- Ensuring departmental compliance with all the procedures outlined in this program.

2.3. Supervisors and/or PI's are responsible for:

- Ensuring compliance with this program in their work area(s).
- Developing Standard Operating Procedures (SOPs) that address the specific safety measures to be implemented when using compressed air and gas cylinders.
- Ensuring employees working around compressed air and gas cylinders receive the appropriate training before handling compressed air and/or cylinders.
- Coordinating the provision of medical examinations, exposure monitoring and record keeping.

- Arranging for immediate emergency response, if necessary, for chemical spills, injuries and overexposures.
- Maintaining a Safety Data Sheet (SDS) for all compressed gas cylinders used in the work area.
- Maintaining the manufacturer's manual for the compressed air units.

2.4. Employee Occupational Health Services (EOHS) is responsible for:

- Maintaining records of physical examinations, x-rays and tests.

2.5. Employees and Researchers are responsible for:

- Knowing the provisions of the Compressed Air and Gas Cylinder Safety Program.
- Reporting accidents, possible exposures or unsafe conditions to their supervisor.
- Following proper safety protocols when using compressed air/gases.
- Utilizing appropriate engineering controls, administrative controls, and PPE.

All stakeholders have the right to stop work if an unsafe condition arises within the work environment.

3. GAS CYLINDER SAFETY

3.1. Restricted Hazardous Gases

Restricted hazardous gases present an increased risk to personnel and for the University of New Mexico; therefore, we recommend that personnel contact EHS for consultation before ordering the following gases:

- Carbon monoxide
- Hydrides (arsine, disilane, diborane, germane, phosphine, silane)
- Hydrogen
- Toxics (NFPA Health Rating of 3 or 4)
- Oxidizers (chlorine, fluorine)
- Liquid Oxygen
- Corrosives

3.2. General Safety Procedures

EHS uses the hierarchy of controls to reduce exposure to hazards. The hierarchy of controls methods are listed below in the order in which they should be implemented to reduce exposure. PPE is used as a

last resort, in an emergency, or as an extra layer of protection. PPE alone is not sufficient protection for employees.

3.2.1. Engineering Controls

The following engineering controls must be implemented when using, transporting, moving, and storing compressed gas cylinders:

- Secure cylinders and lecture bottles in an upright position using the appropriate restraining devices. NOTE: Securing devices for various sizes and shapes of compressed gas cylinders can be purchased from gas suppliers or safety equipment companies.

Ventilate (typically six air changes per hour or more) areas where the cylinders are used and stored. Install, where required such as for toxic gases, the following engineering control measures:

- Continuously exhausted gas cabinets or enclosures.
- Gas detection systems, alarms, etc.
- Nitrogen purge system.
- Automatic shut-off valves.
- Flashback arrestors.
- Place and tighten the valve protection cap on the compressed gas cylinder when the cylinder is not in use.
- If using flexible (non-fixed) tubing, the tubing must be under 10 feet in total length.

Contact EHS (505-277-2753 / EHSWEB-L@list.unm.edu) for consultation on modifying or assessing engineering controls for your lab or workspace.

3.2.2. Administrative Controls

The following administrative controls must be implemented when transporting, moving, and storing compressed gases cylinders.

- Replace or remove damaged or compromised cylinders or equipment.
- Use the associated equipment that is "assigned" to the compressed gas cylinder.
- Display the appropriate signs and labels.
- Be familiar with the UNM Chemical Hygiene Plan (CHP) and the lab's CHP Binder.
- Write and implement SOPs for using, transporting, moving, and storing compressed gas cylinders in the work location.
- For labs: Contact EHS (505-277-2753 / EHSWEB-L@list.unm.edu) to request labels.
- For workspaces: to create a door sign, go to the EHSA website to find the Placard Creator or contact EHS.

3.2.3. Personal Protective Equipment

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:

- Eye protection – required any time compressed gases are handled or used.
- Foot protection – required any time when moving or handling compressed gas cylinders.
- Hand and body protection – to protect against cold exposure, corrosives, pinch point, and high-pressure injuries.
- Respiratory protection – may be required depending on the type of gas being used and the procedures being used with the gas.

3.3. Gas Cylinder Labels

Do not accept a cylinder from the gas supplier without a proper label. Cylinders must be legibly marked by stenciling, stamping, or labeled with at least the chemical name (or commonly accepted name of the material contained) and the primary hazard associated with the chemical (such as “flammable”).

In addition, the cylinders must bear the approved markings of the Department of Transportation (DOT) stamped in the metal at the top of the cylinder.

3.4. Storage

1. Signage:
    a. Appropriate signage is required for all compressed gas cylinders.
2. Cylinder restraints:
    a. Cylinders must be stored upright, with caps in place, and secured by chains, straps or in racks to prevent falling/tipping.
    b. All cylinders are to be placed into the final use area/cabinet and immediately restrained using cylinder straps or chains, prior to removal of the cylinder cap.
    c. Cylinders must be secured in one or more of the following methods.
        i. 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.
        ii. By a noncombustible rack, framework, cabinet, approved strapping device, security to a cylinder cart or other substantial means that prevents the cylinder from falling.
        iii. Straps must surround the cylinder approximately 1/2 to 1/3 of the height of the cylinder measured from the floor.
3. Storage Temperature:
    a. Cylinders are not be subjected to temperatures outside of the following range: -20 °F (-29 °C) to 125 °F (52 °C). 3.
    b. Only properly designed heating systems are to be used.
    c. For safety a second independent temperature controller shall be used to alarm and shut off the heating system.
4. Prohibited connections:
    a. Valve outlet adapters to change the valve outlet connection to match the gas cabinet pigtail are prohibited.

   b. Teflon tape or pipe thread sealant shall not be used on any cylinder CGA outlet connection threads.
   c. Connection to the valve outlet shall be smooth and not forced.
5. Prohibited tool use:
   a. Tools such as wrenches shall not be used to open or close valves unless they are designed for wrench operation, in this case a short wrench 6" (15 cm) shall be used.
   b. Tools or other objects shall not be inserted into the cylinder cap vent hole help remove it.
6. Gas systems must be set up for specific gas:
   a. Gas systems set up for one gas service shall not be used for other services unless formally reviewed via a Job Hazard Analysis.
7. Gas cylinders must use a pressure regulator:
   a. All compressed gas cylinders in use (except low vapor pressure gases such as boron trichloride) shall have a pressure regulator to lower the pressure.
8. Gas-Specific Procedures:
   a. Use "Buddy System" when changing highly toxic or pyrophoric gas cylinders.
   b. Highly toxic or high-pressure pyrophoric cylinder valves shall have a RFO (Restrictive Flow Orifice) installed sized for the size of the abatement system.
   c. Only systems designed and cleaned for oxygen service shall be used for oxygen and other oxidizer gases.
   d. Strong fluorine gases (ClF3, F2, NF3, etc.) shall only be used in systems that have been oxygen cleaned and fluorine passivated.
   e. Fluoride gases that hydrolyze in air (ClF3, F2, SiF4, BF3, AsF5) create a HF exposure hazard when released.

3.5. Disposal

There are two general types of compressed gas cylinders:

1. Returnable (owned by the gas supplier, rental fee charged to the University)
2. Non-returnable.

Most suppliers will accept the return of their cylinders even if they are not empty. However, suppliers will not accept non-returnable cylinders under any circumstances. Disposal of non-returnable cylinders containing highly toxic or reactive gas can be very expensive.

Purchase compressed gases in returnable cylinders if available. If non-returnable cylinders are the only alternative, be prepared to pay for the cost of disposal. Contact EHS for disposal of these non-returnable cylinders.

3.6. Inspection Procedures

Compressed gas cylinders should be inspected as necessary to ensure they are fit for use.

1. Compressed gas cylinders should be visually inspected at the time of delivery and as necessary thereafter, depending on the manufacturer's recommendations.
2. Inspections of cylinders should be conducted in accordance with the following applicable standards:
    i. 49 CFR 171-179 – Department of Transportation Hazardous Materials Regulations
    ii. Compressed Gas Association (CGA) Pamphlet C-6-1968 – Standards for Visual Inspection of Steel Compressed Gas Cylinders)
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.

Inspection of associated equipment:

1. The cylinder mounting and restraining devices must not show any signs of damage or loss of integrity.
2. Valves and regulators must not show signs of damage (cracks, corrosion, etc.).
3. Cylinder regulators and connections must be tested for leaks.
    i. For argon, nitrogen, hydrogen, or air, use a soapy water solution to test for leaks. For other gases, leak test the lines and equipment with an inert gas before using.

When inspecting cylinders and associated equipment after use, verify the following actions have been taken:

- Valves are closed and tightened.
- Any remaining residual gas has been safely released from the line.
- Valve protection caps are securely fastened during long-term storage.

NOTE: Any problem with pressure-relief devices should be immediately reported to your supplier. Never tamper with pressure-relief devices in valves or cylinders. Only qualified gas supplier personnel should service pressure-relief devices.

Responses to Identified Problems:

If at any time you notice a problem with a cylinder or its associated equipment, contact the supplier for technical advice, replacement, or both.

If you identify a leak that you cannot fix and the cylinder contains a hazardous material, call UNMPD at 911 and evacuate the area.

3.7. Employee Information and Training

Supervisors are responsible for ensuring that employees with potential exposure to high pressure gas receive the appropriate training before working with it. A basic laboratory gas cylinder training is available through UNM Learning Central. All employees working with gas cylinders in labs must take this training. Further on the job training must be done. All training must be documented by the

individual presenting the training session or through Learning Central. Supervisors should review this information with employees annually. It will cover the following:

- Requirements of the OSHA Compressed Gas Cylinder Standard
- Explanation of UNM's Compressed Gas Cylinder Safety Program
- Contents of the Safety Data Sheet for all compressed gas cylinders
- Description of the medical surveillance program (if applicable)
- Description of the health hazards associated with exposure (of all gases used)
- Signs and symptoms of exposure (of all gases used)
- Description of the operations in the work area where compressed gas cylinders are present
- Work practices to reduce exposure, including engineering and administrative controls and required PPE
- Instructions for handling unintentional releases and emergency procedures

This training must be conducted whenever a new hazard is introduced into the work area, when there is a change in procedure, and whenever the employee demonstrates behavior that indicates a lack of understanding of the basic rules for the safe handling of compressed gas cylinders.

3.8. Maximum Allowable Quantity (MAQ)

National Fire Protection Association (NFPA) 55 and International Fire Code have established a maximum allowable quantity (MAQ) of compressed gas that can be used and stored within a building. Therefore, use the following best management practices to minimize the amount of compressed gas located in your workplace.

- Substitute, if possible, with a gas that is less hazardous.
- Limit the amount of hazardous compressed gas to that which is deemed necessary.
- Minimize the quantity of compressed gases on hand using the following strategies:
  - Maintain the smallest quantities of compressed gases as possible
  - Have no more than one back up cylinder of each gas
  - Use just-in-time delivery

The NFPA laboratory standard controls the quantity of hazardous gases in a building. MAQs vary based factors such as the floors above grade, quantity and type of gas used and stored, fire control zones, and sprinkler protection.

Contact UNM Environmental Health & Safety (505-277-2753 / EHSWEB-L@list.unm.edu) for assistance if determining the MAQ for your lab or workspace.

4. Compressed Air Safety

This section provides information regarding portable air compressors, safety work practices, and the hazards associated with compressed air.

4.1. Compressed Air Hazards

- Compressed air, if used improperly, can cause serious injury, possibly death, and property damage.
- Air contained under high pressure can dislodge particles with the force of shrapnel. Damage caused by particles depends on the size, weight, shape, speed, etc. of the particles.
- Compressed air itself, even at relatively low pressures, can cause serious damage.
- Compressed air can cause hearing damage.

4.2. Safe Work Practices

- Read and follow the manufacturer's manual before operating.
- Complete the appropriate training offered by the laboratory, shop, etc.
- Do not use it to clean dirt/dust from clothing or off a person's skin.
- Do not adjust the air pressure greater than the attachment rating.
- All components of a compressed air system should be visually inspected regularly and before each use.
- Use hoses that are resistant to abrasion, crushing, and cutting.
- Do not use damaged, cracked, worn, or leaking air hoses.
- Hose ends must be secured before operation to prevent whipping during operation due to a cut/break.
- Wear appropriate PPE. Safety glasses and hearing protection are required. In some cases, face guards/shields, gloves, and steel-toed shoes might also be required. Never wear loose clothing while working with compressed air. Long hair should be tied back or secured under a cap.
- Gasoline/Diesel powered compressors must be used in well-ventilated areas/outdoors.
- Electric compressors need to be plugged into a properly grounded plug.
- Drain the compressor at the end of each work day to remove any remaining water to avoid rust. Note: Water in compressed air lines can ruin pneumatic tools/motors. Units equipped with automatic drain systems are exempt from this requirement.
- Store the tank inside in a cool, dry place with the valves open.
- Only authorized/qualified personnel should be permitted to repair air tanks. All work must be done according to the established safety standards.

4.3. Air Compressor Operation

- Read and follow the manufacturer's manual before operating.
- Air compressor equipment should be operated only by authorized/trained personnel.

- The air intake should be from a clean, outside, fresh air source. Screens/filters can be used to clean the air.
- Equipment should not become overheated.
- Moving parts that could be hazardous should be guarded.

4.4. Pneumatic Tools

- Includes an air compressor and a variety of tool attachments. Some common attachments include nail guns and wrenches. They require special handling, but can be efficient.
- Read and follow the manufacturer's manual before operating.
- Always visually inspect the entire system before each use. Ensure that all fittings/etc., are securely tightened. If the system/tool fails inspection, remove it from use, tag it out by attaching a tag that states "Do not operate – Out of Service", and notify your supervisor.
- Remove any air from the line before attaching a tool.
- Be cautious when using pneumatic tools near fuel, flammable vapors, or explosive atmospheres. They must be properly grounded/bonded, since they can generate static electricity.
- Never point pneumatic impact tools toward a person.
- Before disconnecting a pneumatic tool, turn off the air supply at the control valve and tool blade.

5. APPENDIXES

5.1. APPENDIX A: MAQS OF HAZARDOUS MATERIALS PER CONTROL AREA

Table 6.3.1.1 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area

			Storage			Use — Closed Systems			Use — Open Systems	
Material	Class	High Hazard Protection Level	Solid Pounds	Liquid Gallons	Gas[a] scf (lb)	Solid Pounds	Liquid Gallons	Gas[a] scf (lb)	Solid Pounds	Liquid Gallons
Cryogenic fluid	Flammable	2	NA	45[b,c]	NA	NA	45[b,c]	NA	NA	45[b,c]
	Oxidizing	3	NA	45[d,e]	NA	NA	45[d,e]	NA	NA	45[d,e]
	Inert	NA	NA	NL	NA	NA	NL	NA	NA	NL
Flammable, gas[f]	Gaseous	2	NA	NA	1000[d,e]	NA	NA	1000[d,e]	NA	NA
	Liquefied	2	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
	LP	2	NA	NA	(300)[g, h,i]	NA	NA	(300)[g]	NA	NA
Inert gas	Gaseous	NA	NA	NA	NL	NA	NA	NL	NA	NA
	Liquefied	NA	NA	NA	NL	NA	NA	NL	NA	NA
Oxidizing gas	Gaseous	3	NA	NA	1500[d,e]	NA	NA	1500[d,e]	NA	NA
	Liquefied	3	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
Pyrophoric gas	Gaseous	2	NA	NA	50[d,j]	NA	NA	50[d,j]	NA	NA
	Liquefied	2	NA	NA	(4)[d,j]	NA	NA	(4)[d,j]	NA	NA
Unstable (reactive) gas	Gaseous									
	4 or 3 detonable	1	NA	NA	10[d,j]	NA	NA	10[d,j]	NA	NA
	3 nondetonable	2	NA	NA	50[d,e]	NA	NA	50[d,e]	NA	NA
	2	3	NA	NA	750[d,e]	NA	NA	750[d,e]	NA	NA
	1	NA	NA	NA	NL	NA	NA	NL	NA	NA
Unstable (reactive) gas	Liquefied									
	4 or 3 detonable	1	NA	NA	(1)[d,j]	NA	NA	(1)[d,j]	NA	NA
	3 nondetonable	2	NA	NA	(2)[d,e]	NA	NA	(2)[d,e]	NA	NA
	2	3	NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
	1	NA	NA	NA	NL	NA	NA	NL	NA	NA
Corrosive gas	Gaseous	4	NA	NA	810[d,e]	NA	NA	810[d,e]	NA	NA
	Liquefied		NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA
Highly toxic gas	Gaseous	4	NA	NA	20[e,k]	NA	NA	20[e,k]	NA	NA
	Liquefied		NA	NA	(4)[e,k]	NA	NA	(4)[e,k]	NA	NA
Toxic gas	Gaseous	4	NA	NA	810[d,e]	NA	NA	810[d,e]	NA	NA
	Liquefied		NA	NA	(150)[d,e]	NA	NA	(150)[d,e]	NA	NA

NA: Not applicable within the context of NFPA 55 (refer to the applicable building or fire code for additional information on these materials).
NL: Not limited in quantity.
Notes:
(1) For use of control areas, see Section 6.2.
(2) Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column.
(3) The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in the building code.

(Table from NPFA 55)

5.2. APPENDIX B: FLAMMABLE GASES

Any gas for which flammable limits in air are reported is considered flammable. However, if the gas were also toxic, then toxic would be the primary hazard with flammable noted as secondary.

When using, handling, or storing a compressed gas that lists its primary and secondary hazard as

flammable, incorporate the following controls into your standard operating procedures for using, handling, and storing compressed gases.

CONTROL	DESCRIPTION
Engineering Controls: All Quantities	• All lines and equipment associated with flammable gas systems must be grounded and bonded. • Flash arrestors are designed to prevent a flash-back, should it occur, in a line containing a flammable gas. • A portable fire extinguisher must available in the area where compressed gases and cylinders are used and stored. • Use spark- proof tools when working with flammable gas. • Do not use vessels, piping, or other materials that contain a significant amount of copper (usually considered to be more than 50% copper) with cylinders containing acetylene.
Engineering Control: Above the MAQ	Flammable gas quantities above the MAQ may be required to have the following engineering controls: The workspace is equipped with a continuous gas detection system. • The gas detection system must initiate a local alarm that is both visible and audible. • The gas detection system must transmit a signal to a constantly attended control station. • Activation of the gas detection system must automatically shut off the flow of gas related to the system being monitored. The gas detection system must detect the presence of gas at or below the Lower Explosive Limit (LEL). If the gas is also toxic, the system should detect the presence of gas at or below the OSHA permissible exposure level or ceiling limit of the gas in lieu of the LEL. • Emergency power must be provided for the exhaust ventilation, gas detection system, and alarm systems when required. • Sprinkler protection for gas cabinets and other protective features may be required. **NOTE:** This information is for general guidance. Consult with your EHSA representative to determine requirements for your particular usage. A code analysis may also be required.
Administrative Controls	• Do not use acetylene at an operating pressure over 15 psig. • Do not leave flow experiments using flammable gases unattended.

5.3. APPENDIX C: OXIDIZING GASES

Oxidizing gases that, in the presence of an ignition source and a fuel, support and may vigorously accelerate combustion. If the gas is also toxic, this would be listed as primary hazard with oxidizer as the secondary hazard. Some gases, such as fluorine, are as aggressive an oxidizer as they are toxic, so both

hazards are listed as primary.

When using, handling, or storing oxidizing gases, incorporate the following controls into your standard operating procedures for using, handling, and storing compressed gases.

CONTROL	DESCRIPTION
Administrative Control	• All equipment used for oxidizing gases must be cleaned with oxygen-compatible materials free from oils, greases, and other contaminants. • Do not use oily hands or gloves when handling cylinders. The reaction between oxygen and hydrocarbons can be violent, even when small quantities are involved.

5.4. APPENDIX D: PYROPHORIC GASES

When using, handling, or storing a compressed gas that is pyrophoric, incorporate the following controls into your standard operating procedures for using, handling, and storing compressed gases.

NOTE: This information is for general guidance. Consult with your EHS representative to determine requirements for your particular usage. A code analysis may also be required.

CONTROL	DESCRIPTION
Engineering Control: Lecture Bottles	• All equipment used for oxidizing gases must be cleaned with oxygen-compatible materials free from oils, greases, and other contaminants. • Do not use oily hands or gloves when handling cylinders. The reaction between oxygen and hydrocarbons can be violent, even when small quantities are involved.
Engineering Controls: Cylinders Greater than Lecture Bottle Size	• Cylinders of pyrophoric gases (greater than lecture bottle size) must be kept in approved continuously mechanically ventilated, sprinklered gas cabinets and must be equipped with an excess flow control device.

Engineering Control: Above the MAQ	• In addition to the requirements listed above, any quantity of Pyrophoric Gas above the MAQ may be also required to have the following engineering controls upon consultation with an EHS representative: • The workspace must be equipped with a continuous gas detection system. • The gas detection system must initiate a local alarm that is both visible and audible. • The gas detection system must transmit a signal to a constantly attended control station. • Activation of the gas detection system must automatically shut off the flow of gas related to the system being monitored. • The gas detection system must detect the presence of gas at or below the Lower Explosive Limit (LEL). If the gas is also toxic, the system must detect the presence of gas at or below the OSHA permissible exposure level or ceiling limit of the gas in lieu of the LEL. • Emergency power must be provided for the exhaust ventilation, gas detection system, and alarm systems when required.

5.5. APPENDIX E: TOXIC AND CORROSIVE GASES

In all cases, if a gas is toxic, this is the primary hazard. A toxic gas is any gas that has an LC50 less than or equal to 5,000 ppm.

Primarily, most gases in the absence of water are not corrosive. However, because most sources refer to the gas properties in moist air, corrosive is listed as a mostly secondary hazard where appropriate.

Corrosive gases can chemically destroy exposed body tissue; therefore, avoid contact to skin and eyes.

When using, handling, or storing a compressed gas that lists its secondary hazards as corrosive, incorporate the following controls into your standard operating procedures for using, handling, and storing compressed gases.

When using, handling, or storing a compressed gas that is toxic, incorporate the following controls into your standard operating procedures for using, handling, and storing compressed gases.

NOTE: This information in the table is for general guidance. Consult with your EHSA representative to determine requirements for your particular usage.

CONTROL	DESCRIPTION
Engineering Control: Lecture Bottles	Lecture bottles of toxic gases that have a health hazard rating of 3 or 4 ,or a health hazard rating of 2 without physiological warning properties and are located in workspaces must be kept in a continuously mechanically exhausted ventilated hood or other continuously mechanically exhausted ventilated enclosure.
Engineering Controls: Below MAQ	Departments using or storing toxic gas cylinders (greater than lecture bottle size) with a health hazard rating of 3 or 4 or a health hazard rating of 2 without physiological warning properties in the workspace must comply with the following requirements as a minimum: • Cylinders must be kept in approved continuously mechanically ventilated gas cabinets. • The workspace must be equipped with a continuous gas detection system. NOTE: Gas detection may not be required where the physiological warning properties for the gas are at a level below the accepted permissible exposure level or ceiling limit of the gas. The gas detection system shall initiate a local alarm that is both visible and audible.
Engineering Controls: Above the MAQ	• Departments using a toxic gas in quantities above the MAQ in any size cylinder may be required to have the following engineering controls upon consultation with an EHSA representative: • An approved continuously mechanically ventilated gas cabinet to store the cylinders. • A continuous gas detection system in the workplace that meets the following requirements: NOTE: Gas detection may not be required where the physiological warning properties for the gas are at a level below the accepted permissible exposure level or ceiling limit of the gas. • It must initiate a local alarm that is both visible and audible. • It must transmit a signal to a constantly attended control station. • Activation of the gas detection system must automatically shut off the flow of gas related to the system being monitored. • It must detect the presence of gas at or below the OSHA permissible • exposure level or ceiling limit of the gas. • Emergency power for the exhaust ventilation, gas detection system, and alarm systems when required. • Treatment systems for the exhaust. • Sprinkler protection for gas cabinets and other protective features.

Additional Controls for Corrosive Gases:

CONTROL	DESCRIPTION
Engineering Control	Install an emergency shower and eyewash within 25 feet where corrosive materials are used. NOTE: This engineering control is required.
Administrative Controls	Check equipment and lines frequently for leaks. Metals become brittle when used in corrosive gas service.
PPE	Wear safety goggles, lab coat, and gloves as indicated by your workspace SOP.

6. REFERENCES

1. Air Compressor Safety. Southwest Center for Agricultural Health, Injury Prevention, and Education.
2. Compressed Air Safety. University of Florida.
3. Pneumatic Tools Safety Awareness. Harvard College, EHS.
4. Compressed Air and Gas Safety. University of California.
5. Department of Transportation Hazardous Materials Regulations CFR 171-179

6. Report to the University of Hawaii at Manoa on the Hydrogen/Oxygen Explosion of March 16, 2016: Appendix B: Compressed Gas Safety Guidelines, Page 27-36

7. Compressed Gas Association documents:
    - Handbook of Compressed Gases, Compressed Gas Association (CGA), Inc.
    - CGA P-20 – 2009, Standard for Classification of Toxic Mixture, CGA, Inc.
    - CGA P-23 – 2008, Standard for Categorizing Gas Mixtures Containing Flammable and Nonflammable Components CGA, Inc.
    - CGA P-1 – 2000, Safe Handling of Compressed Gases in Containers, CGA, Inc.
    - CGA C-6: Standards for Visual Inspection of Compressed Gas Cylinders, CGA, Inc.
    - CGA S-1.1, Pressure Relief Device Standards- Part 1-Cylinders for CGA, Inc.
    - CGA S-1.2, Pressure Relief Device Standards- Part 2- Portable Containers for Compressed Gases, CGA Inc.
    - CGA S-1.3, Pressure Relief Device Standards- Part 3-Stationary Storage Containers for CGA, Inc.
    - CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connection, CGA, Inc.
8. NPFA Regulations
    - NFPA-55: Compressed gases & Cryogenic fluids
    - NPFA-400: Hazardous materials code

Compressed Air Gas Cylinder Safety Program R2

Final Audit Report 2024-01-02

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