



SECTION 44

COMPRESSED GAS CYLINDER PROGRAM



- 1. Introduction:** Compressed and liquefied gases have the potential for creating hazardous working environments. This document contains information on the proper storage, handling, use and disposal of compressed and liquefied gas cylinders. Most of the information is general and applies to all compressed and liquefied gases. Specific information on selected hazard classes is contained in section 5 “Gases with Specific Hazards” of this document.

- 2. Purpose and Scope:** Compressed and liquefied gases are routinely used in various construction and industrial work sites. This Gas Cylinder Safety Guideline applies to all company employees and subcontractors who use or otherwise handle compressed or liquefied gases or systems that use compressed or liquefied gases. It is the intent of this guideline to provide information on the safe usage of compressed and liquefied gases at work locations and afford employee protection from potential health and physical hazards associated with gas and cylinder usage. Maul Electric, Inc. promotes the safe use of gases by offering training and information on the proper storage, handling, usage and disposal of gases and gas cylinders. Only trained and qualified personnel shall be allowed to use compressed and liquefied gases. Training should include the associated hazards of the materials, necessary safety precautions, personal protective equipment (PPE) and emergency response procedures. Appropriate material safety data sheets (MSDS's), associated “Safetygrams™,” or other gas supplier product information shall be made accessible to compressed gas users.

- 3. Storage of Compressed and Liquefied Gas:** Proper storage is critical for the safe usage of compressed and liquefied gases. Cylinder storage areas should be prominently posted with hazard information regarding the gases stored. The NFPA 704 diamond with a cylinder indicated in the “specific hazard” (white) section of the diamond and the corresponding 2 flammability, health and reactivity hazard sections also marked is an accepted method of signage. Other storage requirements are outlined below:
 - A. Storage Requirements:** All gas cylinders:
 1. Shall not be stored in exits or egress routes.
 2. Shall be stored within a well-ventilated area.
 3. Shall not be stored in damp areas, near salt or corrosive chemicals, fumes, heat or where exposed to the weather.
 4. Shall be stored in an upright position.
 5. Shall be secured with a chain or appropriate belt above the midpoint, but below the shoulder. Laboratory cylinders less than 18" tall may be secured by approved stands or wall brackets.
 6. Shall be capped when not in use or attached to a system (if the cylinder will accept a cap).
 7. Shall be kept at least 20 ft. away from all flammable, combustible or incompatible substances. Storage areas that have a noncombustible wall at least 5 ft. in height and with a fire



- resistance rating of at least 30 minutes may be used to segregate gases of different hazard classes in close proximity to each other.
8. Shall be stored so that cylinders are used in the order in which they are received.
 9. Shall be stored so that gases with the same hazard class are stored in the same area. Inert gases are compatible with all other gases and may be stored together.
 10. Shall not be stored longer than one year without use.
 11. Shall be stored so that full cylinders remain separate from empty cylinders.

4. Compressed and Liquefied Gas Handling: The Following requirements shall apply to the handling of gas cylinders:

- A. Compressed gases shall be handled only by properly trained persons. Training must include the contents of this guideline as well as any specific information relevant to the gas being used and emergency information outlined in Maul Electric, Inc. HASP, available at the construction site office.
- B. Safety shoes are required when moving cylinders.
- C. Cylinders should not be dragged or physically carried. Transport cylinders with a hand truck designed for the transport of cylinders. Cylinder caps shall be secured during transport.
- D. Prevent damage to cylinders. Locate cylinders where they will be protected from physical damage by striking or falling objects, corrosion or damage from public tampering.
- E. No person other than the gas supplier shall attempt to mix gases in a cylinder.
- F. Cylinders shall not be subjected to artificially create low temperatures without approval from the supplier.
- G. Containers shall not be used for any other purpose than holding the contents as received.
- H. Damaged or leaking cylinders must be reported to the project manager or local safety office immediately for proper disposal. See disposal information in section 7 of this document.
- I. Cylinders shall not be picked up by the cap.
- J. Ropes, chains and slings shall not be used to suspend cylinders, unless cylinder was designed for such.
- K. Magnets shall not be used for lifting cylinders.
- L. Where appropriate lifting attachments have not been provided on the cylinder/container, suitable cradles or platforms to hold the containers shall be used for lifting.
- M. The user shall not paint cylinders.
- N. Leaking, defective, fire burned and corroded containers shall not be shipped without the approval of the supplier.



- 5. Compressed and Liquefied Gas Use:** The following are general “good practices” guidelines to follow when using gas cylinders and compressed gases.
- A. General Requirements
1. Ensure that regulator pressure control valve is relieved (i.e., closed) before attaching to tanks.
 2. Close valves on gas cylinders when a system is not in use.
 3. Remove all pressure from regulators not currently used (by opening equipment valves downstream **after** the regulators are closed).
 4. Shut-off valves must not be installed between pressure relief devices and the equipment they are to protect.
 5. Use pressure relief valves in downstream lines to prevent high pressure buildup in the event that a regulator valve does not seat properly and a tank valve is left on.
 6. Relief valves should be vented to prevent potential buildup of explosive or toxic gases.
 7. Never allow flames or concentrated heat sources to come in contact with a gas cylinder.
 8. Never allow a gas cylinder to become part of an electrical circuit.
 9. Never partially open a tank valve to remove dust or debris from the cylinder inlet.
 10. Never use cylinder gas as compressed air.
 11. Pressurize regulators slowly and ensure that valve outlets and regulators are pointed away from all personnel when cylinder valves are opened.
 12. Cylinders which require a wrench to open the main valve shall have the wrench left in place on the cylinder valve while it is open. Use adequately sized wrenches (12” long) to minimize ergonomic stress when turning tight tank valves. Never apply excessive force when trying to open valves. Cylinders with “stuck” valves should be returned to suppliers to have valves repaired.
 13. Do not attempt to open a corroded valve; it may be impossible to reseal.
 14. Valves should only be opened to the point where gas can flow into the system at the necessary pressure. This will allow for quicker shutoff in the event of a failure or emergency.
 15. Use a cylinder cap hook to loosen tight cylinder caps. Never apply excessive force or pry off caps. Return to supplier to remove “stuck” caps.
 16. Keep piping, regulators and other apparatus gas tight to prevent gas leakage.
 17. Confirm gas tightness by using compatible leak test solutions (e.g., soap and water) or leak test instruments.
 18. Release pressure from systems before connections are tightened or loosened and before any repairs.



19. Do **not** use Teflon tape on CGA fittings (straight thread) where the seal is made by metal-to-metal contact. Use of Teflon tape causes the threads to spread and weaken, increasing the likelihood of leaks.
20. Never use adapters or exchange fittings between tanks and regulators.
21. Fluorescent light can be used to check for grease or oil in regulators and valves.

B. Labeling: The following labeling requirements shall apply to all gas cylinders:

1. Know the contents of each cylinder you are using.
2. Use only the vendor label for positive identification of contents of the cylinder. Be aware that color coding may be inconsistent from vendor to vendor.
3. Mixed gases shall be clearly labeled with the contents of the cylinder.
4. Empty cylinders shall be labeled with the word empty or the abbreviation MT.

Preferred labeling includes the identity of the material, statement of hazard and the associated signal word. For example, the preferred label for nitrogen would be:

Nitrogen
CAUTION: HIGH PRESSURE GAS
CAN CAUSE RAPID SUFFOCATION

Excellent sources of information for the warning and hazard information that should be contained on cylinders are the Air Products, Matheson and other gas company catalogs, the CGA Pamphlet C-7: "Precautionary Labeling and Marking of Compressed Gas Cylinders," as well as the manufacturer or distributor of the gas.

C. Manifolds, Valves and Regulators: The following information applies to the use of manifolds, valves and/or regulators:

1. Where compressed gas containers are connected to a manifold, the manifold and its related equipment, such as regulators, shall be of proper design for the product(s) they are to contain at the appropriate temperatures, pressures and flows.
2. Use only approved valves, regulators, manifolds, piping and other associated equipment in any system that requires compressed gas. Care must be taken to ensure that pressure gauges on regulators are correct for the pressure of the gas cylinder used. With the exception of lecture bottles, threads, configurations and valve outlets are different for each class of gases to prevent mixing of incompatible gases.
3. CGA Pamphlet V-1: Standard for Compressed Gas Cylinder Valves, lists the appropriate valve for each gas. Manufacturers and



distributors should also be able to identify the valves and associated equipment required for each gas.

4. Lecture bottles use universal threads and valves, some of which are interchangeable. Label all associated equipment with the gas name to prevent unintentional mixing of incompatible materials.
5. Valves and regulators should undergo periodic maintenance and repair. A visual inspection should be performed before each usage to detect any damage, cracks, corrosion or other defects. Long term maintenance or replacement periods vary with the types of gases used, the length of use, and conditions of usage. Consult the cylinder, regulator or gas supplier for recommended valve and regulator maintenance schedules.
6. Valves and regulator maintenance histories should be known before usage. Valves that pass visual inspection are still subject to failure, therefore it is critical that toxic or poisonous gases are used in ventilated enclosures and have local exhaust ventilation in place for downstream pressure relief valves, etc.
7. Valves and regulators should only be repaired by qualified individuals. Valve and regulator manufacturers, gas supply companies, or valve and regulator specialty shops should be consulted for any repair needs.

6. Gases with Specific Hazard Classes

- A. The following information regarding specific classes of gases is offered as additional guidance to be used in conjunction with the general usage requirements listed in Section 5.
 1. **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.
 - a) Metals become brittle when used in corrosive gas service, check equipment and lines frequently for leaks.
 - b) A diaphragm gauge should be used with corrosive gases that would destroy a steel or bronze gauge. Check with gas supplier for recommended equipment.
 - c) Remove regulators after use and flush with dry air or nitrogen.
 2. **Cryogenic Liquids and Gases:** 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 oxygen, hydrogen, helium, and liquid neon.



The following information applies to the use and handling of cryogenics:

- a) Use appropriate personal protective equipment (PPE) including insulated gloves and eye protection (goggles and a face shield) during any transfer of cryogenic liquid.
 - b) In the event of skin contact with a cryogenic liquid, do not rub skin, place the affected part of the body in a warm water bath (not to exceed 40°C [105°F]).
 - c) Use only equipment, valves and containers designed for the intended product and service pressure and temperature.
 - d) Inspect containers for loss of insulating vacuum. If the outside jacket on a container is cold or has frost spots, some vacuum has been lost. Empty the contents into another cryogenic container and remove the damaged unit from service. Repairs should be made by the manufacturer or an authorized company.
 - e) Transfer operations involving open cryogenic containers such as dewars must be conducted slowly to minimize boiling and splashing of the cryogenic fluid.
 - f) Ice or other foreign matter should not be allowed to accumulate beneath the vaporizer or the tank. Excessive ice buildup could result in the discharge of excessively cold gas or structural damage to the cryogenic container or surroundings.
 - g) All cryogenic systems including piping must be equipped with pressure relief devices to prevent excessive pressure build-up. Pressure reliefs must be directed to a safe location. Do not tamper with pressure relief valves or the settings for the valves.
 - h) Hot air, steam or hot water should be used to thaw frozen equipment. DO NOT USE water to thaw liquid helium equipment.
3. **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 iso-butane.
- a) Flammable gases, except for protected fuel gases, shall not be used near ignition sources. Ignition sources include open flames and sparks, sources of heat, oxidizing agents and ungrounded or non-intrinsically safe electrical or electronic equipment.
 - b) Portable fire extinguishers shall be available for fire emergencies. The fire extinguisher must be compatible with the apparatus and the materials in use.



- c) Flames shall not be used for detecting leaks. A compatible leak detection solution shall be used for leak detection.
 - d) Spark proof tools shall be used when working with or on a flammable compressed gas cylinder or system.
 - e) Access doors to areas which use or store flammable gases shall be posted "No Open Flames."
 - f) Manifold systems shall be designed and constructed by competent personnel who are thoroughly familiar with the requirements for piping of flammable gases. Manifolds should comply with the standards of a recognized safety authority such as Underwriters Laboratories, Inc. Federal, state, local or insurance company specifications must be identified before starting design and construction. Consultation with the gas supplier before installation of manifolds is recommended.
4. **Fuel, High Pressure and Oxidizing Gases:** The following information applies to the use and handling of fuel, high pressure and oxidizing gases:
- a) Fuel gases often use a combination of flammable and oxidizing gases. Use of fuel gases must comply with OSHA 29 CFR1910.253--Oxygen-Fuel Gas Welding and Cutting, 29 CFR1910.102--Acetylene and 29 CFR1910.103--Hydrogen. Additionally, adherence to the requirements of the Compressed Gas Association as defined in Pamphlet G-1: Acetylene, Pamphlet SB-8: Use of Oxy-fuel Gas Welding and Cutting Apparatus, and the requirements of the National Fire Protection Association Standard 51: Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes is required.
 - b) High pressure gases can be rated up to 3000 pounds per square inch (psi). Typical uses include MIG welding gas mixtures, cryogenics, non-toxic gas distribution, medical gas distribution, and emergency oxygen services. In addition to any gas specific hazards, high pressure gases should carry the following hazard label : CAUTION: HIGH PRESSURE GAS
 - c) Oxidizing gases are non-flammable gases (e.g., oxygen chlorine, fluorine and nitrous oxide), but in the presence of an ignition source and fuel can support and vigorously accelerate combustion. Do not use oil in any apparatus where oxygen will be used. Gauges and regulators for oxygen shall bear the warning "OXYGEN - USE NO OIL."
5. **Toxic and Highly Toxic Gases:** The following information applies to the use of toxic and highly toxic gases:



- a) All gases with a NFPA Health Hazard rating of 3 or 4 must be stored and used in accordance to applicable regulations.
- b) Unless otherwise indicated, all gases must be stored in a continuously mechanically ventilated gas cabinet, fume hood or other enclosure.
- c) Small quantities (e.g., lecture cylinders) or dilute concentrations of these gases may be stored outside of a ventilated enclosure with the approval of site management and the safety officer.
- d) Audible alarms should be utilized in ventilated hoods that are dedicated to toxic gas usage or storage.
- e) Standard Operating Procedures (SOP's) for processes or procedures which use corrosive, toxic or highly toxic gases shall be developed that include emergency response actions. All affected employees shall be trained on the contents of these procedures.

7. Gas Cylinder Disposal: The following information applies to the disposal of compressed gas cylinders:

- A. If possible, purchase compressed gas only from manufacturers that will agree to take back the empty cylinder.
- B. A cylinder is considered empty when the container pressure is at atmospheric pressure.
- C. Refillable cylinders should be returned to materials handling personnel or directly to the vendor.
- D. If a refillable cylinder is encountered that does not have a manufacturer label, contact materials handling personnel to see if they can identify the manufacturer through stamp marks on the cylinder.
- E. Maintain manufacturer labels and label the cylinder with an "Empty" or "MT" tag.
- F. Materials handling personnel or the vendor should be contacted for disposal of partially full cylinders.
- G. Proper identification of the contents of all cylinders is required and is the responsibility of the cylinder owner.
- H. Disposal fees for unknown cylinders is the contractors expense.

8. Handling Compressed Gas Cylinder Leaks and Emergencies

- A. **Preplanning:** Despite strict adherence to safety practices, accidents involving gases may occur in the work site. The amount of damage sustained by personnel and property from these accidents will be directly related to the quality of the sites emergency plan and procedures. Users of compressed gas cylinders must be familiar with necessary safety precautions. Standard Operating Procedures (SOPs) for using compressed gases shall include a discussion of possible accident scenarios, appropriate employee responses and should take into account the following factors:



1. The nature of the operation (e.g., equipment used and type of injury that might be inflicted).
 2. The potential location of a release or spill (e.g., outdoors versus indoors, in a laboratory, corridor or storage area, on a table, in a hood or on the floor).
 3. The quantities of material that might be released and the type of containment (i.e., compressed gas tank size, manifold systems, etc.).
 4. The chemical and physical properties of the compressed gas (e.g., its physical state, vapor pressure and air or water reactivity).
 5. The hazardous properties of the compressed gas (e.g., its toxicity, corrosivity and flammability).
 6. The availability and locations of emergency supplies and equipment.
 7. A contingency plan which identifies building evacuation routes, emergency telephone numbers, chemical containment procedures, fire extinguisher usage, etc., should be posted in the worksite.
- B. **Minor Leaks:** Occasionally a gas cylinder or one of its component parts may develop a leak. Most of these leaks occur at the top of the cylinder in areas such as the valve threads, pressure safety device, valve stem and valve outlet. The following information applies to the remediation of minor leaks:
1. If possible, verify suspected leaks using a flammable gas detector or soapy water solution (a flame should not be used for detection). **If the leak cannot be stopped by tightening a valve gland or packing nut, emergency action procedures should be initiated and site safety and management should be notified.**
 2. For flammable, inert or oxidizing gases, move the cylinder to an isolated, well-ventilated area away from combustible materials. Post signs that describe the hazard.
 3. For corrosive and toxic gases, move the cylinder to an isolated, well-ventilated area and use suitable means to direct the gas into an appropriate chemical neutralizer. Post signs that describe the hazards.
 4. If it is necessary to move a leaking cylinder through populated portions of the building, place a plastic bag, rubber shroud or similar device over the top and tape it (duct tape preferred) to the cylinder to confine the leaking gas.
- C. **Major Leaks:** In the event of a large gas release or if an accident takes place in which readily available personal protective equipment (PPE) is inadequate to ensure worker safety, **activate the following Emergency Procedures:**
1. **Immediately call 911** and report the incident.
 2. Activate building and area fire alarms (or chemical safety alarms if applicable).



3. Evacuate the area, securing entrances and providing assistance to others on the way out.
4. Provide emergency response officials with details of the problem upon their arrival.

D. Accidents Involving Personnel Injury

1. For medical emergencies, call the site emergency response number or 911.
2. Assist persons involved and administer immediate first aid which may include:
3. Washing under a safety shower (in case of burning clothing or chemical exposures).
4. Removing contaminated clothing.
5. Irrigating the eyes at an eyewash.
6. Administering artificial respiration.
7. Notify personnel in adjacent areas of any potential hazards (e.g., activate building or area alarms).
8. Move injured personnel only if necessary to prevent their exposure to further harm.

E. Fire and Fire-Related Emergencies

1. **For all fires, immediately call the site emergency response number or 911.** Small isolated fires within the laboratory may be extinguished using the appropriate portable fire extinguisher if personnel are confident that they can safely extinguish the fire. Additional information on fire extinguisher use is contained in the site safety plan. For large or rapidly spreading fires, the following procedures should be followed:
 - a) Call the site emergency response number or 911 to report the fire.
 - b) Activate building and area alarms.
 - c) Evacuate the building, shutting doors and providing assistance to others on the way out.
 - d) Provide fire or police officials with the details of the problem upon their arrival.