Compressed Gases Safety Program

Summary: 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 to the standard required work practices for inert gases, hazardous gases may require additional controls and work practices including, but not limited to, the use of gas cabinets, gas monitors, emergency shutoffs, proper equipment design, leak testing procedures, and the use of air supplying respirators for certain highly toxic gases.

1. Program Description
UC Irvine users of compressed gases will take precautions to prevent injuries, property damage, and disruption to operations caused by leaks of compressed gas and over-pressurizations. Types of injuries and accidents that will be controlled include:

- Injuries caused by flying objects accelerated by an explosion or pressure release
- Fires and injuries caused by flammable gas ignition
- Injuries caused by inhalation of toxic or asphyxiating gases

This program requires the use of industry standard gas systems, engineering controls, administrative controls, and training. Higher-hazard gas systems may require redundant levels of engineering controls.

2. Scope
To assure that UC Irvine employees handling compressed gases are adequately trained in the inherent hazards of the cylinders and their contents, as well as proper handling, storage, and use according to Cal/OSHA requirements.

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 to the standard required work practices for inert gases, hazardous gases may require additional controls and work practices including, but not limited to, the use of gas cabinets, gas monitors, emergency shutoffs, proper equipment design, leak testing procedures, and the use of air supplying respirators for certain highly toxic gases.

This program applies to the storage, use, and handling of gases in pressurized portable containers and gas systems. The primary focus of this program is on single gas uses and systems. Additional requirements may be applied to:

- Use of multiple gases in a single control area or building
- Pressure and cryogenic systems
- Large compressed gas facilities, storage areas, or use areas
- Transportation of compressed gases on or across Irvine public roads

3. Definitions

Anesthetic gas - A gas that may cause loss of sensation with or without the loss of consciousness.

Cal/OSHA – California Occupational Safety and Health Administration

CGA – Compressed Gas Association

Corrosive Gas - A gas that can cause visible destruction of, or irreversible alterations in, living tissue (e.g., skin, eyes, or respiratory system) by chemical action.

Cryogenic Liquids – Gases condensed to liquid form at extremely low temperatures. Example: Liquid Nitrogen is –196°Celsius (–320°Fahrenheit). The term “cryogenics” applies to all temperatures less than –150°C (–238°F).

DOT - U.S. Department of Transportation.

Flammable gas - A gas that can be ignited in air.

Compressed gas - A material that is shipped in a compressed gas cylinder and acts as a gas upon release at normal temperature and pressure or is used or handled as a gas.

Hazardous gas - A gas that is included in one or more of the following hazard categories: corrosive, flammable, health hazard, oxidizer, pyrophoric, reactive, or toxic.


Oxidizing gas - A gas that initiates or promotes combustion in materials, either by catching fire itself or by causing a fire through the release of oxygen or other gases.

Oxygen deficiency - A condition that occurs when a breathable atmosphere contains less than 19.5% oxygen. Note: normal air contains 20.8% oxygen.

Pyrophoric gases - Gases that may spontaneously ignite in air at or below 54 °C (130 °F). Specific gases may not ignite in all circumstances or may explosively decompose.

STP – In Chemistry, Standard Temperature and Pressure or STP is defined as 0 °C (32 °F) and 1 atmosphere of pressure (101.325 kPa or 29.92 inches of Mercury).

Toxic gas – A gas that is poisonous or capable of causing injury or death, especially by chemical means.

4. Responsibilities

Principal Investigator/Supervisor

- Ensures that University policies are enforced and safe work practices are followed.
5. Program Components

A. General Guidelines

Read the label on the cylinder and identify the contents before using. If the label is illegible or missing, return the cylinder to the supplier. Don’t rely on stenciling or color of the cylinder. Do not use a cylinder with unidentified contents. All cylinders must be permanently labeled as to their contents and if they are full or empty (example - an empty cylinder may be marked “MT”. Empty cylinders must also be separated from full cylinders. Know the hazards of the contents and follow appropriate safe use practices for the material inside. Reference the to the substance’s Material Safety Data Sheet (MSDS) for additional information.

- All compressed gas cylinders must be properly stored in compliance with Cal/OSHA and NFPA code requirements. All cylinders whether empty or full must be stored upright and secured by chains, straps or in racks to prevent them from falling.
- Gas cylinders must be secured to prevent falling due to accidental contact, vibration, or earthquakes. Cylinders must be secured in one of the following ways:
  - By a noncombustible, two-point restraint system (e.g., chains) that secures the cylinder at the top and bottom one-third portions.
  - By a noncombustible rack, framework, cabinet, approved strapping device, secured cylinder cart, or other assembly that prevents the cylinder from falling.
- Cylinders must be segregated 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.
- Compressed gas cylinders must be transported with protective caps in place. Cylinders may be moved on chain equipped hand trucks or carts; they must never be rolled or dragged.
- Cylinders without regulators must be chained or strapped at an angle on carts designed for such cylinders. Cylinders with regulators must be upright, attached to the wall or a sturdy structure.
- If a cylinder valve cannot be opened, the valve should never be forced. If a valve cannot be opened by hand, the cylinder should be returned and another obtained. Employees must not attempt to repair cylinders or cylinder valves, or to force stuck or frozen cylinder valves.

**METHODS OF SECURING CYLINDERS**

<table>
<thead>
<tr>
<th>Recommended</th>
<th>Not Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure storage in public access area</td>
<td>Not secured</td>
</tr>
<tr>
<td>Adjustable bay storage rack</td>
<td>Securely chained to floor</td>
</tr>
<tr>
<td>Securely chained at an angle on cylinder</td>
<td>Securely chained to ceiling</td>
</tr>
</tbody>
</table>

- All cylinder storage areas, outside or inside, shall be protected from extreme heat and cold and from access by unauthorized personnel.
- Do not allow grease or oil to come in contact with oxygen cylinder valves, regulators, gauges or fittings. An explosion or fire can result. Oxygen cylinders and apparatus must be handled with clean hands and tools.
- Open cylinder valves slowly, directed away from your face.
- Report all suspected leaks immediately.
- If the material in the tank is highly toxic or flammable and you suspect a leak, evacuate everyone out of the area and report it to the appropriate person in your department.

B. Cryogenic Liquids

- All cryogenic liquids should be used with caution due to the potential for skin or eye damage due to the low temperature, and the hazards associated with pressure buildups in enclosed piping or containers.
- A full face shield, loose fitting cryogenic handling gloves, apron, and cuffless pants are the recommended equipment for transferring cryogenic fluids.
- Portable containers should only be used where there is sufficient ventilation. Do not place containers in a closet or other enclosed space where there is no ventilation supply to the area. The buildup of inert gas in such an area could generate an oxygen deficient atmosphere.
- Special vacuum jacket containers with loose fitting lids should be used to handle small quantities. Vacuum jacketed containers provided by the gas supplier will have overpressure relief devices in place.
- Any space where cryogenic fluids may accumulate (consider leakage into enclosed equipment) must be vented or protected by overpressure relief devices. Tremendous pressures can result in enclosed spaces as the liquid converts to gas. For example, one cubic centimeter of liquid nitrogen will expand to 700 times this volume as it converts (warms) to its gaseous state.
Containers to be filled with cryogenic liquids should be filled slowly to avoid splashing. Cryogenic containers showing evidence of loss of vacuum in their outer jacket (ice buildup on the outside of the container) should not be accepted from the gas supplier. Contact with air (or gases with a higher boiling point) can cause an ice plug in a cryogenic container.

C. Precautions for Specific Gases

- Consult the Material Safety Data Sheet for all gases used. Some gases are pyrophoric (phosphine) corrosive (hydrogen chloride), toxic (ethylen oxide), anesthetic (nitrous oxide), or highly reactive (anhydrous ammonia). If you are unsure how to control dangerous properties of a compressed gas, call EH&S at 4-6200.
- Flammable gases such as propane, hydrogen, and acetylene always have a red label. However, the color of the cylinder itself is not a good indicator of flammability as different distributors may use different colored cylinders for the same gas. Check the label for flammability.
- Hazardous gas (arsine, carbon monoxide, hydrogen, phosgene, phosphine, etc.) cylinders should be stored in a suitable exhausted location. If a hazardous gas cylinder develops a leak, evacuate and restrict area access. Remove sources of ignition if the gas is flammable. Call 911, or if using a cell phone, (949) 824-5223.
- Inert gases, such as nitrogen and carbon dioxide must be treated with caution. If left to leak into closed space, these gases may displace oxygen and create a risk of asphyxiation.
- Oxidizing gases such as compressed oxygen or nitrous oxide, while not combustible themselves, will cause many materials to burn violently. Never use grease, solvents, or other flammable material on an oxygen valve, regulator, or piping.
- Toxic, corrosive, and pyrophoric gases have special handling and storage requirements. Contact EH&S if you plan to use these gases.

6. Reporting Requirements

Constant awareness of and respect for compressed gas cylinders and equipment and compliance with all applicable UC Irvine safety rules is mandatory.

Representatives of the Environmental Health & Safety Office are authorized to issue warnings to employees and stop unsafe work from continuing.

Supervisors may issue warnings and implement disciplinary actions up to and including termination for failure to follow the guidelines of this program.

Employees shall report any safety concerns to their supervisor or EH&S.

7. Training Requirements and Competency Assessment

All persons handling or using cylinders must have basic training initially at time of employment and periodically thereafter. Training will include review of information on the hazards associated with compressed gas include oxygen displacement, fires, explosions, toxic effects from certain gases and the physical hazards associated with pressurized systems. Special storage, use and handling precautions necessary to control these hazards will also be covered.

The training program will be provided by EH&S and will include classroom instruction and operational training on specific compressed gas cylinder hazards on campus.

Employees will require refresher training under any of the following conditions:

- Changes in the workplace render previous training obsolete
- Changes in the types of cylinder systems or equipment used render previous training obsolete
- Inadequacies in an employee’s knowledge of compressed gas cylinders or equipment or observed behavior indicate that the employee has not retained the required training

8. Information and External References

Title 8 California Code of Regulations, General Industry Safety Orders - §3301, §3304, §4649, §4650
Compressed Gas Association
American National Standards Institute (ANSI)

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