

Safe Handling and Use of Specialty Gases

General Precautions and Emergency Assistance

A. General Precautions

Safety is a critical part of our business. We take every precaution to see that our products are delivered to you safely. But safe delivery is only the beginning. As our customer, you need to continue this concern for safety in the handling, storage, and use of our products.

The following are six general recommendations for you to follow:

1. Know and Understand Product Properties

Know and understand the properties, uses, and safety precautions before using any gas, gas mixture, or chemical. Consult Airgas' Material Safety Data Sheets (MSDSs) for safety information on the gases you will be using.

2. Check Equipment

Leak-test lines and equipment before they are used. Lines and equipment should be designed and maintained to handle full cylinder pressure. Materials of construction should be compatible with the gases being used.

3. Develop Emergency Plans

Be aware of potential hazards and develop plans to cover all possible emergencies. Use emergency drills to practice implementing these plans. Inform local hospitals, fire departments, and other local emergency response organizations of the gases in use, so that they too will be prepared in the event of an emergency.

4. Provide Personal Protection

Require personnel to wear suitable protective clothing, including gloves and face protection. Safety equipment, such as self-contained breathing apparatus and fire extinguishers, should be located near hazardous areas. Personnel should be well informed of the potential hazards of the gases with which they are working and should be trained to carry out emergency plans and first aid procedures.

5. Follow Regulations

Follow all federal, state, and local regulations pertaining to the storage and use of compressed gas cylinders. Compressed Gas Association (CGA) Pamphlet P-1 provides excellent guidance. Follow the National Fire Protection Association (NFPA) codes, especially for flammable products.

6. When in Doubt, Contact Airgas

If you are unfamiliar with the hazards associated with a particular gas or unsure of the correct handling and storage procedures, call Airgas' Technical Information Center at **1-877-ASG-4-GAS**.

B. Emergency Assistance

Airgas gas systems are designed according to the highest safety standards. We provide our customers with information on the hazards and precautions associated with the gases they are using. In addition, Airgas has established an emergency response program. Through this program, we can assist customers in responding to emergencies by providing information both to our customers and to their local emergency response groups.

To provide quick, efficient assistance, Airgas has organized teams of trained technical personnel throughout the U.S. Six primary teams and more than 20 local teams are on call at all times. In the event of an emergency, our 24-hour, toll-free emergency number will put you in touch with an emergency response spe-

cialist. This specialist will provide you or other safety/technical personnel with recommendations by phone, or if warranted, will immediately send a team to your location.

C. Summoning Help

If you are faced with an emergency involving our gases, chemicals, or equipment, Airgas can provide assistance. Call toll-free **1-800-949-7937**.

D. Primary Hazards

The following is an overview of the primary hazards to be avoided when handling and storing compressed gases and cryogenic liquids.

1. Asphyxiation

Simple asphyxiation is the primary hazard associated with inert gases. Because inert gases are colorless and odorless, they can escape into the atmosphere undetected and quickly reduce the concentration of oxygen below the level necessary to support life. The use of oxygen monitoring equipment is strongly recommended for enclosed areas where inert gases are being used. Exhaust streams should be vented to a safe location.

If oxygen concentrations fall below 19.5%, self-contained breathing apparatus (SCBA) must be used.

2. Fire and Explosion

Fire and explosion are the primary hazards associated with flammable gases, oxygen, and other oxidizing gases. Flammable gases can be ignited by static electricity or by a heat source, such as a flame or a hot object. Oxygen and other oxidizing gases do not burn but will support combustion of flammable materials. Increasing the concentration of an oxidizer accelerates the rate of combustion. Materials that are nonflammable under normal conditions may burn in an oxygen-enriched atmosphere.

3. Chemical Burns

Corrosive gases can chemically attack and eat away various materials, including fire-resistant clothing. Some gases are not corrosive in their pure form, but can become extremely destructive if a small amount of moisture is added. Corrosive gases can cause rapid destruction of skin tissue and mucous membranes.

4. Chemical Poisoning

Chemical poisoning is the primary hazard with toxic gases and liquids. Even in very small concentrations, brief exposure to these gases can result in serious poisoning injuries. Symptoms of exposure may be delayed.

5. Cold Burns

Cryogenic liquids such as liquid argon, nitrogen, and oxygen and certain liquefied gases can cause cold burns and freeze skin tissue. Cryogenic liquids can cause cold burns and tissue damage because of their extremely low temperatures. Contact with liquefied compressed gases can cause cold burns because of rapid evaporation of the liquid.

6. High Pressure

All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder. A sudden release of pressure can cause injuries by propelling a cylinder or whipping a line.

7. Improper Handling of Cylinders

Cylinders containing compressed gases and chemicals are heavy and awkward to handle. Improper handling of cylinders could result in sprains, strains, falls, bruises, and broken bones. Other hazards such as fire, explosion, chemical burns, poisoning, and cold burns could occur if gases accidentally escape from the cylinder due to mishandling.

A. Compressed Gas Cylinders

Compressed gas cylinders should be handled only by persons familiar with the hazards and who know proper handling techniques. All cylinder movement should be done with material handling equipment such as cylinder carts. Always secure the cylinders when in storage or use. Safety glasses, work gloves, and safety shoes with metatarsal guards should be worn.

1. Cylinder Handling Precautions

The following precautions should be taken to prevent injuries caused by improper handling of cylinders:

- Never subject cylinders to abnormal mechanical shocks which may cause damage to their valves or pressure relief devices.
- Never drop, drag, or slide cylinders.
- Never lift a cylinder by the cap.
- Never use lifting magnets or slings when cylinders must be transported by crane. Use a platform cage or cradle.
- Never use cylinders as rollers for moving material or other equipment.
- Never attempt to catch a falling cylinder.

2. Cylinder Cap Precautions

Cylinder caps perform two functions. First, they protect the valve on the top of the cylinder from damage if it is knocked over. Second, if gas is accidentally released through the valve, the cap will vent the gas out of both sides, minimizing the likelihood that the cylinder will topple.

To prevent injuries caused by high pressure and improper handling of cylinders, take the following precautions:

- Keep the valve protection cap on until the cylinder is secured in place and ready for use.
- Never stick fingers or tools into the holes. You could inadvertently open the valve.

- Always replace the cap securely—hand-tight only.
- If you cannot remove the cap, contact your supplier. Do not try to force it open. You could accidentally open the cylinder valve.

3. Cylinder Storage Precautions

The following precautions should be taken to prevent injuries caused by asphyxiation, fire and explosion, high pressure, and improper handling of cylinders:

- Separate oxidizers, combustible materials, and flammable gas storage areas by at least 20 feet or by a noncombustible wall of fire-resistant construction.
- Separate full and empty cylinders. Arrange full cylinders so that old stock is used first.
- Always store cylinders in the upright position in their assigned area.
- Cylinders should be secured in storage.
- Store only the amount of compressed gas required for a specific application.
- The storage area should be dry, cool, well ventilated, and preferably fire-resistant.
- Never store cylinders near radiators or other heat sources.
- Monitor the atmosphere in areas where gases may be vented and collected.
- Restrict access to cylinder storage areas.
- Post suitable warning signs, e.g. "No Smoking".
- Store cylinders away from high-traffic areas and emergency exits.
- Cylinders shall not, if possible, be stored in confined spaces or basements.
- If storage is outdoors, protect against weather extremes and damp ground to prevent rusting.

Handling, Storage, and Use of Gases and Cryogenic Liquids

Special care must be taken in the handling and storage of gases. Please review and follow all of the recommendations in this section. Because cryogenic liquids present special hazards, they are listed separately.

- Consult the NFPA codes for specific instructions on the storage of flammable gases.

4. Things to Keep Away from Cylinders

Take the following precautions to prevent injuries caused by high pressure, fire, and explosion:

- Never expose any part of a cylinder to a temperature above 125°F.
- Keep sparks or flames from coming in contact with cylinders.
- Never allow cylinders to come into contact with electrical apparatus or circuits.
- Never strike an arc on a cylinder.
- Never heat cylinders to raise the pressure except when using an approved system.
- Never permit smoking or open flames in oxygen or flammable gas cylinder storage areas.
- Never permit oil, grease, or other combustible substances to come into contact with oxygen or other oxidizing gas cylinders, valves, and systems.

5. Cylinder Use

The following precautions should be taken to prevent injuries caused by asphyxiation, fire and explosion, chemical burns, chemical poisoning, cold burns, and high pressure:

- Never fill and ship a compressed gas cylinder without the consent of the owner. This is a violation of federal law.
- Never return product to a cylinder.
- Never introduce another material into a cylinder.
- Never attempt to mix gases in a cylinder.
- Use regulators and pressure relief devices when connecting cylinders to systems with lower pressure ratings. Only regulators approved for the specific gas and rated for the cylinder

pressure should be used. Open the cylinder valve slowly before adjusting the pressure on a regulator.

- Always open a cylinder valve slowly.
- Cylinder valves should be closed and the pressure should be relieved from equipment connected to the cylinder at the end of a workday or whenever an extended idle period is anticipated.
- Use check valves or traps to prevent backflow of water or other contaminants into the cylinder. If backflow occurs, mark the cylinder “contaminated” and notify Airgas immediately.
- Never use oxygen as a substitute for compressed air.
- Use only oxygen-compatible threading compounds on systems for oxygen or oxidizer service.
- Never refill a compressed gas cylinder. Compressed gas cylinders may be refilled only by qualified producers.
- Never remove product identification labels or change cylinder color.
- If a cylinder valve is difficult to operate, do not use. Contact Airgas. Do not use wrenches on valves equipped with hand wheels. Before returning the cylinder to Airgas, tag the cylinder identifying the problem.

6. Return of Cylinders

When returning an empty cylinder, close the valve before shipment, leaving at least 25 psig of residual pressure in the cylinder. Replace the valve cap and any valve outlet caps or plugs originally shipped with the cylinder. If repair is needed on a cylinder or its valve, be sure to mark it and return it to Airgas.

B. Cryogenic Liquids

Many of the safety precautions observed for compressed gases also apply to cryogenic liquids. Two important properties distinguish cryogenic liquids from compressed gases. Both properties present additional potential hazards:

- **All cryogenic liquids exist at very low temperatures.** The common cryogenic liquids include argon (–302°F), hydrogen (–423°F), nitrogen (–320°F), and oxygen (–297°F). Their cold boil-off vapor rapidly freezes human tissue. Most metals become stronger upon exposure to cold temperatures, but materials such as carbon steel, plastics, and rubber become brittle or even fracture under stress at these temperatures. Proper material selection is important. Cold burns and frostbite caused by cryogenic liquids can result in extensive tissue damage.
- **All cryogenic liquids produce large volumes of gas when they vaporize.** Liquid nitrogen will expand 696 times as it vaporizes. The expansion ratio of argon is 847:1, hydrogen is 850:1, and oxygen is 860:1. If these liquids vaporize in a sealed container, they can produce enormous pressures which could rupture the vessel. For this reason, pressurized cryogenic containers are usually protected with multiple pressure relief devices. Primary protection is usually a pressure relief valve; secondary protection is a frangible disc.

Vaporization of cryogenic liquids (except oxygen) in an enclosed area can cause asphyxiation. Vaporization of liquid oxygen can produce an oxygen-rich atmosphere. Although oxygen is not flammable, it is an oxidant and will support and accelerate the combustion of other materials. Vaporization of liquid hydrogen can form an extremely flammable mixture with air.

All systems for handling cryogenic liquids must be suitably protected by use of pressure relief devices.

1. Handling Cryogenic Liquids

Most cryogenic liquids are odorless, colorless, and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, the cold boil-off gases condense the moisture in the air, creating a highly visible fog.

Always handle these liquids carefully. Because of their extremely low temperatures, they can produce cryogenic burns and frostbite. When spilled on a surface, they tend to cover it completely and, therefore, cool a large area. The vapors from these liquids are also extremely cold and can produce burns. Exposure which may be too brief to affect the skin of the face or hands may damage delicate tissues, such as the eyes.

Boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids. Perform these tasks slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid.

Never touch uninsulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even nonmetallic materials are dangerous to touch at low temperatures. In addition to the hazards of frostbite or flesh sticking to cold materials, objects that are soft and pliable at room temperature, such as rubber or plastic, become hard and brittle and are broken easily at these extremely low temperatures.

2. Protective Clothing

Face shields are recommended during transfer and handling of cryogenic liquids. If severe spraying or splashing could occur, safety glasses or chemical goggles will provide additional protection.

Wear cryo gloves when handling objects that come into contact with cryogenic liquids and vapor. Trousers should be worn on the outside of boots or work shoes. Depending on the application, it may be advisable to wear special clothing.

Emergency Action

A. Fire Extinguishing Methods

Before working with flammable or oxidizing materials, consult the appropriate safety literature (MSDSs, NFPA guidelines, etc.) to develop a fire prevention and control plan. When working with toxic or corrosive materials, or products which form toxic or corrosive compounds in a fire, self-contained, breathing equipment and other emergency protective equipment should be available and personnel should be trained and skilled in their proper use.

If an emergency should occur in which a flammable or oxidizing gas is feeding the fire, stop the flow of gas—if it is possible without risk—before extinguishing the fire. If a flammable gas fire is extinguished before the gas flow is turned off, an explosive mixture of flammable gas and air may be formed. Even with protective equipment, emergency personnel should never enter an area where flammable gases may have accumulated. If a fire must be extinguished before the gas supply can be shut off, make sure there is adequate ventilation to dissipate the gas. Cool the cylinder(s) and the surrounding area with water spray and eliminate other sources of ignition. If you have a controlled fire coming from a cylinder, it is often desirable to let the fire burn until the cylinder is empty.

Oxidizing gases, nonflammable toxic gases, or nonflammable corrosive gases may be involved in a fire. Develop procedures to eliminate or minimize the hazards associated with these products. Wear self-contained breathing apparatus when fighting fires involving toxic gases and gases that decompose when heated, producing toxic fumes. Wear goggles with suitable respiratory protection and fully protective clothing when fighting fires involving gases that are irritating or corrosive to the eyes or skin, or gases that react to produce irritants or corrosives. Consider the physical and chemical properties (specific gravity, solubility, reactivity, etc.) of the particular gas in relation to the firefighting measures to be used.

B. Handling of Leaking Cylinders

When the leaking product or the size of the leak constitutes a hazard, wear self-contained breathing apparatus and protective clothing.

Most leaks occur at the valve in the top of the cylinder. Areas that may be involved are:

- Valve threads
- Pressure relief devices
- Valve stem
- Valve outlet

If a leak develops, begin emergency procedures and call **Airgas Emergency Response — 1-800-949-7937**. Never attempt to repair a leak at the valve threads or safety devices.

1. Minimum Size Leaks

The following procedures are for leaks of minimum size, where action can be taken without serious exposure to personnel:

- **Flammables, Inerts, Oxidants**

If a leak develops in a cylinder containing flammables, inerts, or oxidants, make sure there is adequate ventilation to dissipate the gas. Move the cylinder to an isolated area (away from combustible material if the leak involves flammable or oxidizing gases) and post signs that describe the hazards and state warnings. Contact Airgas.

- **Corrosives**

Some corrosives are also oxidants or flammables, adding to the seriousness of the leak. If the product is corrosive, the leak may increase in size as the gas is released. Move the cylinder, wearing suitable personal protective equipment, to an isolated, well-ventilated area. Post signs that describe the hazards and state warnings. Contact Airgas.

- **Toxics**

Follow the same procedure for toxic gases as for corrosive gases. Move the cylinder, wearing suitable personal protective equipment to a ventilated gas cabinet, fume hood, or to an isolated, well-vented area. Post signs that describe the hazards and state warnings. Contact Airgas.

2. Large or Uncontrollable Leaks

Basic action for large or uncontrollable leaks should include the following steps:

- Evacuation of personnel
- Rescue of injured personnel by crews equipped with adequate protective clothing and breathing apparatus
- Firefighting action
- Decontamination
- Contact Airgas

C. First Aid Measures

The following first aid instructions are considered applicable for most incidents. Nevertheless, a study of the particular product involved may indicate either additional or completely different first aid instructions. Consult the Material Safety Data Sheet (MSDS) for specific recommendations.

1. Asphyxiants

If a person is overcome by an asphyxiant, remove the victim to an uncontaminated area. Keep the person warm and quiet. If not breathing, administer artificial respiration or oxygen by resuscitator. If breathing is difficult, administer oxygen. Call a physician.

2. Irritants, Corrosives

Remove the victim to an uncontaminated area. If not breathing, administer artificial respiration or oxygen by resuscitator. If breathing is difficult, administer oxygen. If an irritating or corrosive gas comes in contact with the eyes, gently flush the eyes with large quantities of water for at least 15 minutes. Gently separate the lids to promote thorough irrigation. If a corrosive gas comes in contact with the skin, flush the affected area with large quantities of water for at least 15 minutes, while removing contaminated clothing and shoes. Call a physician. Do not apply ointments unless prescribed by a physician.

3. Toxics

If a person inhales a toxic gas or if inhalation is suspected, remove the victim to an uncontaminated area. If breathing is difficult, administer oxygen. If not breathing, provide artificial respiration or oxygen by resuscitator. Call a physician. Keep the person warm and quiet. In the case of eye or skin contact, follow first aid procedures for irritants. Exposed or potentially exposed persons should avoid exertion and may require medical observation. Symptoms of exposure may be delayed.

4. Liquefied Gases

Some compressed gases are liquid in the cylinder. When the liquid is released to atmospheric pressure, it vaporizes rapidly, absorbing large quantities of heat from the surroundings. If the liquid comes in contact with the body, it absorbs this heat from the tissue, causing "burns." In case of cold injury, flush the affected area gently with tepid water (102°F–105°F). Call a physician.

Frozen tissues are extremely vulnerable to additional injury and must be handled carefully before and after thawing. Never apply direct heat. Frozen tissues should be gently thawed with tepid water (102°F–105°F). Cryogenic burns require medical attention. Frozen or thawed tissues should be protected with a loose covering (sheet or dressing) while the patient is being transported.

5. Cryogenic Liquids

When cryogenic liquids come into contact with tissue, they produce damage similar to thermal burns and cause severe frostbite with extensive destruction of tissue. In case of contact, flush affected areas with large volumes of tepid water (102°F–105°F). Do not apply heat. Loosen any clothing that may restrict circulation. Apply a sterile protective dressing to the affected area. Call a physician.