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 specialist. 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.

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-ventilated 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.