1. Flammable Gases

- No cylinders are to be stored near highly flammable solvents, combustible waste material, unprotected electrical connections, gas flames, or other sources of ignition. Common examples of flammable gases include acetylene, hydrogen, methane, propane, carbon monoxide, and isobutene.
- At no time shall a flame be used to detect a leak. A soapy water solution or approved commercial leak detection solution shall be used.
- Inside buildings, stored oxygen shall be separated from flammable gas cylinders by a minimum of 20 feet or separated by a fire-resistant partition with a height no less than that of the cylinders.
- Flammable gases must be stored in well-ventilated areas away from flammable liquids, combustible materials, oxidizers, open flames, sparks and other sources of heat or ignition. A distance of 20 feet or a noncombustible barrier having a fire rating of at least ½ hour is the minimum separation requirement.
- All piping and equipment associated with flammable gas systems must be grounded and bonded.
- Do not use flammable gases near ignition sources (except for welding gases).
- Have a portable fire extinguisher (carbon dioxide or dry chemical type) readily available for fire emergencies.
- Use spark-proof tools when working with, or on, a flammable compressed gas cylinder or system.
- Post a warning sign (see image below) on access doors to areas where flammable gases are stored and used.

- Manifold systems must be designed and constructed by trained personnel. Consultation with the gas supplier and ESH before installing manifolds is required.
- In an emergency involving a flammable gas leak, fire or explosion, leave the work area immediately. Do not attempt to extinguish burning gas if the flow of product cannot be shut off immediately and without risk.
- Post “No Open Flames” signage on access doors to areas that use or store flammable gases.

2. Poisonous Gases

- Before using a poisonous gas, all label information and Safety Data Sheets (SDS's) associated with the use of the gas shall be read. Users shall be familiar with the hazards and health effects of the gas that they are using, and procedures to be followed in the event of an emergency.
- Poisonous gases shall only be used in force-ventilated areas, preferably in hoods with forced ventilation, or outdoor.
- Poisonous gas cylinders shall be of a size that will ensure the complete usage of the cylinder within a reasonable period.

3. Corrosive Gases

- Cylinders containing corrosive gases shall not be stored for more than 6 months.
- Remove regulators after use and flush with dry air or nitrogen.
- Metals become brittle when used in corrosive gas service, check equipment and lines frequently for leak.
- Use a diaphragm gauge with corrosive gases that would destroy a steel or bronze gauge. Check with the gas supplier for recommended equipment.

4. Cryogenic Liquids and Gases

- Cryogenic liquids and their boil-off gases rapidly freeze human tissue and cause embrittlement of many common materials. All cryogenic liquids produce large volumes of gas when they vaporize and may create oxygen-deficient conditions. Common examples of common cryogenic liquids include liquid oxygen, nitrogen, hydrogen, neon, and helium.
    - Use appropriate personal protective equipment, including insulated gloves, lab coat, and eye protection (goggles and face shield) during any transfer of cryogenic liquid.
    - 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]). If a burn is significant, seek medical attention.
    - Use only equipment, valves, and containers designed for the intended product, service pressure, and temperature.
    - Inspect containers for loss of insulating vacuum. If the outside jacket on a container is cold or has frost, some vacuum has been lost. Empty the contents into another cryogenic container and remove the damaged unit from service. The manufacturer or an authorized company shall make repairs.
    - Transfer operations involving open cryogenic containers must be conducted slowly to minimize boiling and splashing of the cryogenic fluid.
    - Ice or other foreign matter shall 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.
    - Hot air, steam, or hot water shall be used to thaw frozen equipment. Exception: Do not use water to thaw liquid helium equipment.
    - 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.

5. Fuel, High Pressure and Oxidizing Gases

- Fuel gases often use a combination of flammable and oxidizing gases. Use of fuel gases must comply with the following:
  - OSHA 29 CFR1910.253 – Oxygen-Fuel Gas Welding and Cutting
  - OSHA 29 CFR1910.102 – Acetylene
  - OSHA 29 CFR1910.103 – Hydrogen
- High Pressure gases can be rated up to 3,000 pounds per square inch (psi). Typical uses for high-pressure gases include:
  - Inert welding gas mixtures
  - Cryogenics
  - Non-toxic gas distribution
  - Medical gas distribution
  - Emergency oxygen services

6. Storage and Handling of Specialty Gases

- Facility Requirements
  - Valves that pass visual inspection are still subject to failure. 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.
  - A continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure is required for the **storage and use** of lecture sized bottles of the following types of gases:
    - Gases that have health hazard ratings of 3 or 4.
    - Gases that have a health hazard rating of 2 without physiological warning properties
    - Pyrophoric gases.
  - At a minimum, a continuously mechanically ventilated gas cabinet is required for the above gases in cylinders that exceed a lecture-bottle size.
- **Maximum Internal Cylinder Volume per Laboratory**
  - Maximum allowed usage and storage of compressed gases are set for work areas. Consult ESH for allowable mixture limits.

Class	Areas less than 500 sq. ft	Areas greater than 500 sq. ft
Liquefied flammable gas	1.2 sft^3	0.0018 ft^3 per sq. ft of lab space
Flammable gas	6.0 sft^3	0.012 ft^3 per sq. ft of lab space
Oxidizing gas	6.0 sft^3	0.012 ft^3 per sq. ft of lab space
Toxic gas	0.3 sft^3	0.0006 ft^3 per sq. ft of lab space
Corrosive gas	0.3 sft^3	0.0006 ft^3 per sq. ft of lab space

7. Oxidizer Gases

- Oxidizing gas: a gas that can support and accelerate combustion of other materials. Examples include oxygen, chlorine, fluorine, and nitrous oxide.
- Follow the below guidelines to work safely with oxidizer gases:
  - Oxidizers shall be stored separately from flammable gas containers or combustible materials. A distance of 20 feet or a noncombustible barrier at least 5 feet high having a fire rating of at least 1/2 hour is the minimum separation requirement.
  - Do not use oil or other hydrocarbon products to clean any equipment used with oxidizer gases.
  - Gauges and regulators for oxygen use should be labeled with a warning statement - "Oxygen - Use No Oil".

8. Highly Toxic Gases

- Toxic gases are those having a health hazard (HH) rating of 3 or 4, as defined by NFPA 704. The toxic effects of a substance can be either acute or chronic. Examples include arsine, phosphine, hydrogen sulfide, phosgene, and nitrous oxide.
- **Notification of ESH Prior to Obtaining HH3 and HH4 Gases**
  - ESH must be notified prior to obtaining HH3 and HH4 gases (regardless of quantity).
- Guidelines for working with toxic gases:
  - Store all toxic gases with a health hazard rating of 3 or 4 in a continuously, mechanically ventilated gas cabinet, or other exhausted enclosure. Exhausts must be vented directly to outside. Lecture bottles of toxic gases must be kept in fume hoods.
  - Review the Safety Data Sheets (SDS) to determine safety use guidelines.
  - Limit the work to under a fume hood only and avoid contact with skin and eyes.
  - PPE must be used at all times while working with toxic gases.
  - A gas detection system with visible and audible alarms to detect the presence of leaks, etc. should be installed for all toxic and highly toxic gases with hazard rating 3 or 4. See ESH for assistance. Signage for monitoring systems must be posted outside the door.
  - Emergency power must be provided for the gas cabinet exhaust, system shut offs, monitoring, alarms, and associated components.
  - A gas detection and alarm system must be serviced and maintained according to manufacturer's guidelines.
  - An emergency response procedure must be in place and everyone working in the area must be trained on the procedures.
  - Appropriate work planning and control documents shall be developed when using highly toxic gases and shall include emergency response, and training for all involved employees.
  - Only trained employees are allowed to work with highly toxic gases.
  - Container storage areas must be clearly posted with the hazard signs.

9. Corrosive Gases

- Examples of corrosive gases: hydrogen bromide, hydrogen chloride and ammonia.
- Cylinders of corrosive or unstable gases should be returned to the vendor when the expiration date of the maximum retention period has reached. In the absence of this date, a 36-month interval should be used. In the case of hydrogen chloride and hydrogen fluoride the cylinder should be returned to the vendor after two years.
- Special precautions for the use of corrosive gases:
  - Use only under an approved fume hood.
  - Always use required PPE and avoid contact with skin and eyes.
  - An emergency shower and eyewash must be installed within 50 feet where corrosive gases are used and the path to the fixture must not be hindered with obstructions.
  - An emergency response procedure must be in place and everyone working in the area must be trained on the procedures.
  - Post warning signs on the door
- Storage Separation Guide for Special Gases

Gas	Reactives	Corrosives	Oxidizers	Flammable/ Pyrophoric	Toxic
Toxic	20ft	20ft	20ft	20ft	20ft
Flammable/ Pyrophoric	20ft	20ft	20ft	20ft	20ft
Oxidizers	20ft	20ft	20ft	20ft	20ft
Corrosives	20ft	20ft	20ft	20ft	20ft
Reactives	20ft	20ft	20ft	20ft	20ft

- Cryogenic Liquids
  - Cryogenic liquids rapidly freeze human tissue and cause many common materials to crack or fracture under stress. All cryogenic liquids vaporize generating large volumes of gases and may create oxygen-deficient atmosphere. Examples include liquid nitrogen, and helium. For more information refer to ESH-(11000-S)-73326 Cryogenic System Standard.
- Safety Precautions
  - Use appropriate personal protective equipment when working with cryogenic liquids, including insulated gloves, goggles, and a face shield.
  - Never allow an unprotected part of the body to touch uninsulated pipes or containers of cryogenic material. In the event of any skin contact with cryogenic liquids, do not rub the skin. Place the affected part in a warm water bath.
  - Store cylinders or dewars containing cryogenic liquids in well-ventilated areas. A leak or venting from the container could cause an oxygen deficient atmosphere.

Revision History

Rev	Date	Section	Paragraph	Summary of Change	Authorized by
01	10/4/2023	NA	NA	Initial Release	CCR 835