Managing Compressed Gas Cylinders (OHS_OHS200) Course Material

Introduction

Welcome to the course. This training is **required** for anyone who handles, uses, and/or transports compressed gas cylinders. You will receive credit for this course, but it only counts as ***partial training***.

Supervisors and Principal Investigators (PIs) are responsible for providing the hands-on, day-to-day training for their staff. This training must be documented (names, dates, and training content) and kept on file for audits. OH&S may be consulted for assistance if needed.

This course covers generic information regarding compressed gases. However, the Appendices have information on flammable, pyrophoric, toxic, and cryogenic compressed gas cylinders. The assessment will cover all of the information.

Objectives

When you have successfully completed this course, you should be able to:

- Recognize the dangers associated with compressed gas cylinders by examining the labels on them and in the Safety Data Sheet[1]
- Identify the correct Personal Protective Equipment (PPE) to wear when working with different compressed gases
- Receive, use, handle, transport, store, dispose of, and maintain compressed gas cylinders according to regulatory standards and guidelines
- Design a plan to respond to a compressed gas emergency

[1] Safety Data Sheets, or SDS, are required in the workplace. They are substance fact sheets listing the classification of the substance or mixture, the GHS label elements and hazard pictograms, the signal word as well as hazard statements, and as much detail as possible concerning the particular gas inside the cylinder. They are available from both the vendor and ChemWatch.

Training and Standard Operating Procedures (SOPs)

All lab personnel must receive training through this course **and** live, hands-on, in-house training provided by the supervisor, manager, or Principal Investigator (PI) ***before*** being allowed to work with compressed gases and/or the cylinders! This **must:**

- Include hands-on training showing different types of regulators, changing regulators, performing leak tests, etc.
- Be documented with the date and time of the provided training.
- Kept on file and presented upon request.

All areas using compressed gases should have an up-to-date, written SOP and placed in an area for easy access for all working in and around the area.

Any area/lab/department using flammable or pyrophoric, and toxic gases **MUST** have an up-to-date written Standard Operating Procedure (SOP). Contact OH&S for assistance if needed.

Also, consult with OH&S ***before*** purchasing ***any*** pyrophoric or Health Hazard 3 or 4 (HH 3 or HH4) compressed gases!

Description of Compressed Gas Cylinders

Definition

The official definition from the Compressed Gas Association's (CGA) handbook is:

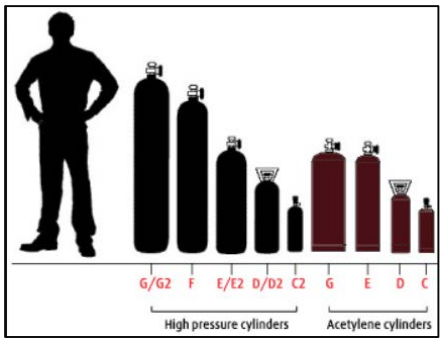
> *Material or mixture having in the container an absolute pressure exceeding 40 pounds per square inch (psi) at 70°F, or regardless of pressure at 70°F, having an absolute pressure exceeding 104 psi at 130°F or any liquid material having a vapor pressure exceeding 40 psi absolute at 100°F.*[2]

[2] Page 597, *CGA Handbook*, 3rd Edition

Material, Gases, and Sizes

Compressed gas cylinders are usually constructed of carbon steel or aluminum. They are made to be compatible with the gas contained inside whether it is inert, flammable, toxic, corrosive, cryogenic, or a mixture.

Most researchers work with either lecture bottles and/or cylinders of varying sizes.



Hazards and Safety

There are two primary hazards associated with **ALL** compressed gas cylinders:

- All compressed gases, when released, will expand rapidly. The gas may displace the oxygen in the room posing an asphyxiation hazard.
- If mishandled or dropped, compressed gas cylinders may become dangerous projectiles. This is a picture of a gas cylinder explosion at the University of Minnesota.

Factoid**:* A 9” X 52” gas cylinder pressurized to 2,000 pounds per square inch (PSI) has the stored energy equivalent to ***one pound of dynamite.

Want to learn more? Go to YouTube and search for “compressed gas cylinder accidents.” The Praxair plant explosion in St. Louis as well as the video from the MythBusters is worth watching if you are interested in learning more. Some of the safety videos are good, but there are quite a few.

Compressed Gas Safety

1. Know the properties of the materials involved!

    a. Is the gas a:

Chemical/ Health Hazard?	Toxic	Carcinogenic	Asphyxiant	Poison	Serious damage to the eyes, respiratory system, skin, etc.
Physical Hazard?	Explosive (Rupture, rocket)	Flammable	Pyrophoric	Corrosive	Frostbite

    b. Can you easily read the label that is on the cylinder? Read it carefully so that you will KNOW the specific hazards.

    c. Have you ordered a SDS to view the details about hazards and warning about the gas inside?

2. Treat all compressed gas cylinders, full or empty, as objects that have a very real potential to severely injure you and others. A leaking or damaged compressed gas cylinder has the power to penetrate concrete walls like a torpedo.

If you need to order a Safety Data Sheet (SDS), ask the vendor, go to Chemwatch or contact OH&S at 4-2487.

Personal Protective Equipment (PPE)

You should ***always*** put on (don) the proper PPE before working with any compressed gas.

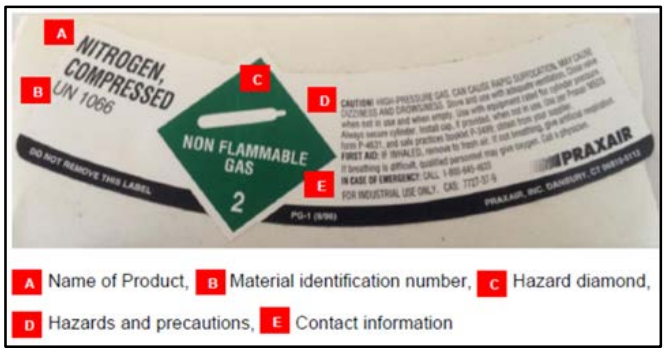
What is the Appropriate PPE?

1. The appropriate lab coat for the compressed gas being used
2. Safety goggles or a face shield in case of a release, leak, or accident
3. Rubber gloves or gloves appropriate for the type of gas being used
4. Safety shoes with both toes and heels enclosed
    a. Shoes must be hard in case of a falling cylinder. Steel-toed shoes are preferable.

Receiving Compressed Gas Cylinders

Pre-acceptance Inspection

1. Inspect for proper labeling.
    a. The label must be visible and durable.
    b. It must be accurately labeled.
    c. Ensure that the compressed gas is what you ordered!
    d. **Never** accept an unlabeled or improperly labeled cylinder!



2. Examine the cylinder for dents, rust, and other damage.
3. Look and listen for leaks – odors, visible fumes, hissing sounds, etc.
4. Verify the hydrostatic pressure test stamped on the cylinder is within the limit, usually five years.

Acceptance/Rejection of Compressed Gas Cylinders

If the cylinders are acceptable, mark the cylinders as ***FULL*** and write the date received on it.

If the cylinders have any issues (dents, leaks, rust, etc.), contact the vendor immediately! Do not accept or use them.

Use, Maintenance, Storage, Transport, and Disposal

Improper handling, storage, and use could lead to catastrophic events such as:

- Oxygen depleted atmosphere
- Fires
- Adverse health effects or even death

Always read the label or review the Safety Data Sheet (SDS) for physical and health hazards before handling, use, etc.

Handling and Use

Only trained individuals are allowed to operate and/or handle compressed gases. This includes this course as well as training from the supervisor and/or PI.

Preparing for Setup

- Wear the appropriate PPE.
    - Read the SDS carefully in regards to the appropriate PPE.

      Gas cylinders may have multiple hazards, for example ammonia. It is both Corrosive and Toxic. If the gas is toxic, that will be the primary hazard. This information would be on the SDS and give you the correct PPE necessary to don when using and/or handling.
- Before moving the compressed gas cylinder(s) into the lab/area, check for leaks, corrosion, and/or damage. Do ***not*** use these cylinders! Return them to the vendor immediately.
- Safeguard the area from other potential hazards ***before*** bringing the cylinder into the area (e.g., remove or move other flammable, toxic, or hazardous chemicals in the area away from the space where the cylinder will be located.)
- Ensure that the lab/area is well-ventilated.

Preparing for Use

- Use only cylinders with regulators with both high and low pressure gauges that are designed for the gas being used.
    - ***Never*** use a cylinder without a regulator.
- Ensure that the cylinder in use is in an upright position and firmly secured to prevent falling before use.
- Attach the regulator securely ***before*** opening the valve.
- Place the cylinder so that the valve is accessible at all times.
- Stand to one side of the regulator when opening the valve.
- Open the cylinder valve ***slowly***.
- Verify secure connections often when the cylinder is in use.
- Close the valve when not in use.

Maintenance and Prevention

Frequently

You should:

- Inspect valves, hoses, and flashback arrestors (if applicable) for leaks or other issues
- Confirm operating pressures

Avoid

You should avoid:

- Using or allowing oil or grease to come in contact with regulator, valves, fittings, or the cylinder
- Repairing the cylinder valves while the cylinder still contains gas pressure
- Using a leaking, corroded, or damaged cylinder

Storage

- Store only the "cylinders in use" inside the lab. This means a cylinder fitted with a regulator and connected to an operation/process and only **one** reserve next to it. All other cylinders should be stored in a designated storage area outside the lab!
- Post storage areas with the names and hazard class of the gases. It is recommended that an appropriate "Danger" or "Warning" sign be posted where acutely toxic, corrosive, oxidizing, or flammable gases are stored, handled (GHS Health Hazard 1 to 3 or NFPA 4 and 3), or used.

- Secure cylinders in holders or clamping devices (straps, chains, or belts).
    - Fasten cylinders individually or up to a maximum of two cylinders.
- Keep properly secured at all times using straps, belts, or chains.
    - **NEVER** leave a cylinder unsecured or unattended!
- Store in a well-ventilated area.
- Keep cylinders away from:
    - Heat:
        - Store in areas less than 125° Fahrenheit
    - Ignition sources
    - Electrical circuits

- Never store cylinders near hallways, public areas, exits, or egress routes. Move them to the designated storage areas when not in use.
- Segregate empty and full cylinders.
    - Return empty cylinders as soon as possible to the vendor.
- Never store cylinders more than a year without use.

Cylinders Not in Use

- Ensure that the cylinder is clearly labeled **Full** or **Empty**.
- Close valves and release pressure on the regulators.
- Keep cap valves on.
- **Store cylinders "not in use" in a designated storage area outside the lab.** This does ***not*** mean in hallways, public areas, exits, or egress routes!
- Always use a cylinder cart and secure the cylinders with a chain when moving.
- Do not remove the protective valve caps when moving or lifting cylinders.

Transportation

- Secure cylinders **before** removing protective caps/regulators.
    - Prior to transporting or relocating a cylinder, remove the regulator, and attach the cylinder cap. The cylinder cap should be screwed all the way down on the cylinder's neck ring and should fit securely.
- Never attempt to handle a large gas cylinder alone.
    - Call a trained co-worker or supervisor.
- Use a cylinder cart, and secure the cylinder with a chain when moving.

Correct Elevator Transport for Inert Compressed Gases

When transporting inert gases, always use the freight elevators if possible. When transporting inert gases on a passenger elevator, never allow people to ride!

Correct Elevator Transport for Other Compressed Gases

When transporting toxic, flammable, and/or pyrophoric compressed gases, the procedure below MUST be followed to ensure human health and safety. This applies to freight and passenger elevators!

- Label the elevator entrances that will be used with signs that state "**TEMPORARILY OUT OF USE**" on each floor. (For example, you are loading a cylinder on the first floor and moving it to the fourth floor. The elevator entrances on both the second and third floors **must** be labeled so that no one will use them while you are transporting.)

- Ensure that a person is on the destination floor to receive the arriving cylinder and check for damage if any.
- Load the cylinder on the freight elevator, push the button of the destination floor, and exit the elevator ***before*** the door closes!

Things NOT To Do

NEVER:

- Leave a cylinder unattended/unsecured.
- Roll cylinders in a vertical position on the edge of the bottom except for distances of less than 12-18 inches and only if absolutely necessary.
- Roll cylinders horizontally.
- Drag along the floor or any surface.
- Carry or drag by the valve or protective cap.
- Carry large cylinders even if empty.
- Drop cylinders.
- Permit cylinders to strike each other or be handled violently or roughly.
- Permit smoking or open flames in oxidizer or flammable gas storage areas.

Disposal

When a cylinder is empty:

- Close the valves.
- Bleed the system.
- Remove the regulator.
- Replace the valve cap.
- Mark the cylinder as “Empty.”
- Return the cylinder to the storage area for empty cylinders.
- Secure empty cylinders as though they were full.
- Store empty cylinders away from full cylinders.
- Contact the vendor for pickup.

Do not keep empty cylinders in the lab! Move them to a designated area, and then return them to the vendor as soon as possible! You (the grant, department, etc.) are paying rent for the empty cylinders. This wastes money and space.

Contents Unknown

Any cylinder whose contents cannot be identified must be marked as ***"Contents Unknown"*** and the manufacturer/vendor contacted for pickup immediately.

If the vendor refuses to accept the cylinder, contact OH&S at (205) 934-2487.

Emergencies and an Emergency Plan

In the event of an emergency:

- Clear the affected area and/or floor immediately if the leak cannot be stopped, and it is an inert gas (e.g., Nitrogen, argon, etc.)
- If the gas is toxic or flammable:
  - Instruct everyone to leave the area immediately!
  - Call 911 or UAB Police 205-934-3535.

Please note that dialing 911 from a campus phone will contact the UAB Police, as will 4-3535. However, dialing 911 from a cell phone or any other phone than a campus landline will contact the Birmingham Police who will then use valuable time to contact the UAB Police. KNOW YOUR NUMBERS!

Every location where compressed gases are handled should have a written emergency plan covering steps to be taken in the event of an accidental release of gas. This plan should consider both the chemical and physical properties inside the cylinder as well as the potential hazard of the cylinder holding the compressed gases.

At a minimum, the plan should specify the following:

- Emergency response contact and numbers displayed predominantly
- Evacuation procedures
- Emergency equipment available for smaller issues
- Containment and disposal procedures for smaller issues
- The type of alarm system(s) you have in place – if applicable

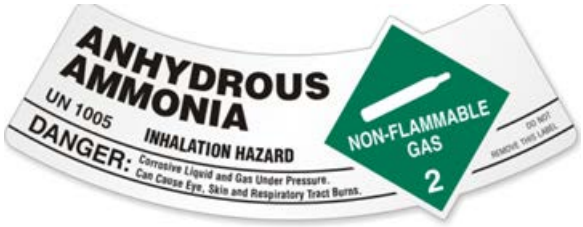
Leaks

- Stop all leaks that occur from the cylinder in gas lines, tubes, or apparatus by closing the main cylinder valve if safe to do so.
- ***If*** the leak cannot be stopped by closing the cylinder valve, and is:
    - An inert gas (e.g., nitrogen, argon, etc.), clear the affected area/floor.
    - A flammable, toxic, or corrosive gas and is outside of a ventilated enclosure that will contain the gas, ***immediately evacuate the building,*** activate the building's fire alarm system, and call 911.
- Never use a flame to locate a gas leak.

APPENDIX A

Corrosive Gases

Corrosive gases will attack and damage human tissue. They will also damage metal and other building materials. (Shown here is a person who received a serious eye trauma from anhydrous ammonia.)



Toxic corrosive gases (i.e. ammonia, chlorine, hydrogen chloride/bromide, nitrogen dioxide etc.) must never be stored longer than six months, since cylinders can degrade over time.

Storage areas should be as dry as possible. If the gas inside is also flammable, the cylinder must be grounded.

Examples are hydrogen chloride, hydrogen fluoride, and ammonia.

Safety Precautions That Must Be in Place and Followed

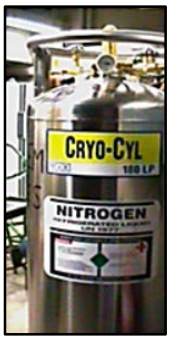
- Consult with OH&S before purchasing corrosive gases.
- Develop and make available Standard Operating Procedures (SOPs) for corrosive gases. These SOPs shall include emergency response, and training for all involved employees
    - Provide, train, and practice an emergency response procedure for everyone working in the area.
    - Have documented training on all lab personnel who will be working with toxic gases.
        - Training must include compressed gas hands-on training showing different types of regulators, changing regulators, performing leak tests, etc.
        - Intermittent emergency drills are required and must include all of those working in the area whether working with toxic gases or not.

  - Train employees to work with corrosive gases and allow only those trained to work with them.

- Wear PPE at all times while working with corrosive gases.
- Work/store in well-ventilated areas
- Review the Safety Data Sheets (SDS) often to remember and observe all safety use guidelines.
- Follow the “buddy system” (two people rule)
- Consult OH&S for alarms and monitoring requirements.

APPENDIX B

Cryogenic Compressed Gases



Cryogenic liquids are liquefied gases kept in their liquid state at very low temperatures. They have boiling points below -150°F. When released, they are extremely cold and can expand into very large volumes of gas condensing into moisture in the air into a highly visible fog.

Hazards include the physical and chemical hazards of the gas, frostbite[3], and asphyxiation if breathable oxygen in the air is displaced.

Safety Precautions That Must Be in Place and Followed

- Consult with OH&S before purchasing cryogenic gases.
- Develop and make available Standard Operating Procedures (SOPs) for cryogenic gases. These SOPs shall include emergency response, and training for all involved employees
    - Provide, train, and practice an emergency response procedure for everyone working in the area.
    - Have documented training on all lab personnel who will be working with cryogenic gases.
        - Hands-on training must include the right use of regulators and the detection of leaks.
        - Periodic cryogenic gas emergency drills are required and must include all of those working in the area whether in direct contact with toxic gases or not.
    - Train employees to work with cryogenic gases and allow only those trained to work with them.
- Appropriate PPE must be worn when working with or around cryogenic gases!
    - Wear thermal gloves!

[3] Frostbite is the freezing of body tissue that happens when the blood vessels contract. This reduces the blood flow and oxygen to the tissue. Normal sensation is lost (numbness, burning feeling, tingling, and/or itching), and color changes occur in the tissues. In extreme cases, severe harm can be done resulting in removal of the damaged tissues or appendages.

  - Remove watches, rings, bracelets, and other jewelry before working with or around cryogenic gas. These can freeze to exposed skin and/or crack when exposed to liquid gases. Use extreme caution.
  - Constantly check for frostbite.

- Require a minimum of two people in the lab when cryogenic gases (large quantities) are being used.
- Keep in mind that common materials such as carbon steel, plastics, and rubber will become brittle and may crack when exposed to the liquid gas.
- Do not store containers where they may come in contact with moisture. Malfunction may occur in the moving parts due to external ice formations.
- Keep ignition sources and combustible materials far away from liquefied oxygen, and ensure that the cylinders are insulated from any sources of heat. (This includes areas outside where they may be exposed to the sun's heat!)
- Avoid storing liquid oxygen cylinders on wood, asphalt, or oil soaked gravel. These materials may explode after an impact as light as a footstep after becoming saturated with liquid oxygen.
- Store all cryogenic compressed gas cylinders in an upright position in well-ventilated areas.
- Review the Safety Data Sheets (SDS) often to remember and observe all safety use guidelines.

The Do and Do NOTs When Working with Cryogenic Gases

DON'T:

- Overfill containers or carry more than one container.
- Use gloves with gauntlets.
- Wear pants with cuffs that could pool and channel spills.
- Make bare skin contact with cryogenic liquids, uninsulated pipes, or equipment.
- Work on charged cryogenic equipment without protective equipment.

DO:

- Use tongs or cryogenic gloves to handle charged liquid containers or other objects that might be cold.
- Stay out of the path of boil off gases.

- Pour cryogens slowly to minimize boiling and splashing.
- Use a phase separator or special filling funnel when transferring cryogens.
- Ensure that all pressure relief valves and rupture disk vent paths are directed away from personnel.
- **Perform routine inspections of all safety equipment and cryogenic systems.**

Liquid Nitrogen

Liquid nitrogen is the most commonly used cryogenic liquid on campus. The best safety rule for liquid nitrogen gas and their cylinders is to know and practice using the proper handling procedures.

There are three types of containers:

1. Dewar,
2. Cryogenic Liquid Cylinder, and
3. Cryogenic Storage Tank

Liquid Nitrogen Approved Containers

Container requirements:

- A closed container with a loose fitting top or pressure relief devices that allow venting
    - If the container is completely covered, the pressure could increase to dangerous levels, so venting is required. If left completely uncovered, the liquid nitrogen will evaporate much faster.

- Vessels **approved** to contain liquid nitrogen
- Vessels with carrying handles or on wheels

Liquid Nitrogen Unapproved/Inappropriate Containers

Open, un-insulated, or glass containers should **never** be used with liquid nitrogen. Use only approved containers!

Areas/Room Containing Liquid Nitrogen in Compressed Gas Cylinders

Areas/rooms/labs that are planning to use or using liquid nitrogen should be well-ventilated! This helps exhaust any nitrogen gas off-gassing from the container. A non-ventilated room could very quickly become oxygen deficient.

In Case of an Emergency

Slight Skin Contact or Frostbite

If your skin comes into contact with liquid nitrogen or develops frostbite:

- Thaw the area slowly with warm water.
- Seek medical attention though 911.

Release of Gas or Severe Burns/Frostbite

If the liquid nitrogen gas is leaking into the room or if a person has severe frostbite or a burn from exposure or contact:

- Call 911 from a UAB phone, if possible, or UAB Police from a cell phone at 205-934-3535.
- Call 911 in case of fire. This is due to the possible asphyxiation hazard.

Alarms and Monitoring Systems for Large Quantities

There are some areas where substantial amounts of cryogenic fluids are used. Because of the large quantities available, their inadvertent and uncontrolled release could produce an oxygen-deficient environment. These areas need special operational safety requirements and systems.

Below are three requirements when working in areas where substantial amounts of cryogenic fluids are used:

- Contact OH&S before purchasing.
- Develop an SOP and get it approved by OH&S.
- Commit to never working alone in these areas, and ensure that co-workers are with another trained co-worker while working with these fluids/gases.

For these areas, OH&S requires:

- Use of natural or local exhausts for ventilation
- Pressure relief devices where cryogenic liquids are enclosed, including all delivery lines and cutoff valves
- Inspection of all pressure-relief devices at regular intervals for leakage, frosting, and dirt accumulation
- Oxygen-monitoring equipment and associated visual and audible alarms in the area
- Clearly marked evacuation routes away from the release area
- Immediate evacuation in the event of an alarm.
    - In case of a lack of oxygen, move immediately to a well-ventilated area, or outside and acquire a respirator.
- No entry into areas/rooms in areas with active alarms.
    - Reentry may only occur by trained personnel with air supplying respirators.

APPENDIX C

Flammable Gases

Flammable gases react rapidly and violently with combustible materials and burn in air. Examples of flammable gases are Acetylene, Hydrogen, Propane, and Propylene.

Handling and Storing Flammable Gases

Always remember to:

- Store flammable gases away from flames or sparks.
- Store flammable gases away from combustible materials like oils, greases, plastics, fabrics, and finely divided metals (e.g., aluminum powder).
- Store flammable gasses in areas <125°F.
- Keep the volume of flammable gas to the minimum necessary for the work being done.
- Use just-in-time delivery when possible.
- Use piping, tubing, fittings, gaskets, and thread sealants suitable for the gas type, gas pressures, and temperatures involved.
- Keep oxidizer gases 20 feet from flammable gases and/or cylinders.
- Require a minimum of two people in the lab when flammable gases are being used.

When working with hydrogen gas, open the cylinder valve slowly. Quickly opening the valve can generate static charge by the escaping gas and may cause ignition.

APPENDIX D

Oxidizer Gases

Oxidizer gases are those that, in the presence of an ignition source and a fuel, support and may vigorously accelerate combustion (e.g., oxygen, nitrous oxide).

Handling Oxidizer Gases and Cylinders

When working with oxidizer gases, remember to:

- Keep oxidizer gases 20 feet from flammable gases and/or cylinders.
- Never handle/touch any part of the cylinder or fittings of oxidizer gas with bare hands that are contaminated with grease or oil.
    - Keep rags and gloves contaminated with grease or oil away from oxidizing gases.
    - Use only lubricants and connection or joint sealants recommended by the gas cylinder manufacturer or supplier.
- Never use oxygen in place of compressed air or nitrogen to purge gas lines.
- Require a minimum of two people in the lab when oxidizer gases are being used.

Fires in atmospheres enriched with oxidizing gases are very hard to extinguish and can spread rapidly!

APPENDIX E

Pyrophoric Gases

A gas with an auto-ignition temperature in air at or below 130° F (54.40C) is considered pyrophoric. Examples of pyrophoric gas are arsine, silane, disilane, dichlorosilane, and diborane.

Handling and Storing Pyrophoric Gases

- Submit a Standard Operating Procedure (SOP) and get approval from OH&S before ordering any pyrophoric gases.
- Store pyrophoric gases inside mechanically ventilated gas cabinets – always!
- Ensure that, outside each gas cabinet, devices for remote manual shutdown of the pyrophoric gas flow exist.
- Check for redundant controls that prevent pyrophoric gas from igniting or exploding with all pyrophoric gas flow, purge, and exhaust systems
    - Confirm that the controls include excess flow valves, flow orifices, mass flow controller sizing, process bypass line control, and automatic gas shutdown.
- Make sure that emergency backup power is provided for all electrical controls, alarms, and safeguards associated with the storage and process systems.
- Purge all process system components and equipment with a dedicated inert gas cylinder.

Safety Precautions That Must Be in Place and Followed

- Consult with OH&S before purchasing pyrophoric gases.
- Develop and make available Standard Operating Procedures (SOPs) for pyrophoric gases. These SOPs shall include emergency response, and training for all involved employees
    - Provide, train, and practice an emergency response procedure for everyone working in the area.
    - Have documented training for all lab personnel who will be working with pyrophoric gases.
        - Training must include compressed gas hands-on training showing different types of regulators, changing regulators, performing leak tests, etc.

        - Intermittent pyrophoric gas emergency drills are required and must include all of those working in the area, whether in contain with pyrophoric gases or not.
    - Train employees to work with pyrophoric gases and allow only those trained to work with them.
- Wear PPE at all times while working with pyrophoric gases.
- Require a minimum of two people in the lab when pyrophoric gases are being used.
- Review the Safety Data Sheets (SDS) often to remember and observe all safety use guidelines.

APPENDIX F

Toxic Gases

Hazards

Toxic gases have the ability to cause injury and/or death when inhaled, ingested or absorbed by the skin. Examples include ammonia, vinyl chloride, and phosgene.

Safety Precautions That Must Be in Place and Followed

- Consult with OH&S before purchasing toxic gases.
- Develop and make available Standard Operating Procedures (SOPs) for Highly Toxic gases. These SOPs shall include emergency response, and training for all involved employees
    - Provide, train, and practice an emergency response procedure for everyone working in the area.
    - Have documented training for all lab personnel who will be working with toxic gases.
        - Training must include compressed gas hands-on training showing different types of regulators, changing regulators, performing leak tests, etc.
        - Intermittent toxic gas emergency drills are required and must include all of those working in the area whether in contain with toxic gases or not.
    - Train employees to work with highly toxic gases and allow only those trained to work with them.
- Wear PPE at all times while working with toxic gases.
- Review the Safety Data Sheets (SDS) often to remember and observe all safety use guidelines.
- Never work with toxic gases outside a fume hood or BSC!
- Avoid contact with skin and eyes.

- Store toxic gases with Health Hazard 3 and 4 rating inside a mechanically ventilated gas cabinet.
    - Small compressed gas cylinders can be stored inside a fume hood and must be secured with a frame casing.
- Maintain negative pressure ventilation relative to the adjacent occupied spaces (i.e., hallways, offices, classrooms, and other laboratories).
- Ensure that a gas detection system with visible and audible alarms to detect the presence of leaks, etc. is installed for all toxic and highly toxic gases with hazard rating 3 or 4.
- Confirm that emergency power is provided for the gas cabinet exhaust, system shut offs, monitoring, alarms, and associated components.
- Service and maintain gas detection and alarm system according to manufacturer's guidelines.
- Require a minimum of two people in the lab when toxic gases are being used.
- Never store toxic oxidizing gases near combustible materials!
- Toxic flammable gases should never be stored near unprotected electrical connections, ignition or heat sources or fire extinguishers.

Health Hazard 3 (HH3) and Health Hazard 4 (HH4) Compressed Gases

OH&S must be notified ***prior to obtaining*** HH3 and HH4 gases (regardless of quantity). OH&S can be notified by phone 205-934-2487. Notification must include the following information:

- Name and location of the Principal Investigator (PI)
- Project Registration and training information
- Type, concentration, and quantity of the gas
- Storage and use location(s)
- Vendor name – including written acknowledgement / agreement confirmation that the vendor will accept the "used" cylinders for return

Conclusion

This concludes the Managing Compressed Gas Cylinders (OHS_OHS200) training course. You should now take the assessment. 90% or higher is considered passing. You have two chances to successfully complete the assessment. Failing both attempts means that you fail the course and must start over.

Want to Learn More?

OH&S has many training courses available to all UAB active employees and students. This includes topics such as in-depth radiation training, biosafety, bloodborne pathogens, chemical safety, Controlled Substances, building life safety, hazardous and medical waste, universal waste, PPE, Hazard Communication, etc.

We have a **decision tree** to assist you in choosing the right course to match the knowledge/skills you may need at work every day as well.

If you have any questions or comments, please feel free to contact OH&S at 205-934-2487.