**Hazardous and Highly Toxic Gases Guidance**

The following information is intended to provide general guidance on how to safely work with a specific class of chemical or hazard. This information is generic in nature. It addresses the use and handling of substances by hazard class only.

Hazardous gases: For the purposes of these guidelines gases that are flammable, toxic, corrosive, pyrophoric or oxidizing are considered hazardous gases.

A list of acutely toxic gases is included at the end of this document.

Definitions:

* CGA: Compressed Gas Association. A trade organization that promotes industry standards for manufacture, storage, transportation and use of compressed gases. The CGA sets standards for cylinder valve outlet connections.
* Two stage regulator: A device that reduces the higher pressure in the gas cylinder to a lower working pressure. Two stage regulators control pressure in two steps allowing precise control of pressure.
* Needle valve: A flow regulating device that allows fine control of gas flow and provides a secondary means of gas shut off.
* Purge assembly: A valving system that permits the flushing of the regulator and delivery tubing with inert gas.
* Flow restricting orifice: A flow limiting devices that restricts the maximum flow out of a compressed gas regulator. These devices are typically critical orifices.

**Procedures and Practices**

The use of hazardous gases by Rowan University Faculty, Students and Staff requires adherence to the following.

*Ventilation*: Proper ventilation is required in laboratories using hazardous compressed gases. The presence of a fume hood is mandatory (except for oxygen use) unless a gas cabinet and special local exhaust system or filtering system is used. Contact EHS to determine if your lab has a ventilation system appropriate for hazardous gas use before purchasing the gas.

*Cylinder Size*: Use lecture sphere or bottle size hazardous gas sources in a returnable cylinder when small volumes are needed. While the initial purchase cost per cubic foot may be lower when hazardous gases are purchased in full sized cylinders the overall cost of experimental setup which may require local ventilation, gas cabinets, stainless steel piping and purging systems may off set the apparent saving from buying hazardous gases in full sized cylinders

*Cylinder holders*: All compressed gas cylinders, regardless of size, must be properly secured. Use floor or bench clamps or secure gases to the wall with chains installed by Facilities. A single floor or bench clamp may not be used to secure multiple cylinders unless it is designed for multiple cylinder support.

*Regulators:*Gases from full sized gas cylinders must be dispensed using a two stage regulator that is both compatible with the gas and the intended use. The maximum pressure of the second stage of the regulator should be a low as is practical for the intended experimental work. Do not select or reuse existing regulators with very high second stage pressure ranges unless needed since this will require the entire experimental setup (tubing, connections) to be engineered to withstand high pressures.

*Flow control valves*: A mechanical flow control valve (needle valve) that is compatible and properly cleaned for the hazardous gas must be attached directly to the gas out port of the gas regulator. This is required even if other flow control devices are present in the experimental device. Flow control must not be attempted through use of the gas regulator.

*Flow restricting orifices*: Where feasible flow restricting devices must be installed after the regulator. Select the appropriate flow restricting orifice based on gas used and the flow rate required for the research.

*Tubing and piping*: Hazardous gases must be dispensed using systems that are properly cleaned and compatible with the gas in use. Bust pressure of tubing and piping must exceed the maximum pressure on the second stage regulator. Exceptions to this requirement may be made for short sections of tubing when it and the compressed gas cylinder are completely enclosed in a fume hood and low pressures and flow rates are used.

*Purge assembly*: Required for all hazardous gas systems that are not used in a fume hood or other ventilated enclosure. Purge assemblies must exhaust into a fume hood or other approved exhaust system. Exceptions may be made for laser systems that contain small quantities of hazardous gas that will be effectively filtered when exhausted. Exemptions must be approved by EHS.

*Vacuum pumps*: Hydrocarbon based vacuum pump oil is incompatible with strongly oxidizing and many reactive gases. New vacuum pumps that have inert lubricants such as DuPont Krytox and never contained oil-based lubricants must be used with oxidizing and reactive gases. Vacuum pumps must be securely vented to a fume hood or other approved exhaust system with tubing that is compatible with the gases used. Exhaust lines must be as short as feasible. Vented enclosures may be required for vacuum pumps depending on the toxicity of the gases used.

*Leak testing:* Hazardous gas systems must be leak tested using inert gas and leak detection solutions such as Snoop™ before use.

**Securing of gas cylinders**

Cylinders of compressed gases must be handled as high energy sources. When storing or moving a cylinder, have the cap securely in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders.

**Decontamination procedures**

**Personnel:** Wash hands and arms with soap and water immediately after handling acutely toxic gases.

**Designated area**

The room sign for the laboratory must contain a Designated Areas Within identifier where acutely toxic gases are used or stored.

All locations within the laboratory where acutely toxic gases are handled should be demarcated with designated area caution tape and/or posted with designated area caution signs. This includes all fume hoods and bench tops where the acutely toxic gases are handled.

**Emergency procedure**

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, should be developed by each laboratory. The procedures should address as a minimum the following:

* **Who to contact:** (Public Safety, Principal investigator/ course director of the laboratory including evening phone number and Office of Environmental Health and Safety)
* The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
* The method used to alert personnel in nearby areas of potential hazards
* Special first aid treatment required by the type of acutely toxic material(s) handled in the laboratory

**Fume hood**

Manipulation of acutely toxic and hazardous gases should typically be carried out in a fume hood. All areas where acutely toxic or hazardous gases are stored or manipulated must be labeled as a designated area.

**Glove (dry) box**

Some processes involving acutely toxic gases may be performed in a properly vented glove box rather than a fume hood.

**Hazard assessment**

Hazard assessment should focus on the education of employees concerning the health risk posed by hazardous gases, on proper use and handling procedures, the demarcation of designated areas, and emergency evacuation and notification procedures in the event of a spill.

**Protective apparel**

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling hazardous gases.

The Principal Investigator/course director is responsible to the select the appropriate PPE. The Office of Environmental Health and Safety is available to provide guidance.

**Eye protection**

Eye protection in the form of safety glasses must be worn at all times when handling acutely toxic or hazardous gases. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI/ISEA Z87.1-2010) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

**Gloves**

Gloves should be worn when handling hazardous gases. Disposable nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals.

**Safety shielding**

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of hazardous gases which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants are acceptable.

The Principal Investigator/course director is responsible to the select the appropriate shielding.

The Office of Environmental Health and Safety is available to provide guidance.

**Eyewash**

Where the eyes or body of any person may be exposed to acutely toxic gases or hazardous gas, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

**Safety shower**

A safety or drench shower should be available in a nearby location where the hazardous gases are used.

**Signs and labels**

* **Doorways:** The room sign must contain a Designated Area Within identifier where carcinogens, reproductive hazards, and/or acutely toxic chemicals are stored or used.
* **Containers:** All hazardous gas cylinders must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

**Special storage**

Acutely toxic gases must be stored in a designated area. Special ventilation of the stored cylinders is required and must be approved by the Office of Environmental Health and Safety.

Continuous monitoring devices which will alert staff of a release of the acutely toxic gas is required for certain gases.

The quantity of an acutely toxic and hazardous gas that may be stored in a laboratory will be determined on a case-by-case basis by the Office of Environmental Health and Safety.

See the end of this procedure for a safety alert pertaining to hydrogen fluoride gas cylinders.

**Special ventilation**

Manipulation of acutely toxic gases outside of a fume hood will require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to hazardous in the laboratory and are the preferred ventilation control device. Always attempt to handle hazardous gases in a fume hood. If your research does not permit the handing of hazardous gases in your fume hood you must contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

**Spill response**

In the event of an escape of gas alert personnel in the area that a spill has occurred. Do not attempt to handle a spill of acutely toxic or hazardous gases. Vacate the laboratory immediately and call for assistance.

* Public Safety 856-256-4911. This is a 24 hour service.
* Office of Environmental Health & Safety 856-256-5105 or EHS@Rowan.edu.

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

**Vacuum protection**

Not applicable

**Waste disposal**

All empty or partially filled hazardous gas cylinders should be returned to the supplier. If the supplier does not accept empty or partially filled cylinders, contact the Office of Environmental Health and Safety concerning disposal at 856-256-5105 or EHS@Rowan.edu.

A list of Acutely Toxic Gases is provided on the next page, as a guide. The list is not inclusive.

## Acutely Toxic Gases

This list is provided as a guide and is not all inclusive. Review the Safety Data Sheet.

| **Name** | **CAS#** | **Name** | **CAS#** |
| --- | --- | --- | --- |
| arsenic pentafluoride | 784-36-3 | oxygen difluoride | 7783-41-7 |
| arsine | 7784-42-1 | phosgene | 75-45-5 |
| boron trifluoride | 7637-07-2 | phosphine | 1498-40-4 |
| chlorine | 7782-50-5 | phosphorus pentafluoride | 7641-19-0 |
| diazomethane | 334-88-3 | selenium hexafluoride | 7783-79-1 |
| diborane | 19287-45-7 | silicon tetrafluoride | 7783-61-1 |
| fluorine | 7681-49-4 | stibine | 10025-91-9 |
| methyl mercaptan | 74-93-1 | sulfur tetrafluoride | 7783-60-0 |