General Use Standard Operating Procedures (SOP)

Acutely Toxic Gases

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*Globally Harmonized System (GHS) Hazard Class: Acute toxicity, inhalation*

*Examples: Nitric oxide, chlorine,* *Diborane fluorine, hydrogen cyanide, boron trifluoride, arsine, Phosphine*

**Note**: This SOP is intended to provide general guidance on how to safely work with acutely toxic gases and only addresses safety issues specific to acutely toxic gases. Other hazard classes may also apply. Review Safety Data Sheets (SDS) and refer to other general use SOPs relevant to the chemical you are working with. Contact the Principal Investigator/ Laboratory Supervisor or the WSU Chemical Hygiene Officer for questions concerning the applicability of any item listed in this SOP (OEHS: 313-577-1200).

**If the chemical of interest is a particularly hazardous substance or a high risk chemical a lab specific SOP is required.**

# Hazard Description

* Acutely toxic gases are gases which cause serious adverse health effects (i.e. lethality) following single or short term inhalation exposure.
* GHS and OSHA Hazard Communication Standard (HCS) classifies acutely toxic gasses in to four main categories as shown below based on the LC50 value. LC50 (Lethal concentration 50) is the concentrations of a chemical suspended in the air that kills 50% of the test animals during a predetermined observation period (typically a four-hour exposure.)

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| --- | --- | --- |
| LC50 | GHS category | GHS Hazard statement |
| < 100 ppm | 1 | Fatal if inhaled |
| >100 but < 500 ppm | 2 | Fatal if inhaled |
| >500 but ≤ 2500 ppm | 3 | Toxic if inhaled |
| >2500 but ≤ 20000 ppm | 4 | Harmful if inhaled |

* Acutely toxic gases belong to category 1 and 2 are particularly hazardous substances (PHS) and require a lab specific SOP. Category 01 acutely toxic gasses are high risk PHS and require WSU Chemical Safety Committee (CSC) approval prior to initiation of any research with those gases.
* Check the Safety Data Sheet (SDS) to determine if the gas is a toxic gas, to identify the corresponding hazard category and for additional hazard information.
* Some toxic gases will also be flammable, pyrophoric, or water reactive – in those cases, the SOPs for those physical hazards must also be followed.
* All purchased toxic gases will be supplied in compressed gas cylinders or lecture bottles. The SOP: Compressed Gases must also be followed.

# Control of Hazards - General

* Conduct a hazard assessment to identify proper use and handling techniques, fire safety, storage, and waste disposal issues specific to the chemical being used.
* Purchase toxic gases in the lowest concentration and in the smallest cylinder that makes sense for the lab.
* Purchase lecture sphere or bottle size hazardous gas sources in a returnable cylinder when small volumes are needed.
* Only trained personal shall connect the regulator and pressure gauge assembly to the cylinder.
* Inspect the gas cylinder and regulator prior to use. Never use gas cylinders or regulators that are damaged or corroded.
* Check connections and hoses regularly for leaks using a specific monitoring instrument or soapy water (or equivalent), using an inert gas prior to introducing the hazardous gas.
* Gas cylinders and lecture bottles of toxic corrosive gases (i.e. ammonia, chlorine, hydrogen chloride/bromide, nitrogen dioxide etc.) must be inspected regularly for signs of corrosion and degradation.
* Cylinders and lecture bottles that are damaged, defective or show signs of corrosion or bulging must be removed immediately from use, and returned to the vendor.
* Keep valve closed and valve cover in place when gas is not in use.
* Gas outlet must be inside chemical fume hood or other engineering control device.
* During transport, toxic gas cylinders should be well secured to the cart and NEVER left unattended.

# Engineering/Ventilation Controls

All components of a system connected to a compressed gas cylinder must be pressure-rated to withstand the maximum pressure capable of being delivered by the cylinder or the maximum output pressure of the regulator that is connected to the cylinder valve. Hazardous gases must be dispensed using systems that are properly cleaned and compatible with the gas in use (including tubing/piping).

The minimum acceptable engineering control for toxic gas use is a chemical fume hood. (One exception to this rule is diagnostic or therapeutic use of nitric oxide (NO), where the concentration of the gas *in the cylinder* is such that it does not pose a threat to human health.)

Depending on the amount, concentration, and other properties of the gas, some of the following controls may be required:

* Exhausted gas cabinets for cylinders and manifolds, possibly with air flow monitors and alarms
* Toxic gas sensors and alarms
* A two-stage regulator
* A mechanical flow control valve (needle valve)
* Restrictive flow orifices that limit the flow of gas
* A purge assembly for flushing of the regulator and delivery tubing with inert gas.
* Secure storage
* Gas trapping and scrubbing for exhaust

# Personal Protective Equipment

* Engineering controls will provide the primary means of minimizing employee exposure to toxic gases, but in some cases emergency respirators may be advised.

In addition to proper street clothing (long pants or equivalent that cover legs and ankles, close-toed non-perforated shoes that completely cover the feet), wear the following Personal Protective Equipment (PPE) when performing lab operations/tasks:

* Safety glasses
* Lab coat.
	+ Hazard assessment of procedures may indicate the need for a flame resistant lab coat, such as Nomex.
* Appropriate chemical‐resistant gloves.
* Refer to Section 8 “Exposure controls/personal protection” of SDS or a glove selection guide (e.g. [Ansell Chemical Protection Guide](https://www.ansellguardianpartner.com/chemical/home#hp)) to identify appropriate glove type.

# Special Handling Procedures and Storage Requirements

* Cylinders and lecture bottles shall be grouped by type of gas and the groups segregated as to compatibility.
* Lecture bottles must be stored on a stable surface in a well ventilated area.
* Never store in cold rooms.
* Cylinders (full or empty) shall be secured by chains, straps, lecture bottle stand/holder, or other sturdy tie-downs during storage and transport.
* Secured cylinders must be stored in a vertical, upright position in a well ventilated area.
* Lecture bottles, cylinders, gas lines and gas cabinets (if available in the lab) MUST be labeled clearly with the gas type and hazard warning.
* Gas lines should be marked with the direction of gas flow.
* Full cylinders shall be separated from empty cylinders within the storage area.
* Flammable toxic gases shall be separated from oxidizing and nonflammable toxic gases.
* **Do Not** store at temperatures above 125 °F or in direct sunlight, or outside of the temperature range specified by the manufacturer.
* Cylinders should not be stored next to doors, within corridors, or where exit from the building could be obstructed.
* Cylinder valves shall be kept closed when not in use.
* Removable caps shall be kept on cylinders at all times, except when cylinders are in use.
* Cylinders shall be protected against tampering and damage.
* Cylinders shall not be stored near combustible materials.
* Cylinders shall not be used or stored in cold rooms or other unventilated enclosures.
* NFPA 55 standard maximum allowable quantity per control area: highly toxic gas, 20 scf for gaseous (4lb for liquefied); toxic gas, 810 scf for gaseous (15lb liquefied).

# Decontamination Procedures

If safe to do so:

* Open windows.
* Turn on and open chemical fume hoods.
* Do not vent to the rest of the building.

# Waste Disposal

NEVER use chemical fume hoods to empty contents of a toxic gas cylinder or lecture bottle as a method of waste disposal.

The compressed gas cylinder, including any unused gas, will be returned to the vendor from which the cylinder was purchased.

Do not dispose of waste by dumping down a drain or discarding in regular trash containers, unless authorized in writing by OEHS. [Submit requests to OEHS](https://research.wayne.edu/oehs/forms/chem-waste) for waste containers, labels, and waste collection. Also, refer to the [OEHS Hazardous Waste Management web page](http://research.wayne.edu/oehs/hazardous/index.php) and [WSU Chemical Hygiene Plan](http://research.wayne.edu/oehs/pdf/chemical-hygiene-plan.pdf) for more information.

# Emergency Procedures

**\*\*If medical attention required, call WSU police (313-577-2222) immediately\*\***

* **Fire Extinguishers** – Refer to section 5 of the SDS for chemical specific firefighting measures. Both ABC dry powder and carbon dioxide extinguishers are appropriate for most fires.
* **Eyewash/Safety Showers** – Depending on the chemical hazard type, an ANSI approved eyewash station and safety shower may be required, easily accessed, and available within 10 seconds travel time for emergency use. Instruct personnel on the locations of eyewashes and safety showers, and how to activate them, prior to an emergency. Refer to [MIOSHA Fact Sheet: Eyewashes and Safety Showers](https://www.michigan.gov/documents/lara/lara_miosha_cet0199_628109_7.doc) to determine if an eyewash/safety shower is required for your specific chemical.

Please note: Additional hazards present in the laboratory may require that an eyewash or safety shower be present. This emergency equipment is required for treating exposures to workplace hazards such as chemical splashes, biological agents, welding sparks, metal shavings, or fine particulates like dust, dirt and sand.

1. **Health Threatening Emergencies**
	1. **Fire, explosion, health threatening hazardous material spill or release, compressed gas leak, or valve failure.**
		1. Call WSU Police (313) 577-2222.
		2. Alert people in the vicinity and activate the local alarm systems.
		3. Evacuate the area and go to your Emergency Assembly Point.
		4. Remain nearby to advise emergency responders.
		5. Once personal safety is established, call OEHS at (313) 577-1200.

Note: For compressed gas leaks, shut off gas supply only if this can be done safely, without risk to personnel.

* 1. **Injuries and Exposures:**
		1. Remove the injured/exposed individual from the area, unless it is unsafe to do so because of the medical condition of the victim or the potential hazard to rescuers.
		2. Call WSU Police (313) 577-2222.
		3. Administer first aid as appropriate.
			1. Eye contact: Promptly flush eyes with copious amounts of water for a prolonged period (at least 15 minutes). Seek medical attention.
			2. Ingestion: Seek medical attention IMMEDIATELY. See first aid section of chemical Safety Data Sheet.
			3. Skin contact: Remove any contaminated clothing. IMMEDIATELY flush contamination from skin using the nearest emergency shower for a minimum of 15 minutes. Seek medical attention.
			4. Inhalation: Get to a source of fresh air. Seek medical attention.
		4. Call OEHS (313) 577-1200, to report the exposure and complete [Report of Injury](https://risk.wayne.edu/files/rofi.pdf) form.
		5. Bring to the hospital copies of the Safety Data Sheets for all chemicals to which the victim was exposed.
1. **Non-Health Threatening Emergencies**
	1. **Injuries and Exposures**

For injuries and exposures that are not considered serious or a medical emergency, visit:

Henry Ford Occupational Health – Harbortown

3300 East Jefferson, Suite 100

Detroit MI 48207

(313) 656-1618

Monday – Friday 8:00 AM to 6:30 PM

If Henry Ford Occupational Health Center is closed or for serious injuries, visit:

Henry Ford Hospital – Emergency Room

2799 W. Grand Blvd.

Detroit MI 48202

(313) 916-8742

OR

Detroit Receiving Hospital - Emergency Room

4201 St. Antoine St, Detroit, MI 48201

Phone: (313) 745-3000

# Minimum Training Requirements

1. **General Training:**
* Online through the [Collaborative Institutional Training Initiative (CITI)](https://about.citiprogram.org/en/homepage/).
	+ Laboratory Safety Training (general lab & chemical safety issues) and Hazard Communication
* [Fire Safety](https://risk.wayne.edu/fire-safety).
1. **Laboratory Specific Safety Training:**
* [Laboratory-Specific Safety Training](https://research.wayne.edu/oehs/docs/lab-safety-training-checklist.doc) checklist
* Review of SDS for chemicals involved in process/experiment.
* Review of this SOP.
* Review [WSU Hazardous Waste Management](https://research.wayne.edu/oehs/hazardous/chemical-waste) guidelines.
* Other: \_\_\_\_\_\_\_\_\_

# Laboratory Personnel Review

Prior to initiating work, lab personnel using these types of chemicals must complete the table below confirming that they have read and understood the above SOP and the associated hazards.

| **Name** | **Signature** | **Date** |
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