Toxic Gases

Standard Operating Procedure

Revision Date: 11/29/23

Laboratory Director (LD) Approval is Required Prior to Performing this Procedure

This standard operating procedure (SOP) outlines the handling and use of toxic gases. Review this document and supply the information required in order to make it specific to your laboratory. In accordance with this document, laboratories should use appropriate controls and personal protective equipment when handling toxic gases.

All laboratory workers must read and understand the [Laboratory Emergencies SOP](https://ehs.umich.edu/wp-content/uploads/2022/05/LaboratoryEmergencyProceduresSOP.docx) prior to commencing any work in a laboratory.

# Description [Provide additional information as it pertains to your research protocol]

The National Fire Protection Association (NFPA) 55 Compressed Gases and Cryogenic Fluids Code defines the following:

A **toxic gas** is any gas that has a median lethal concentration (LC50) in air of more than 200 ppm but not more than 2000 ppm by volume of gas vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust.

A **highly toxic gas** is any gas that has a median lethal concentration (LC50) in air of 200 ppm or less by volume of gas vapor, or 2 mg/L or less of mist, fume, or dust.

**Carbon monoxide,** while not meeting the NFPA definitions for toxic gas or highly toxic gas, is subject to all requirements specified in this SOP and must be managed in the laboratory as a toxic gas.

## Process [Write the steps for using the chemical in your research protocol]

# Potential Hazards [Provide additional information as it pertains to your research protocol]

Check the Safety Data Sheet (SDS) of the gas for exposure limits and to determine inhalation hazards and for skin warnings to determine skin hazards. The SDS will also provide information on other hazards such as whether the gas is flammable, corrosive, etc.

All toxic gases will be supplied in compressed gas cylinders, and the [Compressed Gases SOP](https://ehs.umich.edu/research-clinical/chemical/) must be followed. Some toxic gases will also be flammable, pyrophoric, corrosive, or water reactive. In those cases the SOP for those physical hazards must also be followed.

# Engineering Controls [Provide additional information as it pertains to your research protocol]

All gas cylinders, greater than lecture bottle size, containing toxic gas, highly toxic gas, or carbon monoxide located in a laboratory unit shall comply with the following as a minimum:

* Keep cylinders in approved continuously mechanically ventilated gas cabinets.
* Equip with a continuous gas detection system. The gas detection system shall monitor the exhaust system at the point of discharge from the gas cabinet.
* The gas detection system shall initiate a local alarm that is both visible and audible.

Any use of Toxic Gas in quantities above U-M Maximum Allowable quantities (refer to the Environment, Health & Safety (EHS) [Compressed Gas Use Program](https://ehs.umich.edu/wp-content/uploads/2016/03/Compressed_Gas_Use.pdf)) in any size cylinder may be required to have the following upon consultation with your EHS representative:

* Continuously mechanically ventilated gas cabinets to house cylinders.
* A continuous gas detection system. (Note: Gas detection may not be required where the physiological warning properties for the gas are at a level below the accepted permissible exposure level or ceiling limit of the gas.)
  + The gas detection system shall:
    - Detect the presence of gas at or below the MIOSHA permissible exposure level or ceiling limit of the gas.
    - Initiate a local alarm that is both visible and audible.
    - Transmit a signal to a constantly attended control station.
  + Activation of the gas detection system shall automatically shut off the flow of gas related to the system being monitored.
* Emergency power for the exhaust ventilation, gas detection system and alarm systems when required.
* Treatment systems for the exhaust.
* Sprinkler protection for gas cabinets and other protective features.

Contact EHS at (734) 647-1143 to request an evaluation to determine what controls may be necessary.

**Lecture bottles** containing toxic gas, highly toxic gas, or carbon monoxide must be kept in a continuously mechanically exhausted ventilated hood (fume hood) or other continuously mechanically exhausted ventilated enclosure.

# Work Practice Controls [Provide additional information as it pertains to your research protocol]

* In addition to the EHS [Compressed Gas Use Program](https://ehs.umich.edu/wp-content/uploads/2016/03/Compressed_Gas_Use.pdf), review the additional requirements for toxic, pyrophoric and flammable gases.
* Purchase toxic gases in the lowest concentration and in the smallest cylinder that makes sense for the lab.
* All purchases of toxic, highly toxic, or carbon monoxide gas cylinders greater than lecture bottle size must be approved by EHS via the [Restricted Hazardous Gases Form](https://docs.google.com/forms/d/e/1FAIpQLSflBGaF3LedmhouKl3Hd4_JGCd6nX-bk_ZYDfDEuqDvjLw2-A/viewform?vc=0&c=0&w=1).
* Check all fittings for leaks.
* Keep valve closed and valve cover in place when gas is not in use.
* All compressed gas cylinders shall be legibly marked by stenciling or stamping with at least the chemical name or commonly accepted name of the material contained. In addition, cylinders should bear the approved markings of the Department of Transportation stamped in the metal at the top of the cylinder.

# Personal Protective Equipment [Provide additional information as it pertains to your research protocol]

Engineering controls will provide the primary means of minimizing employee exposure to toxic gases. Other PPE may be necessary during cylinder change out for gases that are also corrosive or pyrophoric. Contact EHS at (734) 647-1143 for an evaluation. As with all lab work, wear a fully buttoned lab coat, safety glasses, standard nitrile laboratory gloves, clothing covering the legs, and closed-toed shoes.

# Transportation and Storage [Provide additional information as it pertains to your research protocol]

* Cylinders (full or empty) shall be secured by chains, straps, or other sturdy tiedowns during storage and transport.
* Cylinders shall be grouped by type of gas and the groups segregated as to compatibility.
* Full cylinders shall be separated from empty cylinders within the storage area.
* A “Just in Time” delivery system should be utilized to minimize quantities on hand.
* Flammable gases shall be separated from oxidizing gases by 20 feet when in storage.
* Cylinders shall not be stored at temperatures above 125 °F or in direct sunlight, or outside of the temperature range specified by the manufacturer.
* 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 refilled, other than by the gas vendor.
* Cylinders shall not be used or stored in cold rooms or other unventilated enclosures.

# Waste Disposal [Provide additional information as it pertains to your research protocol]

The compressed gas cylinder, including any unused gas, must be returned to the vendor from which the cylinder was purchased. Contact EHS Hazardous Materials Management (HMM) at (734) 763-4568 to arrange for the removal of lecture bottles that cannot be returned to the supplier.

When a lecture bottle is empty, write “empty” on the outside of each cylinder and place in a cardboard container and attach a completed hazardous waste manifest.

# Release Procedure

* When a release occurs, personal safety should always come first.
* Alert and clear everyone in the immediate area where the release occurred.

For any release of uncontained gas:

* Attend to injured or contaminated persons and remove them from exposure.
* Alert people in the laboratory to evacuate.
* If the gas is flammable, turn off ignition and heat sources if appropriate. Don’t light Bunsen burners or turn on other switches.
* **Call University of Michigan Division of Public Safety and Security (DPSS) at 911 immediately for assistance.**
* Close doors to affected area.
* Post warnings to keep people from entering the area.
* Have person available that has knowledge of incident and laboratory to assist emergency personnel.

# Emergency Reporting

Report all emergencies, suspicious activity, injuries, spills, and fires to the University of Michigan Police (DPSS) by calling 911 or texting 377911. Register with the [University of Michigan Emergency Alert System](http://dpss.umich.edu/emergency-management/alert/) via Wolverine Access.

# Training of Personnel

All personnel shall read and fully adhere to this SOP when handling any toxic gas.

# Certification

I have read and understand the above SOP. I have received prior approval from my Lab Director to perform this procedure. I agree to contact my Lab Director if I plan to modify this procedure.

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### Major Revisions (Tracking purposes only -- Do not print as part of SOP)

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| Date | Revision |
| 03-26-2018 | Put into EHS format, changed department name, and fixed links. Revised Spill Procedure section (AKJ). |
| 04-09-18 | Revised formatting (AKJ). |
| 05-02-18 | Changes per meeting with Jon (AKJ). |
| 05-15-20 | Updated editing rights to headings (RSH) |
| 05-16-22 | Updated links (LGS) |
| 11-29-23 | Reviewed content. Updated language to match current code and CGU guideline (JMW) |