

2. HAZARDOUS CHEMICAL(S)/CLASS OF HAZARDOUS CHEMICAL(S)

Acutely Toxic Gases (ATG) are gases that may cause significant acute health effects at low concentrations. Health effects may include severe skin or eye irritation, pulmonary edema, neurotoxicity, or other potentially fatal conditions. Under the California Fire Code, both “Highly Toxic” and “Toxic” gases are treated similarly with regard to use and storage. As such, for the purposes of this control-banded SOP, ATGs are defined as:

“A chemical that has a median lethal concentration (LC₅₀) in air of 2000 parts per million by volume or less of gas or vapor, or 20 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within **1 hour**) to albino rats weighing between 200 and 300 grams each.”

Applicable ATGs in this control-banded SOP are identified using the Globally Harmonized System Hazard Code H330 (Fatal if inhaled). Some additional gases with a H331 Hazard Code (Toxic if inhaled) are also applicable, but note that the GHS system classifies gases based on a 4 hour LC₅₀ concentration. One can calculate a 1-hour Acute Toxicity Equivalent (ATE) value by multiplying a 4-hour LC₅₀ value by 2 for gases and vapors, or by 4 for dusts and mists. Some examples of ATGs used at the UC Davis campus include, but are not limited to, the following:

1. Chlorine (CAS – 7782-50-5)
2. Hydrogen Sulfide (CAS = 7783-06-4)
3. Methyl Mercaptan (CAS = 74-93-1)
4. Methyl Bromide (CAS = 74-83-9)
5. Nitric Oxide (CAS = 10102-43-9)
6. Nitrogen Dioxide (CAS = 10102-44-0)
7. Phosphine (CAS = 7803-51-2)

There are additional gases, with 1-hour LC₅₀ values greater than 2000 ppmv that may need to be treated as ATGs. This would include gases with very low Immediately Dangerous to Life and Health (IDLH) values or have corrosive properties. Some examples of such materials include:

1. Anhydrous Ammonia (CAS = 7664-41-7)
2. Carbon Monoxide (CAS = 630-08-0)
3. Hydrogen Bromide (CAS = 10035-10-6)
4. Hydrogen Chloride (CAS = 7647-01-0)
5. Sulfur Dioxide (CAS = 7446-09-5)

Whether a material should be treated as an ATG can be influenced by a number of factors (*e.g.*, quantity, ventilation, procedure, etc.). Contact the Chemical Hygiene Officer or chem-safety@ucdavis.edu for assistance in assessing your materials.

REQUIRED - List (or attach) the applicable chemical(s) for your laboratory, and describe important properties and signs/symptoms of exposure.

3. ENGINEERING/VENTILATION CONTROLS

Use a properly functioning, certified chemical fume hood when using ATGs. Contact the Chemical Hygiene Officer or chem-safety@ucdavis.edu to review the adequacy of available ventilation options if you are unable to use ATGs within a chemical fume hood. Regulators, valves, and piping used to transport ATGs must be made of compatible materials capable of withstanding the operating pressures. Piping shall have welded, threaded, or flanged connections throughout except for

connections located within an exhausted enclosure. The piping system shall be leak-checked with an inert gas prior to being used for delivery of an ATG. Corrosive gas lines must be purged with dry high-purity gases prior to introducing the gas. ATG piping should be labeled with the contents and direction of flow, including both sides of any wall penetration.

Indoor storage of ATGs must be within a gas cabinet or an exhausted enclosure (*e.g.*, chemical fume hood). The number of cylinders located within an exhausted enclosure is limited to three. Cylinders must be segregated from incompatible materials. Quantities of Highly Toxic Gases (H330) may not exceed 20 cubic feet (ft³) at normal temperature and pressure (NTP), and Toxic Gases (H331) may not exceed 810 ft³ at NTP. If you require greater quantities, you must contact the Chemical Hygiene Officer or chem-safety@ucdavis.edu for consultation on additional storage/use requirements.

The chemical fume hood for ATG storage or use must not be the sole exhaust for the room or area (*e.g.*, the room must contain an additional fume hood or general exhaust). A monitoring device is required on exhausted enclosures used for ATG storage, such as audible and visual alarms, magnehelic gauge, or other devices that indicate the enclosure is actively ventilated. These devices must be clearly marked to indicate safe pressure limits or minimum air flow requirements.

Electronic toxic gas monitors with alarms should be installed and continuously operated wherever a toxic gas is used in a high concentration, large quantity, and/or has poor physiological warning properties (lack of odor or immediate irritation). A monitoring system is required for continuous operations, and may be needed on a case-by-case basis for long-term research situations.

REQUIRED - Insert descriptions of lab-specific ventilation controls and equipment safety features utilized to reduce the risk of ATG chemical exposures.

4. ADMINISTRATIVE CONTROLS

The following elements are required:

1. Complete the [UC Laboratory Safety Fundamentals](#) (or approved equivalent) training prior to working in the laboratory;
2. Complete laboratory-specific safety orientation and training on laboratory-specific safety equipment, procedures, and techniques to be used, including any applicable laboratory-specific Laboratory Safety Plan(s), prior to receiving unescorted access to the laboratory;
3. Demonstrate competency to perform the procedures to the Principal Investigator (PI), Laboratory Supervisor, laboratory-specific Safety Officer, and/or trainer;
4. Be familiar with the location and content of any applicable Safety Data Sheets (SDSs) for the chemicals to be used (online SDSs can be accessed from [UC SDS](#));
5. Implement good laboratory practices, including good workspace hygiene;
6. Inspect all equipment and experimental setups prior to use;
7. Follow best practices for the movement, handling, and storage of hazardous chemicals (see Chapters 5 and 6 of [Prudent Practices in the Laboratory](#) for more detail). An appropriate spill cleanup kit must be located in the laboratory. Chemical and hazardous waste storage must follow an appropriate segregation scheme and include appropriate labeling. Hazardous chemical waste must be properly labelled, stored in closed containers, in secondary containment, and in a designated location;
8. Do not deviate from the instructions described in this SOP without prior discussion and approval from the PI and/or Laboratory Supervisor; and

9. Notify the PI and/or Laboratory Supervisor of any accidents, incidents, near-misses, or upset condition (*e.g.*, unexpected rise or drop in temperature, color or phase change, evolution of gas) involving the ATGs described in this SOP.

For ATGs, the following are also required:

10. **DO NOT** use ATGs while alone in the laboratory. At least one other person knowledgeable and proficient with emergency protocols must be present in the same laboratory room when any work involving ATGs is undertaken;
11. Adhere to the general guidance for compressed gases in [SafetyNet #60 - Compressed Gas Safety](#) and adequately secure all cylinders, including lecture bottles, for seismic activity;
12. Rooms and storage areas containing ATGs must be locked at all times when unoccupied or unattended;
13. Outdoor storage is allowed on a short-term basis and must be located at least 75 feet from an exterior door, window, or air intake; and
14. ATGs shall only be purchased from vendors which accept returns of unused materials.

REQUIRED - Insert descriptions of any additional administrative controls (*e.g.*, restrictions on procedure/quantity/work equipment/work locations/unattended operations/etc.), including controls that may be chemical-specific (*e.g.*, peroxide formers).

5. PERSONAL PROTECTIVE EQUIPMENT (PPE)

At a minimum, long pants (covered legs) and closed toe/closed heel shoes (covered feet) are required to enter a laboratory or technical area where hazardous chemicals are used or stored.

In addition to the minimum attire required upon entering a laboratory, the following PPE is required for work with ATGs:

- A. Eye Protection: Eye protection is required for all work with compressed gases, including ATGs.
 - i. At a minimum ANSI Z87.1-compliant safety glasses are necessary.
 - ii. Splash goggles may be substituted for safety glasses, and are required for processes where splashes are foreseeable or when generating aerosols.
 - iii. Ordinary prescription glasses will NOT provide adequate protection unless they also meet the Z87.1 standard and have compliant side shields.
- B. Body Protection: At a minimum a chemically-compatible laboratory coat that fully extends to the wrist is necessary.
 - i. If a risk of fire exists, a flame-resistant laboratory coat that is NFPA 2112-compliant should be worn.
 - ii. For chemicals that are corrosive and/or toxic by skin contact/absorption additional protective clothing (*e.g.*, face shield, chemically-resistant apron, disposable sleeves, etc.) are required where splashes or skin contact is foreseeable.
- C. Hand Protection: When hand protection is needed for the activities described in this SOP define the type of glove to be used based on: A) the chemical(s) being used, B) the anticipated chemical contact (*e.g.*, incidental, immersion, etc.), C) the manufacturers' permeation/compatibility data, and D) whether a combination of different gloves is needed for any specific procedural step or task.

REQUIRED - Insert descriptions of PPE and hygiene practices used with each process, hazardous chemical(s), or hazardous chemical class, including any specialized PPE needed for a procedural step/task.

6. SPILL AND EMERGENCY PROCEDURES

Follow the guidance for chemical spill cleanup from [SafetyNet #13](#) and/or the [UC Davis Laboratory Safety Manual](#), unless specialized cleanup procedures are described below. Emergency procedure instructions for the UC Davis campus and UCD Medical Center are contained in the [UC Davis Laboratory Safety Manual](#), [campus Emergency Response Guide \(ERG\)](#), and [UCD Health System ERG](#). The applicable ERG must be posted in the laboratory. All other locations must describe detailed emergency procedure instructions below.

An emergency is any actual or potential release of an ATG that cannot be stopped by closing the product's cylinder or container valve. In the event of an emergency, evacuate all personnel from the building, which may be accomplished by pulling the fire alarm. Call 911 to dispatch emergency responders.

REQUIRED - Insert descriptions of laboratory-specific procedures for handling small ATG leaks, which includes a lab-specific definition of a small leak.

INSERT IF APPLICABLE - Descriptions of any specialized emergency procedures for locations outside of the UC Davis main campus and the UCD Medical Center campus.

7. WASTE MANAGEMENT AND DECONTAMINATION

Hazardous waste must be managed according to [Safety Net #8](#), and must be [properly labeled](#). In general, hazardous waste must be removed from your laboratory within 9 months of the accumulation start date; refer to the [accumulation time for waste disposal to ensure compliance](#). Hazardous waste pick up requests must be completed using [WASTE](#).

Note: See the [WASTE Factsheet](#) for instructions on how to complete a label.

All empty toxic gas cylinders shall be labeled as "empty." Depleted toxic gas cylinders should be returned to the vendor according to their guidelines. Purchase of any gases that will not be completely used in the course of research must be approved by the vendor for return, or by EH&S for disposal as hazardous waste. Disposal of toxic gas cylinders by EH&S, even when empty, may entail high costs (up to thousands of dollars).

REQUIRED - Insert descriptions of laboratory-specific information on the waste streams generated, storage location, and any special handling/storage requirements.

REQUIRED - Insert descriptions of decontamination procedures for equipment, glassware, and controlled areas (*e.g.*, glove boxes, restricted access hoods, perchloric/hot acid fume hoods, or designated portions of the laboratory).

Upon completion of work with ATGs and/or decontamination of equipment, remove gloves and/or PPE to wash hands and arms with soap and water. Additionally, upon leaving a designated ATG work area remove all PPE worn and wash hands, forearms, face and neck as needed. Contaminated clothing or PPE should not be worn outside the lab. Soiled lab coats should be sent for professional laundering. Grossly contaminated clothing/PPE and disposable gloves must not be reused.

8. DESIGNATED AREA

Designated area(s) for the use and storage of ATGs shall be established where limited access, special procedures, knowledge, and work skills are required. Signage indicating the materials being used and/or stored and the applicable hazards should be easily visible for the designated work space and/or storage area, for example: DANGER! ACUTELY TOXIC GAS WORK AREA!

REQUIRED - Insert description(s) of the designated area(s) for your laboratory, which is required for ATGs. The entire laboratory, a portion of the laboratory, a fume hood, etc. can be designated.

9. DETAILED PROTOCOL

REQUIRED - Insert or attach detailed laboratory-specific procedures for the process, hazardous chemical(s), or hazard class. You may also include any relevant supporting resources such as SafetyNets, journal citations, etc. that are applicable.

