

Chemical Hygiene and Laboratory Safety Plan

NBIC Labs

Rooms 014-020 Singh Center

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Compressed Gases

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any item listed in this procedure contact the Office of Environmental Health and Radiation Safety (898-4453) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Radiation Safety is available to provide guidance during the development of alternate procedures.

Additional requirements may apply if the materials is an acutely toxic compressed gas. Please refer to the SOP for acutely toxic gases if applicable.

Securing of gas cylinders

Cylinders of compressed gases must be handled as high energy sources. They pose a serious hazard if the cylinder valve is dislodged. 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.

Do not store cylinders or lecture bottles with the regulator in place. If the regulator fails, the entire contents of the gas cylinder may be discharged.

Designated area

Compressed gas cylinders which contain acutely toxic gases must be stored in a designated area. See the SOP for acutely toxic compressed gases.

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptoms of overexposure must be developed. The procedures should address as a minimum the following:

Whom to contact (University police, and Office of Environmental Health and Radiation Safety, Principal investigator of the laboratory including evening phone number)

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 compressed gas handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling compressed 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 Z.87. 1 1989) and must be equipped with side shields.

Fume hood

Manipulation of compressed gases should typically be carried out in a fume hood if the compressed gas is an irritant, oxidizer, asphyxiant, or has other hazardous properties.

Hazard assessment

Hazard assessment for work with compressed gases should assure that all staff understand proper use and handling precautions; that all pressurized equipment is properly shielded; regulators are not interchanged between different gas types; all hose connections are properly secured and are appropriate for the pressure(s) used.

Protective apparel

Wear lab coats, closed toed shoes, and long sleeved clothing when handling compressed gases.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of compressed 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.

Signs and labels

All compressed gases must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; **chemical formulas and structural formulas are not acceptable**. The compressed gas cylinder should be labeled to indicate if the container is full or empty.

Special storage

Cylinders should be stored in an upright position and secured to a wall or laboratory bench through the use of chains or straps. Cylinder caps should remain on the cylinder at all times unless a regulator is in place. Cylinders should be stored in areas where they will not become overheated. Avoid storage near radiators, areas in direct sunlight, steam pipes and heat releasing equipment such as sterilizers.

Transport compressed gas cylinders on equipment designed for this function. Never carry or "walk" cylinders by hand.

Special ventilation

Manipulation of compressed gas that is an irritant, oxidizer, asphyxiant, or has other hazardous properties outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to compressed gases in the laboratory and are the preferred ventilation control device. If you have questions contact the Office of Environmental Health and Radiation Safety to review the adequacy of all special ventilation.

Spill response

In the event of a spill of a compressed gas that is an irritant, oxidizer, asphyxiant, or has other hazardous properties all personnel in the area should be alerted. Vacate the laboratory immediately and call for assistance.

- Office of Environmental Health & Radiation Safety, 898-4453
- University Police 511 or 573-3333. This is a 24 hour service.

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

Waste disposal

All empty or partially filled compressed 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 Radiation Safety concerning disposal.

Corrosive Chemicals

Corrosive chemicals are substances that cause visible destruction or permanent changes in human skin tissue at the site of contact, or are highly corrosive to steel. The major classes of corrosives include strong acids, bases, and dehydrating agents.

Decontamination procedures

Personnel: Immediately flush contaminated area with copious amounts of water after contact with corrosive materials. Remove any jewelry to facilitate removal of chemicals. If a delayed response is noted report immediately for medical attention. Be prepared to detail what chemicals were involved.

If the incident involves **Hydrofluoric acid (HF)**, seek immediate medical attention.

If there is any doubt about the severity of the injury, seek immediate medical attention.

Area decontamination procedures vary depending on the material being handled. The corrosivity of some materials can be neutralized with other reagents. Special neutralizing agents should be on hand.

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed. The procedures should address as a minimum the following:

Whom to contact: (University police, and Office of Environmental Health and Radiation Safety, Principal investigator of the laboratory including evening phone number).

The location of all safety equipment (showers, clean-up supplies, 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 corrosive material(s) handled in the laboratory.

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling corrosive materials. Ordinary prescription glasses do not provide adequate protection. Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) 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. It is recommended that face shields be worn when a splash potential exists with corrosive materials.

Eyewash

Where the eyes or body of any person may be exposed to corrosive chemicals, 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.

Fume hood

Manipulation of corrosive substances should be carried out in a fume hood if corrosive vapor production is anticipated.

Gloves

Gloves should be worn when handling corrosive chemicals. Disposable nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact EHRS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Assessment should include instruction on proper use and handling, spill control, and splash protection.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling corrosive materials. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of corrosive materials 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.

Safety shower

A safety or drench shower should be available in a nearby location where the corrosive materials is used.

Signs and labels

All corrosive chemical must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Segregate the various types of corrosives. Separate acids and bases. Liquids and solids should also be separated. Specially designed corrosion resistant cabinets should be used for the storage of large quantities of corrosive materials. Store corrosives on plastic trays. Do not store corrosive materials on high cabinets or shelves.

Special ventilation

Manipulation of some corrosive materials outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to corrosive materials in the laboratory and are the preferred ventilation control device.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the

use of any corrosive chemical. Corrosive spill controls neutralize the hazardous nature of the spilled material. Acids and bases require different types of spill control materials. In the event of a spill all personnel in the area should be alerted.. Do not attempt to handle a large spill of corrosive materials. Vacate the laboratory immediately and call for assistance.

- Office of Environmental Health & Radiation Safety, 898-4453
- University Police 511 or 573-3333. This is a 24 hour service.

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

Waste disposal

Most corrosive materials are hazardous wastes. Questions regarding waste disposal should be directed to the Office of Environmental Health and Radiation Safety.

Electrical Safety in Laboratories

Extension Cords

Use extension cords for temporary (less than three months) use. Situations that require extension cords for greater than three months are considered permanent installations and must be addressed through upgrades to building wiring systems. Extension cords should be no less than 16 gauge.

Do not place extension cords in foot traffic areas or under equipment. Length shall be the minimum required for the specific application but shall not exceed 15 feet. Ground wires are required for all extension cords (i.e., the cord should have three prongs).

Single Conductor Wires

Single conductors shall not conduct greater than 24 volts. Code single conductors red or black and keep them as short as possible. Single conductors shall be a single continuous length of wire unless spliced or joined in a grounded electrical box that provides appropriate strain-relief. Wire nut or other connections that are not housed in a grounded electrical box are not permitted.

Terminal Connections

All electrical connections at the supply end (bus bars) for 24 volt or greater services shall have strain relief and be enclosed. Label the enclosure with the voltage.

Plug style connections are permitted if the conductor is fully insulated and the conducting wire is not exposed when disconnected.

When possible enclose electrical connections in a protective housing. Insulate high temperature (>180°C) connections, such as furnaces, with 3M 69 Class "H" glass cloth tape (call Chemistry department or LRSM stockrooms for availability).

Flammable and Combustible Liquids

The flashpoint of a flammable liquid is the lowest temperature at which it can form an ignitable mixture with air and produce a flame when a source of ignition is present. Flammable liquids are chemicals that have a flash point below 100°F (38.7°C) and a vapor pressure that does not exceed 40 psi at 100°F.

Flammable liquids are commonly divided into three classes

Class	Flash Point	Boiling Point	Example
IA	<73°F	<100 °F	Ethyl, Ether
IB	<73°F	≥100 °F	Acetone, Benzene, Toluene
IC	73–100°F	≥100 °F	Hydrazine and Styrene

Combustible liquids are divided into three classes

Class	Flash Point	Example
II	100-139°F	Acetic acid, naphtha and stoddard solvent
IIIA	140-199°F	Cyclohexanol, formic acid and nitrobenzene
IIIB	≥200°F	Formalin and picric acid

Before you begin

- Abnormally large-scale use may require evaluation. Contact EHRS at 898-4453 for assistance.
- Training requirements based on job duties and responsibilities are determined via Penn Profiler.
- Flammable liquids users should have taken an Introduction to Laboratory Safety course as well as any required annual updates.
- Most introductory programs are offered monthly. Dates are published in the Almanac and on the EHRS website. Annual updates of these programs can be completed online. For more information on these programs or to request a training program on safety or health topics for your department, please contact Valerie Perez at 215-746-6652 or email traininghelp@ehrs.upenn.edu
- A hazard assessment for work involving flammable liquids must thoroughly address the issues of proper use and handling, fire safety, chemical toxicity, storage, and spill response.
- A hazard assessment must be conducted when a process/reaction/work-up/or purification is changed or when scaling-up any flammable liquids use to more than 10 times the original volume.
- The first time a highly flammable solvent such as diethyl ether or hexane is used for a process, a hazard assessment should be conducted.

Setting-up

- One or more Flammable Liquid Storage Cabinets (FLSC) are required for laboratories which store, use or handle more than 5 gallons of flammable or combustible liquids.
- The storage of flammable and combustible liquids in a laboratory, shop, or building area must be kept to the minimum needed for research and/or operations. FLSC are not intended for the storage of highly toxic materials, acids, bases, compressed gases or pyrophoric chemicals.
- In most university laboratories flammable liquids storage is provided under the chemical fume hood. These cabinets are clearly marked “Flammable Storage.”
- Flammable liquids storage cabinets are constructed to limit the internal temperature when exposed to fire. When additional storage is needed, NFPA 30-4.3.3 approved flammable liquids storage cabinet

(FLSC) may be purchased. All flammable liquids must be stored in a FLSC when not in use.

The following requirements apply:

- Cabinets shall be no larger than 45 gallon capacity.
- Cabinets should be located near fume hood alcoves.
- Cabinets shall be marked “Flammable-Keep Fire Away.”
- Doors that do not close and latch must be repaired or the cabinet must be replaced.
- Free standing cabinets may be vented into the fume hood exhaust system or a dedicated system for hazardous materials exhaust if present. Replacement air shall be ducted into the cabinet in such a way as not to compromise the specified performance of the cabinet. Venting details shall be submitted to EHRS and University Engineer for approval.
- Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of flammable liquids 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.
- Manipulation of flammable liquids outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to flammable liquids in the laboratory and are the preferred ventilation control device. Always attempt to handle quantities of flammable liquids greater than 500 mL in a fume hood. If your research does not permit the handling of large quantities of flammable liquids in your fume hood, contact the EHRS to review the adequacy of all special ventilation.
- Vacuum work involving flammable liquids must be conducted in a fume hood, glove box or isolated in an acceptable manner. Evacuated glassware can implode and eject flying glass, and chemicals. Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood. Vacuum pumps should be rated for use with flammable liquids.

Personal protection

- Splash-proof goggles in addition to standard laboratory personal protective equipment (PPE) consisting of a 100% cotton lab coat, closed toe shoes and nitrile gloves must be worn when there is a significant risk of splash. Pouring very large volumes may require additional PPE consisting of thicker gloves and an apron.
- Safety glasses must be worn at all times when handling flammable liquids. Ordinary prescription glasses do not provide adequate protection. Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for a splash hazard exists other eye protection and/or face protection must be worn.
- Gloves should be worn when handling flammable liquids. Disposable nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact EHRS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.
- Additional protective clothing should be worn if the possibility of skin contact is likely. Nomex (fire resistant) lab coats and nomex/leather gloves are available for extra protection during higher hazard flammable liquids handling procedures.
- A safety shower should be available within 10 seconds of travel from where the flammable liquids are used.
- Where the eyes or body of any person may be exposed to flammable liquids, 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.

- Eyewashes must be activated weekly by laboratory workers to ensure proper function of equipment and to flush the plumbing.

Carrying out your work

- Safety cans do not offer protection from heat when exposed to fire and should be stored in a flammable liquids storage cabinet when not in use.
- All flammable liquids must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.
- The label on any containers of flammable liquids should say “Flammable” and include any other hazard information, such as “Corrosive” or “Toxic,” as applicable.
- Do not store flammable liquids in chemical fume hoods or allow containers of flammable liquids in proximity to heating mantles, hot plates, or torches.
- With the exception of vacuum drying ovens, laboratory ovens rarely have any means of preventing the discharge of material volatilized within them. Thus it should be assumed that these substances will escape into the laboratory atmosphere, but may also be present in sufficient concentration to form explosive mixtures within the oven itself. Venting the oven to an exhausted system will reduce this hazard.
- Drying ovens should not be used to dry glassware that has been rinsed with organic solvents until the majority of the solvent has had the opportunity to drain or evaporate at room temperature.
- Do not use mercury thermometers to monitor oven temperatures.

Cleaning-up

- Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any flammable liquids. Spill supplies for flammable liquids are designed to control the liquid portion of the spill and minimize the production of flammable vapors. Never use paper towels on large spills of flammable liquids because it exacerbates vapor production.
- In the event of a spill all personnel in the area should be alerted. Turn off all sources of ignition.
- Flammable liquids are hazardous wastes. Direct questions regarding waste disposal to EHRS.

Spills

- Wash with soap and water immediately following any skin contact with flammable liquids.
- Do not attempt to handle a large spill of flammable liquids. Vacate the laboratory immediately and call for assistance.

—Office of Environmental Health & Radiation Safety, 215-898-4453

—University Police 511 or 215-573-3333. This is a 24 hour service.

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

Fires

- Pull the fire alarm.
- Turn out the lights and close your laboratory door when everyone is out
- Evacuate the building

- Call 511 from a university phone or 215-573-3333 from a safe location to contact Penn Police
- Make yourself available to give emergency responders information as needed.