Chemical Hygiene Plan

for the Monmouth University Science Laboratories

Revised June 25, 2012

This Chemical Hygiene Plan (CHP) is intended to:

1. Inform laboratory employees of the required safety rules and procedures established by Monmouth University to meet the requirements of the federal Occupational Health and Safety Administration (OSHA) regulation, Occupational Exposures to Hazardous Chemicals in the Laboratory (29CFR1910.1450)

2. Inform laboratory employees of the potential health and safety hazards present in their workplace.

3. Inform laboratory employees of the precautions and preventive measures that have been established by Monmouth University to protect employees from a workplace illness or injury.

The Chemical Hygiene Plan will be available for review upon request to all employees and is available to all laboratory workers at all times.
Copies of the plan will be located in the following areas:

- Office of Compliance (Wilson Hall)
- Biology Department (Edison Science)
- Chemistry, Medical Technology & Physics Department (Edison Science)
- http://www.monmouth.edu/resources/HR/compliance/default.asp

Chemical Hygiene Plan

Monmouth University Science Laboratories

ATTACHMENTS

SECTION 1: STANDARD OPERATING PROCEDURES

General Guidelines: In addition to the specific laboratory standard operating procedures, the following general requirements are mandatory at all times:

Carefully read the label before using a chemical. The manufacturer's or supplier's Safety Data Sheet (SDS) will provide special handling information. Be aware of the potential hazards existing in the laboratory and the appropriate safety precautions.
Know the location and proper use of emergency equipment, the appropriate procedures for responding to emergencies, and the proper methods for storage, transport and disposal of chemicals within the facility.

Do's and Don'ts of the Laboratory

1. Do not work alone in the laboratory without expressed permission.
2. Label all secondary chemical containers with appropriate identification and hazard information.
3. Use only those chemicals for which you have the appropriate exposure controls (such as a chemical fume hood) and administrative programs/procedures (training, restricted access, etc.).
4. Always use adequate ventilation with chemicals. Operations using large quantities (500 milliliters) of volatile substances having workplace standards (Permissible Exposure Limits) at or below 50 ppm should be performed in a chemical fume hood.
5. Use hazardous chemicals and all laboratory equipment only as directed or for their intended purpose.
6. Inspect equipment or apparatus for damage before adding a hazardous chemical. Do not use damaged equipment.
7. Inspect personal protective apparel and equipment for integrity or proper functioning before use.
8. Malfunctioning laboratory equipment (hood) should be labeled or tagged "out of service" so that others will not inadvertently use it before repairs are made.
9. Do not dispense more of a hazardous chemical than is needed for immediate use.

Personal Hygiene Measures

1. Remove contaminated clothing and gloves before leaving laboratory.
2. Avoid direct contact with any chemical. Keep chemicals off your hands, face and clothing, including shoes.
3. Never smell, inhale or taste a hazardous chemical. Wash thoroughly with soap and water after handling any chemical.
4. Smoking, drinking, eating and the application of cosmetics is forbidden in laboratories where hazardous chemicals are used. (See University Policy on Eating, Drinking, and Smoking in the Laboratories in Appendix B)
5. Never pipet by mouth. Use a pipet bulb or other mechanical pipet filling device.

6. A lab coat must be worn over street clothes at all times while in laboratory by staff handling hazardous chemicals that could come into contact with the skin.
7. No open toe shoes, sleeveless shirts, or shorts allowed in the lab.
8. Employees must wash hands after handling any chemicals and before leaving the lab.

Housekeeping

1. Keep floors clean and dry. Keep all aisles, hallways, and stairs clear of all chemicals. Stairways and hallways should not be used as storage areas.
2. Compressed gas cylinders shall be secured in an upright position.
3. Keep all work areas, and especially work benches, clear of clutter and obstructions.
4. All working surfaces should be cleaned regularly with disinfectant (Bio) or soap.
5. Access to emergency equipment, utility controls, showers, eyewashes and exits shall be clearly indicated and unobstructed. (Should never be blocked)
6. Wastes should be kept in the appropriate containers and labeled properly.
7. Biohazards should be placed in biohazard labeled bags and/or containers.
8. Any unlabeled containers are considered wastes at the end of each working day.

The following Standard Operating Procedures will be followed by all employees in this laboratory when handling hazardous chemicals.

[a] WHEN NOT TO PROCEED WITHOUT REVIEWING SAFETY PROCEDURES
Sometimes laboratory workers should not proceed with what seems to be a familiar task. Hazards may exist that are not fully recognized. Certain indicators (procedural changes) should cause the employee to stop and review the safety aspects of their procedure. These indicators include:

[1] Selection of Chemicals

1. New procedures, process, or test even if it is very similar to older practices.
2. A change or substitution of any of the ingredient chemicals in a procedure not already specified must be preceded by a review of the chemicals SDS. Special attention is to be given to the reactivity and health hazard sections of the SDS. The chemical with the least toxicity and lowest degree of physical hazard will be selected.
3. A substantial change in the amount of chemicals used (scale up of experimental procedures); usually one should review safety practices if the volume of chemicals used increases by 200%.
4. A failure of any of the equipment used in the process, especially safeguards such as chemical fume hoods.
5. Unexpected experimental results (such as a pressure increase, increased reaction rates, unanticipated byproducts). When an experimental result is different from the predicted, a review of how the new result may affect safety practices should be made.

6. Chemical odors, illness in the laboratory staff that may be related to chemical exposure, or other indicators of a failure in engineered safeguards.

The occurrence of any of these conditions should cause the researcher to pause, evaluate the safety implications of these changes or results, make changes as necessary and proceed cautiously.

[2] Purchase and Transport of Chemicals

Before a new substance that is known or suspected to be hazardous is received, those individuals who will handle it should have information on proper handling, storage, and disposal. It is the responsibility of the principal investigator, or the supervisor, to ensure that the laboratory facilities in which the substance will be handled are adequate and that those who will handle the substance have received the proper training. No container should be accepted without an adequate identifying label.

[a] Chemicals will be purchased in one of two ways: by requisitions with purchase order sent to purchasing or by using a school issued Visa card. No employee will circumvent this procedure by bringing chemicals directly into the lab. Exemptions can be made by the Department Chair.

[b] Whenever possible down size (micro) the experiment and use the least hazardous chemical possible.

[c] Chemicals will not be purchased, transported or stored in amounts greater than 4L or 1 gallon.

[d] All chemicals will be transported within a rubber pail, rigid box, or original shipping container.

[e] Amounts large enough that are difficult to carry will be transported on a cart.

[f] Mail room and facilities management personnel will transport chemicals to the labs using the route with the least exposure to students.

[3] Personal Protective Equipment

The following personal protective equipment is required to be used at Monmouth laboratories whenever handling hazardous chemicals or biologicals: gloves, protective eyewear, lab coats and closed toe shoes.

[a] Eye protection is required for all personnel, students, and any visitors present in the laboratories. Safety glasses or goggles will be worn at all times in the laboratories. In chemistry labs splash goggles must be used at all times.

[b] Gloves will be worn for handling of all chemicals that may cause irritation, allergic sensitization or skin absorption of toxic chemicals. The employee must check the SDS for the chemical to ensure that the type of gloves used will protect against contact with the substance being handled.

[c] There is no respirator program for the science labs. Therefore, respirators will not be used as protective equipment.

[4] Location and Equipment to be Used for Specific Procedures

[a] Fume Hoods:

In the laboratory the chemical fume hood is the primary means of controlling inhalation exposures. Hoods are designed to retain vapors and gases released within them, protecting the laboratory employee's breathing zone from the contaminant. This protection is accomplished by having a curtain of air with a face velocity of 100 linear feet per minute with the sash at the operating height.

Fume hoods are not intended for storage.

Fume Hoods are located in the following areas in the science labs and are to be used for the reactions or operations only.

Labs with hoods: Rooms 209, 210, 147C, 147D, 149A, 149B, 150, 232, 233-A, 234, 234-A, 235, 238, HH105.

[b] Biological Hoods.

The biological safety cabinet (BSC) is the principal device used to provide containment of infectious splashes or aerosols generated by some microbiological procedures as well as maintain sterile conditions for cell culture work.

Biological Hoods are located in the following areas in the Biology Dept.:

Rooms 208A and 147B.

Eye washes and safety showers

- Keep all passageways to the eyewash and shower clear of any obstacle (even a temporarily parked chemical cart).

- Eyewashes should be flushed monthly by laboratory personnel to be certain that water flows through it. Allow them to run for several minutes once per week to clear out the supply lines.

- Showers should be checked routinely to assure that access is not restricted and that the start chain is within reach.

- The flow through the safety showers should be tested monthly to ensure sufficient flow (approximately 30 gallons per minute).

[5] Spill and Leak Procedures

Spill cart with dyking and clean-up material is in the General Chemistry lab (E235) northwest corner identified by signs on the wall above its location. In Biology there is a spill kit in E212 next to the safety shower (above safety goggle cabinet).

[a]Consider all residual chemical and cleanup materials (adsorbent, gloves, etc.) as hazardous waste. Place these materials in sealed containers (plastic bags) and store in the chemical fume hood used as a satellite accumulation collection area.

[b] Very small spills (generally in the 250 cc range or less) of low toxicity chemicals (not corrosive, not significantly toxic through inhalation or skin absorption, and not capable of causing dangerous reactions upon contact with other chemicals likely to be nearby) can be absorbed with paper towels and properly disposed of.

[c] Larger spills: Appropriate spill or leak response is based on the potential hazards that may occur. The following procedures apply to classes of hazards encountered in lab chemical spills and leaks.

i. SPILLS OF FLAMMABLE LIQUIDS IN AMOUNTS GREATER THAN ONE LITER

Legally, flammable liquids are those with flash points of less than 100 degrees F.

For the purposes of spill response in this lab, however, only liquids with flash points of under 70 degrees F and vapor pressures greater than 10 mm Hg need the following response procedures.

a. Extinguish all sources of ignition. Make sure not to turn on or off any machinery, press emergency electrical shut-off button (red button in each room) and do not use tools that may spark.

b. Have any individuals not participating in response leave the immediate area.

c. Notify all nearby staff and make sure no one else enters the spill area.

d. Ventilate spill vapors to the outside (or to the corridor if there are no windows in the laboratory) to prevent accumulation.

e. Use SDS or chemical reference to determine vapor density and hazard for appropriate handling and possible area of vapor travel.

f. Absorb the spill onto absorbent material and place used material into plastic cans. Use. gloves, lab coat and safety glasses when doing this.

g. Sponge or mop spill area with soap and water and absorb the first liquid onto absorbent. Add this to the plastic can.

h. Rinse off the remaining residue with copious amounts of water.

i. If spill was several liters or more, or if substance has a vapor pressure of more than 11 mm Hg, or, if there are obvious high vapor levels remaining, leave lab, ventilate for several hours, and do not return until vapor levels have dropped.

ii. SPILLS OF MORE THAN 500 CC OF CORROSIVE MATERIALS

a. Make sure spill is not likely to contact other chemicals with which it may react violently. If that is a possibility, immediately place absorbent as a dike around the spill. Ventilate spill vapors to the outside (or to the corridor if there are no windows in the laboratory) to prevent accumulation.

b. Refer to SDS and/or reference material to determine vapor pressure is not more than 10 mm Hg. If vapor pressure is more than 11 mm Hg and vapors levels are high enough to cause significant irritation to eyes, nose, throat or lungs, response without a respirators may not be safe. Evacuate the lab and notify the Monmouth University Police.

b. Notify nearby personnel and keep people away from the area.

c. Do not allow water to contact spill. Use full goggles, gloves that are appropriate for the material, lab coat and/or apron if necessary. Absorb spill with absorbent. Place absorbent in plastic can.

d. Rinse spill residue with copious amounts of water to dilute. Absorb first rinse and add to plastic can.

e. Rinse with water until completely flushed.

f. If skin or eye contact occurs, immediately rush to safety shower/eye wash. Seek medical attention immediately.

iii. SPILLS OF LIQUIDS CAPABLE OF PRODUCING SIGNIFICANT TOXIC VAPORS

Store volatile chemicals of high acute or chronic toxicity in the cabinet under the hood or other vented area. In the event of a chemical spill known to be a serious toxic spill risks, follow these procedures:

a. Evacuate the area of all personnel

b. Ventilate spill vapors to the outside (or to the corridor if there are no windows in the laboratory) to prevent accumulation.

c. Be sure no unauthorized personnel enter the area

d. Using the SDS values for Immediately Dangerous to Life and Health (IDLH), the odor threshold, presence or absence of odor and any associated symptoms, determine if there is any risk from entry into the spill area. If there is, or if the levels of vapor are not known, entry may be hazardous. Evacuate area and call the Monmouth University Police.

e. If vapor levels can be determined to be within safe short-term levels, approach using gloves and eye protection. Absorb onto absorbent. Place absorbed material into plastic can from the spill cart.

f. Mop or sponge area of spill with soap and water and absorb the rinse onto absorbent and add to plastic can.

g. Rinse residue copiously with water.

iv. SPILLS OF MATERIALS CAPABLE OF REACTING VIOLENTLY WITH EACH OTHER

A. If the incident causing a spill or leak is such that more than one substance has spilled, and the possibility of contact between two or more chemicals exist, immediately check SDS's of both chemicals to determine the possibility of a violent reaction (such as pyrophoric or explosive reactions).

b. If the chance of a violent reaction exists, but the chemicals have not yet contacted each other, immediately dike between spills with absorbent.

c. Remove combustible and flammable material that may be ignited by heat away from spill area.

d. Have non-participating personnel leave area.

e. Ventilate spill vapors to the outside (or to the corridor if there are no windows in the laboratory) to prevent accumulation.

f. Approach cautiously wearing apron, goggles, and gloves. Absorb one chemical completely onto absorbent and place in plastic can. Remove can from area. Absorb second chemical onto absorbent and place into separate can. Remove to different area.

g. Mop each spill area separately using different wash and equipment. Each first wash is to be absorbed on absorbent material and placed in a plastic can.

v. SPILLS OF MATERIALS CAPABLE OF REACTING TO RELEASE TOXIC BY PRODUCT

Note: mixing of chemicals such as hypochlorite and ammonia or cyanide salts and acids and release fatal levels of toxic gases in very short periods of time. Deaths have occurred in labs from such incidents.
Approach all such incidents very cautiously.

a. Identify such risks using SDS's of both chemicals.

b. If there is any chance of mixing has occurred, or may occur imminently, evacuate area and call the Monmouth University Police and Safety Department.

c. If chemicals are still well separated, immediately dike between with absorbent.

d. Evacuate all other personnel.

e. Ventilate spill vapors to the outside (or to the corridor if there are no windows in the laboratory) to prevent accumulation.

f. Approach cautiously wearing apron, goggles, and gloves. Absorb one chemical completely onto absorbent and place in plastic can. Remove can from area. Absorb second chemical onto absorbent and place into separate can. Remove to a different area.

g. Mop each spill area separately using different wash and equipment.

vi. All spills must be documented and recorded.

a. Faculty or staff directly involved with the spill must write a narrative what transpired, detailing exactly how the spill occurred and the cause. If student or staff were injured in any way the report should reflect what actions were taken and what agencies were contacted.
b. Narrative writer, lab supervisor and department chair should discuss the incident to implement preventive measures, procedures or equipment, which would diminish the incidents reoccurrence.

vii. Hazardous and Non-Hazardous Waste Operating Procedures

The purpose of this section is to inform the faculty and staff of the CMTP (Chemistry, Medical Technology and Physics) and Biology Departments of the operating procedures for hazardous and non-hazardous waste in chemical laboratories.

All hazardous and non-hazardous waste accumulated in each CMTP or Biology Department lab is only accumulated for the duration of the experiment, after which time it will be picked up by the appropriate chemical hygiene officer (CHO) (Rigoberto Garcia or Anne Marie Lavin) and taken to the appropriate Hazardous Waste Satellite Accumulation Area. The CHO will ensure that the material is properly documented and integrated into the various containers there. They will also ensure that facilities management is notified in a timely manner that waste is ready for removal to the Hazardous Waste Storage Area.

Faculty supervising laboratory activities are responsible for promptly notifying the CHO for their department when an experiment is completed. Waste containers used in the labs must be labeled indicating whether waste is organic or inorganic, liquid or solid and hazardous or non-hazardous. A list of all the chemicals in each container must accompany the container.

This procedure is designed to enhance safety and environmental compliance by preventing:

- Students crossing hallways with hazardous chemical waste.
- Students segregating chemical waste when they are not specifically authorized to do so.
- Student lab assistants employed in the various chemistry laboratories segregating waste streams without direct faculty supervision.

VIII Biohazardous Waste

Some wastes associated with biological materials must be disposed of in special ways because they may have been contaminated with infectious organisms or agents. (Refer to Regulated Medical Waste Program)

These wastes include the following:

All sharps, glass implements, needles, syringes, blades, etc. that have been used with infectious materials.

Biologically-cultured stocks and plates.
Animal carcasses.

IX Handling Liquid Nitrogen

a. When transferring liquid nitrogen from the large tank to a smaller container or Dewar, the doors must be open at all times. It can replace the oxygen in a room, so danger of asphyxiation is present.
b. Always wear a lab coat, safety goggles or face shield and cryogenic gloves. No open shoes or shorts. This material is so cold (-320 F) that it will cause frostbite very quickly.
c. Place metal hose into the Dewar above the existing liquid.
d. Slowly turn the valve until liquid starts going into the container.
e. Fill up to desired level and turn valve off.
f. Remove metal hose from Dewar and replace on tank.
g. See Attachment 7 for more information.

SECTION 2: CRITERIA TO DEVELOP AND IMPLEMENT CONTROL MEASURES

The purpose of this section is to describe a set of specific objective criteria that will be used by staff at the Monmouth University Biology and CMPT Laboratories in making decisions about the appropriate level of protective equipment for any given process or operation.

General Consideration - Personal Protective Clothing/Equipment

Personal protective clothing and equipment should be selected carefully and used in situations where engineering and administrative controls cannot be used or while such controls are being established. These devices are viewed as less protective than other controls because they rely heavily on each employee's work practices and training to be effective. The engineering and administrative controls which should always be considered first when reducing or eliminating exposures to hazardous chemicals include:

- **Substitution** of a less hazardous substance
- **Scaling down size of experiment**
- **Substitution** of less hazardous equipment or process (e.g., safety cans for glass bottles)
- **Isolation** of the operator or the process
- **Local and general ventilation** (e.g., use of fume hoods)

The Safety Data Sheet (SDS) will list the personal protective equipment (PPE) recommended for use with the chemical. The MSDS addresses worst case conditions. Therefore, all the equipment shown may not be necessary for a specific laboratory scale task.

Your supervisor, other sections of this manual or the Chemical Hygiene Officer can assist you in determining which personal protective devices are required for each task. Remember, there is no harm in being overprotected. Appropriate personal protective equipment will be provided to employees.

The following controls are potentially available to Monmouth staff when handling hazardous materials:

Gloves
Gauntlets
Aprons
Safety Glasses
Goggles
Face Shields
Fume Hoods

(Respirators are not part of the Monmouth Biology and CMPT departments' hazard control plan)

Section 2A – Protective Clothing and Gloves

Chemical resistant and special gloves should be worn whenever the potential for contact with corrosive, cryogen or toxic substances and substances of unknown toxicity exists. Gloves should be selected on the basis of the materials being handled, the particular hazard involved, and their suitability for the operation being conducted. Before each use, gloves should be checked for integrity. In some cases (when corrosives or dermally absorbed toxic substances have been handled) gloves should be properly rinsed prior to removal to prevent skin contamination. Non-disposable gloves should be replaced periodically, depending on frequency of use and their resistance to the substances handled. Non-disposable gloves should be washed prior to removal whenever possible to prevent skin contamination.

Protective garments are not equally effective for every hazardous chemical. Some chemicals will "break through" the garment in a very short time. Therefore, garment and glove selection is based on the specific chemical utilized. General selection criteria is as follows:

GLOVE TYPE SELECTION GUIDE

CHEMICAL FAMILY	BUTYL RUBBER	NEOPRENE	PVC (VINYL)	NITRILE	NATURAL LATEX
Acetates	G	NR	NR	NR	NR
Acids, inorganic	G	E	E	E	E
Acids, organic	E	E	E	E	E
Acetonitrile, Acrylonitrile	G	E	G	S	E
Alcohols	E	E	NR	E	E
Aldehydes	E	G	NR	S*	NR
Amines	S	NR	NR	F	NR
Bases, inorganic	E	E	E	E	E
Ethers	G	F	NR	E	NR
Halogens (liquids)	G	NR	F	E	NR
Inks	G	E	E	S	F

Ketones	E	G	NR	NR	G
Nitro compounds (Nitrobenzene, Nitromethane)	G	NR	NR	NR	NR
CHEMICAL FAMILY	BUTYL RUBBER	NEOPRENE	PVC (VINYL)	NITRILE	NATURAL LATEX
Oleic Acid	E	E	F	E	NR
Phenols	E	E	NR	NR	G
Quinones	NR	E	G	E	E
Solvents, Aliphatic	NR	NR	F	G	NR
Solvents, Aromatic	NR	NR	F	F	NR

**Not recommended for Acetaldehyde, use Butyl Rubber*

S - Superior E - Excellent G - Good F - Fair NR - Not Recommended

Section 2B – Eye Protection.

Eye protection is required for all personnel and any visitors present in locations where chemicals are handled and a chemical splash hazard exists. Safety glasses, goggles and goggles with face shield should be worn in the laboratory based upon the physical state, the operation or the level of toxicity of the chemical used. Safety glasses effectively protect the eye from solid materials (dusts and flying objects) but are less effective at protecting the eyes from chemical splash to the face. **Goggles must be worn in situations where chemicals are handled and chemical splashes to the face are possible.** Goggles form a liquid-proof seal around the eyes, protecting them from a splash. When handling highly reactive substances or large quantities of hazardous chemicals, corrosives, poisons and hot chemicals, goggles with face shield should be worn. Safety glasses should be used when working with tools and injection devices.

In some cases contact lenses can increase the risk of eye injury if worn in the laboratory. Chemical splashes to the eye can get behind all types of lenses. Once behind a lens the chemical may be difficult to remove with a typical eye wash. **For these reasons it is recommended that contact lenses not be worn in laboratories.**

Section 2C – Protective Clothing

Skin and body protection involves wearing protective clothing over all parts of the body which could become contaminated with hazardous chemicals. Personal protective equipment (PPE) should be selected on a task basis, and checked to ensure it is in good condition prior to use (e.g. no pinholes in gloves). Normal clothing worn in the laboratory where there is no immediate

danger to the skin from contact with a hazardous chemical it is still prudent to select clothing to minimize exposed skin surfaces. Employees should wear sleeved shirts, full length pants and avoid short trousers or skirts. A laboratory coat should be worn over street clothes and be laundered regularly. Laboratory coats are intended to prevent contact with dirt, chemical dusts and minor chemical splashes or spills. If it becomes contaminated it should be removed immediately and affected
skin surface washed thoroughly. Shoes should be worn in the laboratory at all times. Sandals, perforated or open toe shoes are not appropriate. In addition, long hair and loose clothing should be confined. Additional protective clothing may be required for some types of procedures or with specific substances (such as when carcinogens or large quantities of corrosives, oxidizing agents or organic solvents are handled). These
garments can either be washable or disposable in nature. The choice of garment depends on the degree of protection required and the areas of the body which may
become contaminated.

These control measures will be required when the following criteria are met:

FOR SKIN ABSORBABLE TOXIC SUBSTANCES, SKIN ALLERGENS, AND MODERATE TO SEVERE IRRITANTS: Gloves

FOR CORROSIVES, MODERATE TO SEVERE EYE IRRITANTS, ALL SOLUTIONS WITH pH <2.5 OR > 11.0 AND RAPIDLY SKIN-ABSORBED HIGHLY TOXIC SUBSTANCES: Gloves, Gauntlets, Apron, Goggles or Face Shield (see Grant: Toxicology of the Eye; Thomas, 1974.)

FOR ALL MODERATELY TO HIGH TOXIC SUBSTANCES BY INHALATION: Conduct operations under hood. (Highly Toxic Substances as defined by OSHA 1910.1200 as substances with a median lethal dose (LD 50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing 200 to 300 grams each.

SECTION 3: SPECIFIC MEASURES TO ENSURE PERFORMANCE OF FUME HOODS AND OTHER EQUIPMENT

In the laboratory, the chemical hood is the primary means of controlling inhalation exposures. Hoods are designed to retain vapors and gases released within them, protecting the laboratory employee's breathing zone from the contaminant. This protection is accomplished by having a curtain of air (approximately 100 linear feet per minute) move constantly through the face (open sash) of the hood. Chemical hoods can also be used to isolate apparatus or chemicals that may present physical hazards to employees. The closed sash on a hood serves as an effective barrier to fires, flying objects, chemical splashes or spattering and small implosions and explosions.

Hoods can also effectively contain spills which might occur during dispensing procedures particularly if trays are placed in the bottom of the hoods.

When using a chemical fume hood keep the following principles of safe operation in mind:

- Always work back into the hood. Keep all chemicals and apparatus at least six inches inside the hood (behind sash).
- Hoods are not intended for long-term chemical storage. Materials stored in them should be kept to a minimum. Stored chemicals should not block vents or alter air flow patterns.
- Keep the hood sash at a minimum height (4 to 6 inches) when not manipulating chemicals or adjusting apparatus within the hood.
- When working in front of a fume hood, make sure the sash opening is appropriate. This can be achieved by lining up to arrows placed on the sash door and hood frame. This sash opening will ensure an adequate air velocity through the face of the hood.
- Do not allow objects such as paper to enter the exhaust ducts. This can clog ducts and adversely affect their operation.

Follow the chemical manufacturer's or supplier's specific instructions for controlling inhalation exposures with ventilation (chemical fume hood) when using their products. These instructions are located on the products SDS and/or label. However, it should be noted that these ventilation recommendations are often intended for non-laboratory work environments and must be adapted to suit the laboratory environment as well as the specific procedure or process.

The functioning of the existing hoods and of any added in the future should be checked at the time of installation, and again under any of the following circumstances:

[a] At regularly scheduled intervals, as specified by hood manufacturer and ANSI regulations, complete the attached (appendix) form for every hood.

[b] If the hood is going to be used for a different purpose, such as working with a new substance or performing a different procedure, which may represent a significantly more hazardous situation; or

[c] Any evidence of impaired performance (employee observation, odors, symptoms);

[d] Upon any change in the ventilation system of the building or the hood that might affect the performance of the hood;

[e] With any change of the building structure that might affect ventilation systems.

2. The evaluation of the fume hoods will include the following:

   Fume hood should be evaluated to confirm that it is performing adequately (a face velocity of at least 100 linear feet per minute (±20%)) with the sash at the operating height.

   [a] Facilities Management arranges for annual inspection of all the hoods by an outside contractor (Micro-Clean Corporation).

Biological Safety Cabinets:

Will be inspected and HEPA filters replaced every month or by use as needed by the Biology CHO.

SECTION 4: EMPLOYEE INFORMATION AND TRAINING

Summary of the Lab Rule Information and Training Requirements:

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer. OSHA allows refresher training to be given in segments as long as all employees complete it annually.

(3) Information. Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees.

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory;

(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory, including but not limited to Safety Data Sheets, received from the chemical supplier. Maintaining SDSs online is in compliance with OSHA's Hazard Communication Standard, if computers are readily available to employees.

(4) Training.

(i) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released);

(B) The physical and health hazards of chemicals in the work area;

(C) The measure employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

Information and Training Program at Monmouth University Science Laboratories:

1. Under the lab rule, lab employees will be provided the information required in a packet given to each employee at the time of implementation of this program, and in the future, upon hiring. A copy of this packet/outline is attached.

2. Training will be provided to all employees in a half day training session. The training outline is attached.

3. Refresher training will be conducted annually, or at any time when a significant change in lab operation, policy or equipment or chemicals in use creates hazards or conditions that have not been adequately addressed in the most recent training session. At a minimum, refresher and update training will be scheduled annually. It is not necessary for the employer to retrain a new employee if said employee has received prior training by the past employer.

4. All new laboratory staff will have training in the categories of hazards they may encounter, labeling procedure and a walk-through of the laboratories as part of their orientation before beginning work.

5. OSHA Hazard Communication Safety Training for staff and student employees is on e-campus under community-chemistry services. (https://monmouth.desire2learn.com/d2l/lp/homepage/home.d2l?ou=118885)

SECTION 5: CIRCUMSTANCES REQUIRING PRE-APPROVAL

Pre-Approval of Operations:

The staff handling hazardous chemicals in these labs are all university science faculty or are trained and supervised by university faculty. Therefore, no pre-approval will be used.

SECTION 6: MEDICAL CONSULTATION AND EXAMINATION

The Lab Rule requires the following for medical evaluation of lab staff:

[1] The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

> [i] Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination;

[ii] Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard; or

[iii] Whenever an event takes place in the work area such as spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

[2] All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

[3] Information provided to the physician. The employer shall provide the following information to the physician:

[i] The identity of the hazardous chemical(s) to which the employee may have been exposed;

[ii] The description of the conditions under which the exposure occurred including quantitative data, if available; and

[iii] A description of the symptoms of exposure that the employee is experiencing, if any.

[4] Physician’s written opinion.

[i] For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and

(D) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

[ii] The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

The Monmouth University Science Laboratories will use the following procedure for all medical referrals:

1. In the event an employee requests an evaluation because of possible over-exposure, **Mel Dale**, Director of Compliance will arrange the evaluation. The forms (Attachments 3 and 4) will be used to inform the physician and to receive back the physician report.

2. Employees will be told the results of all medical evaluations and exams.

3. In the event of an urgent need for evaluation, the **Monmouth Medical Center Emergency Room (732-923-7386)** will be contacted. The contact person is **Deb Choffe, Clinical Director (732-923-7188).**

SECTION 7: CHEMICAL HYGIENE OFFICER

The Chemical Hygiene Officer is an employee who is designated by the University, and is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. Rigoberto F. Garcia is the Chemical Hygiene Officer for Chemistry, Medical Technology, Physics. Anne Marie Lavin is the Chemical Hygiene Officer for the Biology department.

The Chemical Hygiene Officer's responsibilities include the following:

[a] Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices

[b] Monitor procurement, use, and disposal of chemicals used in the lab

[c] See that appropriate audits are maintained

[d] Help project directors develop precautions and adequate facilities

[e] Know the current legal requirements concerning regulated substances

[f] Seek ways to improve the chemical hygiene program including an annual review and update of the Chemical Hygiene Plan.

SECTION 8: ADDITIONAL EMPLOYEE PROTECTION FOR PARTICULAR HAZARDS

There are three classes of compounds that must receive special consideration, each defined by somewhat different criteria. The three are:

[1] Select Carcinogens; Select carcinogens are defined as those substances that meet any of the following criteria:

[a] The chemicals that OSHA has specifically designated as carcinogens and written standards for. At this time, the following substances are OSHA- regulated carcinogens.

Asbestos	Benzidine	Inorganic arsenic
4-Nitrobiphenyl	4-Aminodiphenyl	Benzene
alpha-Napthylamine	Ethyleneimine	Methylene Chloride

Methyl chloromethyl ether	1,2-dibromo-3-chloropropane	beta-Propiolactone
3',3'-Dichlorobenzidine (and its salts)	2-Acetylaminoflourene	Acrylonitrile
	4-Dimethylaminoazobenzene	Ethylene oxide
bis-Chloromethyl ether	N-Nitrosodimethylamine	beta-Napthylamine
Vinyl chloride	Cadnium	Formaldehyde
Methylenedianiline	1,3 – Butadiene	

[b] All chemicals listed in the "Annual Report on Carcinogens" published by the National Toxicology Program (NTP) as "known to be carcinogens".

[c] All chemicals listed in the publication called "International Agency for Research on Cancer Monographs" (IARC) under the list titled: "Group 1-Carcinogenic to Humans".

[d] Chemicals that appear in the same NTP document described in [a] above on the list headed "reasonably anticipated to be carcinogens", or, appear on the IARC publication referred to in [c] above on the lists headed 2A (probably carcinogenic to humans) and 2B (possibly carcinogenic to humans) **and** also meet the following criteria:

"Causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

{1} After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to levels of less than 10 mg/m^3;

{2} After repeated skin application of less than 300 (mg/kg of body weight) per week; or

{3} After oral dosages of less than 50 mg/kg of body weight per day.

[2] Reproductive toxins (OSHA defines these as chemicals as substances which affect the reproductive capabilities including chromosomal damage [mutations] and effects on fetuses [teratogenesis]); and

[3] Substances which have a high degree of acute toxicity. OSHA uses the appendix from the Hazard Communication Standard which defines high acute toxicity in the following way:

[a] median LD 50 of 50 mg/kg orally in albino rats, 200-300 grams

[b] median LD of 50 of 200 mg/kg by continuous contact for 24 hours with the bare skin of albino rabbits weighing between two and three kilograms

[c] median LC 50 in air of 200 ppm (or 2 mg/liter) continuous inhalation for one hour

All of the chemicals described above fall into a single category in the lab rule: particularly hazardous substances. For any such chemical, when it is used in this lab, provisions for “additional protection” will be used where appropriate. These will consist of:

[a] Establishment of “designated areas”. Designated areas will be posted, and all employees working there will be informed of the nature of the hazards. Use of special hazards, will be contained in the designated areas.

[b] Use of containment devices such as fume hoods or glove boxes. These devices will be used for any of these substances when the following exist:

[1] volatile substances;

[2] manipulations that may result in the generation of aerosols; or

[3] any process that may result in an uncontrollable release of the substance.

[c] Establishment of procedures for safe removal of contaminated waste. Disposal of any of the substances will be through Clean Harbors Environmental Services Inc., 41 Tompkins Point Road., Newark, NJ 07114 Phone: 973-643-6025

[d] Decontamination procedures: after working with special hazards, employees should follow the following protocol designed to ensure that residues of the chemical do not remain on your body, clothes or equipment:

[1] Remove any outer protective gear (gloves, aprons, gauntlets, etc.) and place into a labeled container for cleaning or disposal by proper personnel.

[2] Wash hands and face and remove inner layer of protection (lab coats, eye protection, etc.)

[3] Place equipment, glassware, etc. in labeled containers to be cleaned by protected, trained personnel.

[4] Shower if skin contamination has possibly occurred.

[5] If the substance has been used on a bench or other surface that could be contaminated, proper cleansing of the surface is required.

The following chemicals used in this lab are designated as significant special hazards and will be handled according to the listed protocols:

benzene
chloroform
formaldehyde
estradiol (17-beta)
lead compounds
cyanide compounds
hexavalent chromium compounds
sodium azide
phenol
progesterone
thiourea
arsenic
aniline
o-toluidine
styrene
thioacetamide
dichloromethane
cadmium
carbon tetrachloride
2 butoxy-ethanol
chlorine
1,4-dichlorobenzene
silica
ethylene dibromide
2-naphthylamine
phenacetin
4-amino biphenyl
benzidine
2-nitropropane
chlorophenols
trichloroethylene

EMPLOYEE TRAINING PROGRAM FOR THE MONMOUTH UNIVERSITY SCIENCE LABORATORIES OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

INTRODUCTION:

The new OSHA Lab Rule requires that all employees of this lab receive a training program on hazardous chemicals in laboratories. This program attempts to emphasize practical health and safety information. It is put together mainly from experiences in other laboratories, and explanations of some of the terms and concepts used in the occupational health field.

I. METHODS AND OBSERVATIONS THAT MAY BE USED TO DETECT THE PRESENCE OR RELEASE OF A HAZARDOUS CHEMICAL

A. Recognizing Hazards in the Laboratory - What makes a work situation dangerous:

1. THE CHEMICAL IN ITSELF IS EXTREMELY HAZARDOUS
   Although many lab chemicals are fairly hazardous, a small subset are extremely hazardous and present a high degree of risk under almost any conditions of use. Cyanide salts and hydrogen sulfide are examples of extremely hazardous chemicals.

2. THE CHEMICAL IS USED IN LARGE AMOUNTS
   Relatively low hazard chemicals can cause serious health effects when used in amounts large enough to cause high level exposures. Pathology residents at a Boston hospital lab experienced an epidemic of heartbeat irregularities from very high levels of freon generated by doing frozen sections.

3. THE CHEMICAL USED OVER A LONG PERIOD OF TIME
   Some chemicals that may not be extreme hazards, and are not used in large amounts, can still cause serious hazards when exposure occurs repeatedly over many years. This type of exposure occurs in workers who remain at the same kind of job over a prolonged period of time. Workers have developed partial paralysis from long-term repeated exposure to acrylamide.

4. THE WORK INVOLVES PROCESSES THAT CHANGE THE PROPERTIES OR FORM OF THE CHEMICAL
   Chemical reactions are, of course, the main purpose of the lab. In most cases, the person carrying out the reaction is familiar with what will occur. Runaway reactions, unplanned reactions, or formation of byproducts all occur, however, and can cause fire, explosion, or release of toxic substances. Such reactions can also occur in the lab when using chemical-containing products for non-lab purposes such as cleaning and maintenance, (i.e., if a maintenance worker attempted to remove a polymerized residue of an isocyanate product with floor wax stripper that contained ammonia, the resulting isocyanate vapors could cause significant repiratory problems in that worker).

5. THE WORKER HAS LITTLE OR NO CONTROL OVER EXPOSURE
   In most workplace situations, if you begin to experience adverse effects from chemical exposure, you can take steps to stop the exposure or remove yourself from the area. When outside circumstances limit your control, the chances of a serious incident become higher. These may include working in a confined space, such as removing a cylinder of gas in a basement storage closet with no ventilation, an uncontrolled release such as a spill or leak, or working under time pressures and deadlines, when normal safety instincts are overridden.

B. Recognizing Exposure in the Laboratory - How you can tell if you are being exposed:

1. THE CHEMICAL IS VISIBLE AND OPEN TO THE AIR
   All liquids will produce at least traces of vapor, and of course many will produce large amounts if they are open to room air. Solids, when they are handled, rarely fail to generate at least slight amounts of dust. In general, it is safest to assume that slight exposure is occurring any time a chemical is handled in the open.

2. THE CHEMICAL THAT HAS ESCAPED FROM ITS CONTAINER AND IS VISIBLE IN THE AIR
   Although it is not a quantitative measure of exposure levels, the visible presence of dust, mist, fumes or vapor is a clear-cut indication that exposure is occurring at more than a trace level.

3. YOU EXPERIENCE A SYMPTOM OF ANY KIND
   The intent of the Lab Rule as well as all health and safety regulations is to ensure that employees do not suffer adverse health effects as a result of workplace exposures. If you are having irritation, dizziness, headaches, or other minor health problems as a result of chemical exposure, you are being over-exposed.

4. A WARNING SYSTEM HAS BEEN ACTIVATED OR AN INCIDENT HAS OCCURRED
   In some labs there are warning devices to warn of chemical release. If there are any such devices in your lab, it is important to know exactly which alarms signify what types of releases, and to be aware of what you should do in the event an alarm does go off.

How you can tell if exposure **has** happened:

5. OSHA ILLNESS AND INJURY LOG
   All employers must post a record, once a year during the month of February, of all injuries and illnesses related to work that resulted in lost time. In addition, the log must be maintained, and employees given access to it, throughout the year. In this facility, the log is posted in science department offices. Inspection of this document can reveal a pattern of illness that demonstrates that a hazardous chemical exposure is occurring.

6. MORE THAN ONE PERSON IN THE SAME AREA EXPERIENCES SIMILAR HEALTH PROBLEMS AT THE SAME TIME
   It is very unlikely that two or more people who work in the same place would develop the same type of health problem at the same time by coincidence. If you or your co-workers discover that several of you have had similar health problems during the same time period, it may be an indication that chemical over-exposure is occurring, and certainly warrants further investigation.

C. Measuring Exposure

1. BULK SAMPLING
   Simply taking some of the unknown material and sending it to a lab for identification is called bulk sampling.

2. INDUSTRIAL HYGIENE MONITORING
   This is collecting air and checking for the amount of chemical present in it.

   a) **Area Sample** - samples are collected at the point where the chemical is coming out of the container or general room air is sampled.

   b) **Personal Sample** - the employee's personal breathing air is sampled.

There are several different ways to collect a sample:

   a) **Grab Sample** - sampling is done for a few seconds to determine exposure at that moment.

b) **Continuous Sample** - sampling is done over a longer period of time.
c) **Wipe Sample** - picking up dust or residue off a surface with a wipe and then analyzing it.

Results of Sampling:

Most industrial hygiene results are reported in **parts per million (ppm)** for gases and vapors. PPM refers to parts of a substance per million parts of air. (i.e., 10 PPM of acetic acid would mean that out of a million parts of air, 10 of them are acetic acid.)

Solids are reported in **milligrams per cubic meter (mg/m^3)**. This refers to milligrams of a substance per cubic meter of air. Various experts have determined safe exposure limits which can then be compared to the results of the sample.

3. BIOLOGICAL MONITORING
This type of monitoring tests the worker for the chemical in their body (it sometimes tests for the **effects** of the chemical in the body). The worker undergoes medical tests with the results showing if overexposure has occurred. When this kind of testing is done, workers have a right to the results of the tests.

II. MEASURES EMPLOYEES CAN TAKE TO PROTECT THEMSELVES FROM HAZARDS

A. Controlling Exposure in the Laboratory

There are many possible methods that can be used to control exposure in the lab ranging from simple room ventilation, eye protection and a lab coat, up to glove boxes and respirators. The control measures that provide the necessary protection, with the least expense and inconvenience for the person working with it, will vary widely with the chemicals involved and the type of process carried out. Control measures can be divided into three broad categories:

1. AT THE SOURCE
Controlling chemical at the source refers to those methods where the exposure is stopped before it exists at all. There are several ways to do this:

a) Substituting a safer chemical for a hazardous one. If a reaction is being run with a particularly hazardous chemical, it may be possible to find a less hazardous alternative. Benzene, for instance, is used as a standard in gas chromatography, but if another aromatic hydrocarbon will be adequate, you will be able to control the exposure to a human carcinogen at the source by substitution.

b) Enclosing the container or process where the chemical is used, such as a glove box, can prevent exposure.

c) Isolating the process to another area of the facility, such as a "designated area" will control the exposure for some employees who do not have to be there. It means, of course, that the employees who do not work there will need additional protection.

d) Process change. Sometimes a reaction is run or a procedure is carried out under conditions that create hazards. It may be possible to design an alternative reaction to test or produce the same result that eliminates the hazard, (i.e., running a reaction at a high temperature that causes high vapor levels may create exposures that could be controlled if a catalyst was used and the reaction was run at room temperature).

2. ALONG THE PATH

This is controlling the chemical in the air between its container and the worker. Methods of **along the path** control include:

a) Local exhaust ventilation (hood).

b) General ventilation (fans, windows, normal building ventilation).

c) Careful housekeeping (wiping up spills, dusts).

d) Special work methods.

If properly used these methods can keep down the level of chemicals in the air very effectively, as long as exposures are not excessive.

3. AT THE WORKER

If the chemical is not controlled at the source or along the path, it will reach the individual carrying out the process. At that point, if exposure levels are hazardous, illness and injury can only be avoided by personal protective equipment. Personal protective equipment should be used only when there is no other alternative, because this method allows dangerous levels of chemicals to reach the personal environment of the worker. If you are going to use personal protective equipment you must properly be trained, fitted and the equipment must be the right type for the hazard it is protecting against. **Improper personal protective equipment can be worse than none at all**. In the lab, gloves, eye protection and protective clothing are the mainstays of control measures and are very appropriate for many situations. Details about specific types of protective equipment are described below.

B. Specific Information about Controls in this Laboratory

Standard Operating Procedures for this lab can be found in the Chemical Hygiene Plan. The SOP's have also been attached to this training manual as an appendix. These SOP's will be reviewed during this training. These SOP's include the types of Personal Protective Equipment to use when working with specific chemicals and for emergency procedures. The Chemical Hygiene Plan developed for this facility also includes sections on fume hoods and other controls in use.

C. Personal Protective Equipment

1. What is Personal Protective Equipment?

Personal Protective Equipment (PPE) is a term used for a variety of products worn by lab workers which are designed to protect them from safety and health hazards.

2. When is PPE needed?

PPE is needed anytime there is a possibility that you may be exposed to a hazardous chemical.

3. What type of PPE will I use?

The level of protection you are required to wear depends on the specific hazards of the chemicals you are working with. The three most common types of PPE to use in the labs are:

a) Eye/Face Protection

b) Gloves

c) Apron/Protective Clothing/Lab Coat

If you are required to use respirators, you will need several additional hours of classroom and hands-on training. It will also require proper fitting and testing instruction. If anyone in your lab uses respirators, your employer is required to develop a full "respirator program" under OSHA standards. Even if one is present in your work area, **respirators should never be used without proper training!!** Because certain respirators and their cartridges provide protection only against certain substances, **improper use of a respirator may provide no protection or may cause more harm than no respirator at all.**

D. Limitations of PPE

1. **Without proper fitting and selection, PPE is ineffective**.

If gloves are too large, they may hinder your ability to obtain a good grasp. Loose cuffs on gloves may allow irritating material to get into the glove and be held next to the skin. If the chemical penetrates the glove, there will be repeat exposure every time the glove is used.

THERE IS NO SINGLE GLOVE OR CLOTHING MATERIAL THAT PROTECTS AGAINST ALL CHEMICALS!

Gloves and aprons are made of certain materials to protect against certain hazards. Gloves and aprons made to protect against alcohols may not protect against acids.

*****Make sure you have protective clothing made of the proper material to protect against the hazard you are working with.**

Data is usually provided by the manufacturer about the type of hazard the glove or apron is made to protect against. If this information is not available in the package, ask your supervisor to call the manufacturer.

Eye/Face protection may only protect against splashing and not irritating vapors.

2. **PPE may be uncomfortable**.

3. **PPE may restrict sight, hearing, touch, and movement**.
Take note of the effect PPE has on your senses before using it in a work situation. Make sure the gloves you wear do not prevent you from keeping a grip on glass test tubes, beakers, and other containers where chemicals are placed. Make sure that goggles or face shields do not restrict your sight.

4**. PPE may become ineffective with use if not maintained properly.**
The actual life of protective clothing will depend on use conditions, length of contact with chemicals, temperature, concentration of chemicals and physical wear and tear. After a certain amount of exposure some protective clothing materials deteriorate and develop small cracks which allow breakthrough.

E. Care and Maintenance of PPE
The manufacturer's instruction for care and maintenance of PPE should be followed, however, there are some basic guidelines to help keep PPE maintained.

1. **Protective clothing make of different materials should be stored separately** because it is often impossible to tell the materials apart. Because there is not
one material impervious to all chemicals, selecting protective clothing made of the wrong material for the hazard could result in an illness or injury due to exposure.

2. **Do not fold gloves or aprons in an unnatural way**. If possible, store them laying flat. Folding causes stress to the folded areas, weakening them and making them more susceptible to breakthrough.

3. **Periodic cleaning, depending on frequency of use, to remove chemical build-up will lengthen the life of the PPE.**

4. **Gloves with a rough finish require a more thorough cleaning** because the surface traps solutions which may cause deterioration.

5. **If protective clothing swells, they should be taken out of use** to permit chemicals to evaporate and the original shape to be restored.

6. **Defective PPE should be immediately scrapped and replaced**. You should inform your supervisor immediately if PPE is defective, or hinders your ability to perform a task.

7. **PPE should be inspected before and after use for wear or holes.**

F. Standard Inspection Procedures for Protective Clothing

Before use:
1. Determine that the clothing material is correct for the hazard it is to be used against.

2. Visually inspected for imperfect seams, non-uniform coatings, tears, and malfunctioning closures.

3. Hold it up to the light to check for pinholes.

4. Flex the clothing - observe for cracks and other signs of deterioration.

5. If the clothing has been used before, check for signs of “chemical attack”: discoloration, swelling, stiffness.

While working, periodically check for tears and punctures, discoloration, closure failure, swelling, stiffening, or softening.

G. Glove Inspection

Before use:
Pressurize gloves for pinholes, **even if they are brand new!** This can be done by inflating the gloves and holding them under water. NO air should escape. You should wash your hands and face thoroughly with skin cleanser after use of PPE to ensure that the skin is free from any substance that may have permeated the protective clothing.

The protective equipment that will be used in this lab is as follows:

- Goggles-located in the cabinets or on the walls
- Face Shields
- Lab Coats, Aprons
- Gloves

III. THE PHYSICAL AND HEALTH HAZARDS IN THE WORK AREA

There are tens of thousands of commercially available hazardous chemicals and many labs routinely use hundreds or more of these. It is not possible to discuss each one individually, so chemicals are usually grouped into categories of hazards. There are many ways to do this. The system used below divides all potential hazards into two broad groups: physical and health. Each group is then further divided into specific hazards based on how they are likely to occur or be experienced by the employee.

A. Physical/Safety Hazards

1. FIRE (Physical)

The biggest fire hazard in most labs comes from the ignition of vapors, from a flammable liquid, by a spark or flame. Under the definition of flammable used in the Lab Rule, a flammable liquid is one that can give off sufficient vapor, at a temperature under 100 degrees Fahrenheit, to ignite from a spark or a flame. <u>The amount of vapor a flammable liquid is likely to produce and where that vapor will travel to, can help to identify the extent of the hazard.</u>

Important Definitions:

Vapor Pressure is a measure of how readily a liquid or solid mixes with air at its surface. A higher vapor pressure indicates a higher concentration of the substance in the air, and therefore, increases the likelihood of breathing it in. Less than 10 is relatively safe. 10-100 is a moderate fire hazard. Over 100 is a serious fire hazard.

Vapor Density is how heavy the vapor given off by a chemical is compared to the air and thus, whether it will rise or fall when it is given off. Air has a vapor density of 1.00. The higher the vapor density above 1.0, the more likely it is that the chemical vapor will sink to the floor. A vapor density of 3.2 is heavier than air, therefore, the vapor will sink to the floor. A vapor density of -1.0 will result in the vapor rising.

Flashpoint is <u>the temperature at which</u> a liquid or solid gives off vapor that can form a <u>flammable mixture with the air</u>. Less than 100 degrees is flammable. The lower the flashpoint the easier to flash (below 60 is dangerous).

In labs, ethers are one common source of fires. Ethyl ether, for instance, has a flash point of 27 C, a vapor pressure of 442 mm Hg, and a vapor density of 2.56. Thus ether readily gives off vapors capable of creating a flammable mixture with the air at even low temperatures, and the vapor tends to sink, or "creep" along the top of a lab bench. Igniting a Bunsen burner can then make the flame flash back along the vapor to the container of ether and start a fire.

Examples of some important flammable hazards in this lab are:

benzene	acetonitrile	ethers
acetone	alcohols	many acetates

2. REACTIVITY AND EXPLOSION

All lab employees are familiar with chemical reactivity. However, recognizing reactive hazards may involve a slightly different perspective than you usually use, in that a side reaction may be of no consequence to the procedure you are doing yet may have more serious implications in terms of hazards. It is also important to be alert to reactions that may occur that are not part of the procedure you are doing, but accidental. Finally, many people working in labs may not be fully aware of all classes of reactivity, either because the focus of the lab does not involve using that chemistry knowledge every day, or because their own training was not in that area.

a) Reactive Hazards

i) **Oxidizers** are chemicals that can act as a supply of oxygen to other chemicals when mixed. When an oxidizer comes in contact with a substance that can accept the oxygen it gives off, a reducer, a tremendous amount of heat can be produced. Oxidizers, like bleach and peroxides, will react violently when mixed with reducers. They may self-ignite or explode. They should never be stored next to each other, or be allowed to combine, except under controlled conditions.

ii) **Explosives** are materials which are capable of detonation, explosive decomposition or reaction at normal temperatures and pressures.

iii) **Polymerization** - Some substances will form long chains of single molecules (polymerize) when catalyzed into doing so. When done slowly, this is a safe, useful reaction. Some compounds can polymerize on their own, and do this so rapidly that they cause a fire or explosion.

iv) **Incompatibility** - Some chemicals will catch fire, explode or give off toxic by-products when combined with certain other specific chemicals. For example, sodium metal will catch fire on contact with water. Ammonia compounds can react with chlorine compounds to produce chloramine gas which is highly toxic.

v) **Unstable** chemicals spontaneously change with age or certain other conditions. The reaction that can then occur can cause fire or explosion. For example, ether can change spontaneously to an organic peroxide which can then explode on jarring.

Examples of some reactive hazards in this lab are:

hydrogen peroxide	chlorates	hypochlorites
perchlorates	nitric acid	chlorine
calcium carbide		

b) Health Hazards

i) How do chemicals affect the body?

{a} DOSE **(How Much?)**
This means simply how much of the chemical gets to the part of the body where it has its effect. For example, if you handed someone **2** aspirin tablets, the **dose** would be how many milligrams of aspirin they swallowed and kept down.

{b} DURATION **(How Long?)**
This refers to the **length of time** you received a certain dose of a chemical. A person taking a dose of 2 aspirin **every 4 hours for a week** is going to have a lot more aspirin in their body than someone who takes **3 aspirin a single time.**

{c}ROUTE OF ENTRY **(How Do The Chemicals Get There?)**
Chemicals can affect you by four different paths:

{i} BREATHING
Any chemical that is in the air will be inhaled into your lungs. Once there, many will pass into your bloodstream.

{ii} SKIN
Some chemicals are able to pass straight through the skin, usually without you feeling it, and directly into the bloodstream. Chemicals like this, (Kerosene, Phenol), can be dangerous, because there is no way to measure exposure and the employee will not know he/she is being exposed.

{iii} SWALLOWING
Any dust or residue that is in the workplace can settle on your hands, face, food, cigarette or drink. In all these cases the chemical may then get into your mouth and be swallowed. Even if in a place separate from where you work, the residue may remain on your hands or face and could get into your mouth and be swallowed.

{iv} DIRECT CONTACT
Some substances do direct damage to any tissue they touch. For example, some chemicals burn the skin on contact, without ever entering the body.

ii) Types of Exposure and Effect

{a} **Exposure**

{i} If you walked into a room where there was leaking chlorine gas, you would have **acute** exposure.

{ii} If you worked around formaldehyde and gradually developed an allergy over several weeks, you would have **chronic** exposure.

{b} **Effect**

{i} If you got a sudden bout of trouble breathing and wheezing from the formaldehyde, that lung allergy reactions would be an **acute** effect.

{ii} If there was enough chlorine gas to cause scarring of the lungs so that years later you still had trouble breathing, you would have suffered a **chronic** effect.

The main thing to remember is that acute **effects** will be felt quickly, and chronic effects last for a long time and are usually gradual, but that both types of effects can come from either short, quick (acute) **exposures** or long, slow (chronic) exposures.

c. Five Types of Health Hazards

i) IRRITATION
Some substances cause damage on contact with human tissue. These substances are called **irritants**. If the damage is very quick and severe, leading to <u>permanent damage</u>, the substance is called <u>**corrosive.**</u>

It is important to remember that even if the sensation you feel is mild, there is a chance that if the contact with the chemical continues, a more severe reaction can develop. If you breathe in a strong irritant you may get coughing and tightness in your chest, and in severe cases, even pain and trouble breathing. Severe irritation of the lungs can cause a serious reaction much like internal swelling. The fluid build-up, called pulmonary edema, can be fatal.

PREVENTION
The best way to protect yourself from the effects of irritants will vary with the chemical. If you are working with small amounts of nitric acid in a lab, goggles, and special gloves may be necessary. If you are around vapors of a highly irritating substance, full respirator protection will be required.

The major irritant/corrosive problems in this lab are:

Mineral acids		Hydroxides		Chlorine

ii) POISONS
Chemicals which shut down the functions of the body necessary for life - heartbeat, breathing, brain function, etc. Poisons usually enter the body without warning (many are not irritating) and begin to work in a very short time. In toxicology, chemicals may be classified as

{a} **Asphyxiants**
They prevent oxygen from entering cell metabolism.

{b} **Central Nervous System Depressants**
They inhibit brain cell activity.

In any case, if you are exposed to enough poison, death can be almost instant. At lower than fatal levels you may experience the following symptoms: lightheadedness, dizziness, weakness, trouble breathing, trouble concentrating, nausea, confusion.

If you experience these symptoms, it may be that you just need some fresh air, or if you are being exposed to a chemical at high levels, you should leave the area immediately and notify someone. Most of the time it will be serious, but every year **thousands** die of chemical poisoning. In many of these cases people thought they were just getting a little dizzy and kept working.

PREVENTION
Keeping exposure levels low is the only prevention. The most important thing you can do is take these risks seriously and stay informed about the hazards of the chemicals you are working with or around.

Examples of some poison problems in this lab are:

Phenol	Azides	Ethers
Alcochols	Xylene	Toluene

iii) ORGAN DAMAGE OVER TIME

Some chemicals are damaging to just one particular part of the body, called the **target organ**. These kinds of chemicals usually take a long time to do damage and the worker usually feels fine. By the time the symptoms appear and the organ no longer works right, the damage is usually permanent.

<u>PREVENTION</u>

Keeping exposure levels low is the only prevention. Most chemicals that can cause this kind of damage have legal exposure levels which should protect workers from the long-term effects of these chemicals.

Some chronic organ toxins in this lab are:

Cadmium

Beryllium

Carbon Tetrachlorides (liver toxin) lead

Hexane (absorbed through the skin - causes paralysis)

Mercury: [inorganic] not absorbed through the skin
[organic] absorbed through the skin
[metal] at room temperature gives off significant vapor.

iv) ALLERGY

Allergy causing chemicals, also called allergens and sensitizers, produce allergic reactions in people who have developed a **hypersensitivity** to them. Allergies always develop after the first exposure, but symptoms can occur at any time after that. In the process, exposure to an allergen leads to the formation of antibodies within the cells being sensitized. The antibodies cause no symptoms, but do mean that sensitization has occurred. On any subsequent exposure, histamine and other substances are released which cause the symptoms of allergy. Allergies cause 4 kinds of problems:

{a} **Skin Allergy** causes rashes that itch (i.e., poison ivy); the longer the exposures, the worse the reaction. If the worker is away from the chemical for a while it may get better.

{b} **Lung Allergy** causes asthma attacks, with shortness of breath, tightness in the chest, wheezing and coughing. Asthma also has other etiologies. Chemical asthma can be very serious.

{c} **Nose and Eye Allergies** - These allergic symptoms include: itching, watering eyes, etc., similar to those symptoms caused by hay fever.

{d**}** **Systemic Reaction -** This is a general overall body reaction. This includes anaphylaxis, a complete collapse of the circulatory system. You can easily and rapidly die from this. Workplace chemicals usually don't cause this kind of reaction, but in rare cases they might.

PREVENTION
If you have any of the above symptoms, check the SDS's of the chemicals you work with to see if they can cause allergies. You should also check with your doctor. If you become allergic to a chemical, you will probably need to work out a new job assignment. Chemical allergies usually don't go away, but get worse with time. Once you have become allergic, even small amounts of the chemical can trigger symptoms.

Some allergens used in this lab are:

Formaldehyde   Mercury and Nickel salts (potent skin allergens)

v) ABNORMAL CELL REPRODUCTION
Chemical **mutagens** cause alterations in DNA. **Mutations** can cause three results:

{a} mutations with no noticeable change

{b} cancer

{c} birth defects

Carcinogens are chemicals that cause cell changes that lead to cancer.
Teratogens are substances that cause mutations in a developing fetus that lead to a birth defect.

PREVENTION
There is no safe or unsafe level to exposure to carcinogens, mutagens or teratogens. The only way to deal with this kind of risk is to keep it as low as possible.

The known carcinogen, mutagen and reproductive hazards used in this lab are:

benzene	chloroform	formaldehyde
estradiol (17-beta)	lead compounds	cyanide compounds
hexavalent chromium	sodium azide	phenol
progesterone	thiourea	arsenic
aniline	o-toluidine	styrene
styrene	thioacetamide	dichloromethane
cadmium	carbon tetrachloride	2 botoxy-ethanol
chlorine	1, 4-dichlorobenzene	silica
ethylene dibromide	2-naphthylamine	phenacetin
4-amino biphenyl	benzidine	2-nitropropane
chlorophenols	trichloroethylene	

High incidence of nasal CA in Biology Teachers using formaldehyde.

CONTROL MEASURES

Source Control	Path	Worker
Substitution	Local Exhaust	Good Hygiene
Process Change	General Ventilation	Administrative
Isolation	Housekeeping	Education
Enclosure	Special Work Methods	

IV. SAFETY DATA SHEETS (SDS)

A. What is an SDS?

An SDS is an **information bulletin** provided by the manufacturer of a chemical. SDS's tell you the hazardous ingredients of a product and its particular characteristics. The Lab Rule lists SDS's as one possible reference for the hazards, safe handling, storage and disposal of hazardous chemical found in the lab. OSHA requires that employers maintain any copies of SDS's accompanying a shipment of chemical. When new and significant information become available about a product, chemical manufacturers must **update** their SDS within 3 months. Employers must inform lab workers of the location and availability of SDS's. This information is part of your "Employee Information Materials." OSHA does not require SDSs to be provided for household products as long as they are used in the same manner that a consumer uses them. Generic SDSs can be used for in-house products as long as they meet the minimum requirement found in 29 CFR 1910.1200(g).

B. Contents: Every MSDS should contain the following information:

1. **PRODUCT IDENTIFICATION** - The "identification" on the SDS should match exactly with the name on the container of the substance is labeled with.

2. **INGREDIENTS** - This section should list the components of the substance, their Chemical Abstract Services Number (CAS #), and the percentage of each component in the substance.

3. **PHYSICAL CHARACTERISTICS** - This section should include boiling points, vapor density, vapor pressure, appearance, odor, etc.

4. **CHEMICAL REACTIVITY CHARACTERISTICS** - This section will include what conditions under which the substance is unstable, how it reacts when mixed with certain types of substances, incompatible materials, etc.

5. **FIRE AND EXPLOSION HAZARDS** - This section will contain flashpoints, fire fighting procedures, unusual fire hazards, etc.

6. **HEALTH HAZARDS -** This section will include routes of exposure, symptoms, PELs, TLV's, first aid procedures, etc.

7. **PERSONAL PROTECTION/WORKPLACE CONTROL** - This section includes personal protective equipment, engineering controls, work practices, storage, handling, etc.

8. **SPILL AND LEAK PROCEDURES** - This section includes steps to be taken if the material is released or spilled, methods of disposal, etc.

V. SPILLS AND EMERGENCIES IN THE LAB

In the Standard Operating Procedures of this lab's Chemical Hygiene Plan, response procedures for each potential spill or leak problem are outlined.

VI. CHEMICAL HYGIENE PLAN

A. Availability of the Chemical Hygiene Plan: The Chemical Hygiene Plan must be readily available to all employees, employee representatives and upon request, to OSHA.

B. The Chemical Hygiene Plan must contain the following elements:

1. Standard Operating Procedures

2. Control Measures

3. Fume Hood Requirements

4. Medical Consultation and Exams

5. Prior Approval Forms

6. Designation of Personnel

7. Additional Employee Protection

Emergency Response Training

The University in accordance with OSHA Hazardous waste Operations and Emergency Response Rule 29CFR Part 1910 and the University Emergency Action Plan provides Emergency Response Awareness Level training for all employees likely to witness or discover hazardous substance release. The training focuses on the identifying and reporting of chemical incidents and accidents, understanding contents and use of the Emergency Response Guidebook, laws and guidelines used by DOT and OSHA pertaining to SDSs and labeling. In the Chemistry Department many faculty members find it difficult to attend the scheduled classes which led us to fulfill the regulatory requirements within the department.

During the first Department meeting of the academic year, an overview of the departments Emergency Response procedures is given to all present. Emergency Response procedures are made up of material covered in the Chemistry and Biology Chemical Hygiene Plan-Standard Operating Procedures (SOPs). An overview of the emergency response procedures is done, as well as standard labeling procedures and a review of where to acquire safety and emergency response information from labels and SDSs. SOPs also contains information on incident response and evacuation procedures. A quiz is given at the end of the presentation and discussion, which each employee (including student assistants) must pass with at least 70% accuracy.

A packet of information is given to all staff, including student assistants, which contains reminders for everyone such as where SDSs are located, chemical storage regulations, appropriate attire including clothing and eye protection, labeling regulations, proper disposal of hazardous waste and accident-incident procedures, logs and forms. A copy of the Chemical Hygiene Plan is e-mailed to all faculty and staff and it is also available on the School webpage. A hard copy of the Chemical Hygiene Plan is kept in the Chemistry department office. Also given is a copy of the latest Emergency Response Guidebook. After the presentation there is a question and answer period.

A list of personal hygiene and safety measures is handed out as well as being posted in the student labs.

All employees not present at the meeting and new employees are spoken to on an individual basis.

As a refresher all the above mentioned areas will be reviewed, and each year the training session will emphasize an area of the Chemical Hygiene Plan where changes have occurred or where specific questions need to be addressed.

REFERRAL FOR MEDICAL CONSULTATION/EXAMINATION

Referring Laboratory: ________________________Date:__/______/______

Referred to: Dr.____

Address:____

____

Date and time of appointment:___________,_____/_____/_____at__________.

Employees Name:____

This employee is referred to you for consultation/examination to determine if she or he may have suffered health effects from exposure to hazardous chemicals occurring while working in this lab.

The following are chemical substances the employee may have been exposed to:

____

____

The potential exposures occurred while the employee was performing the following activities:

____

____

Known conditions in the lab that may affect exposure (ventilation, protective equipment, length of exposure, etc.)

____

____

Signs and symptoms reported by the employee:_________________________________

____

PHYSICIAN'S REPORT OF MEDICAL EXAMINATION/CONSULTATION TO EMPLOYER

From: Dr. ________________TO:______________________________Laboratory

Report on Employee:____________________EXAMINATION DATE:___/_____/_____

The results of the evaluation on this individual to determine if there was a possible chemical-related health problem are:

____

____

Tests performed and results:

____

____

Diagnosis (*physician please note: report any medical condition which may place the employee at increased risk as a result of chemical exposure at work, and any possible relationship between current symptoms and chemical exposure; PLEASE DO NOT PROVIDE ANY DIAGNOSES THAT ARE NOT RELATED TO WORK EXPOSURES):

____

____

Recommendations for follow-up and further examination/testing:

____

____

I have informed the individual named above of the results of this consultation/examination and any tests, and advised them of all medical conditions requiring further examination or treatment.

Dr. ______________________

(Signed)

ANNUAL REVIEW AND UPDATE

The annual review of the Chemical Hygiene Plan was conducted on June / 26 / 2012 by Anne Marie Lavin & Rigoberto F. Garcia..

The following chemicals, procedures and policies addressed in the plan are no longer in use in this lab and will be deleted:

Observation of Fume Hoods -- Page 3 was deleted.

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____

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The following new chemicals, procedures and policies have been incorporated into lab operation and will be addressed in revised sections:

Section 1-[4A] Labs with hoods – Rooms E150 and HH105 were added.

Section 4 (4) Training page 21- #5 - (OSHA Hazard Communication Safety Training) was added.

Section 8 [c] – page 26 – Contractor for waste disposal was changed.

____

Experience with implementation of the plan to date has revealed concerns in the following areas which will be addressed by policy adjustments:

____

____

____

____

________________________ ___/___/___

(Signed) (Date)

Most of what appears below was taken from the Air Products' website (http://www.airproducts.com/) with its permission.

INFORMATION SPECIFIC TO LIQUID NITROGEN

- General
- Health Effects
- Physical Properties
- Containers
- Handling and Storage
- Personal Protective Equipment (PPE)

General

Liquid nitrogen is inert, colorless, odorless, non-corrosive, nonflammable, and extremely cold. Nitrogen makes up the major portion of the atmosphere (78.03% by volume, 75.5% by weight). Nitrogen is inert and will not support combustion; however, it is not life supporting. Nitrogen is inert except when heated to very high temperatures where it combines with some of the more active metals, such as lithium and magnesium, to form nitrides. It will also combine with oxygen to form oxides of nitrogen and, when combined with hydrogen in the presence of catalysts, will form ammonia.

Health Effects

Although nitrogen is nontoxic and inert, it can act as a simple asphyxiant by displacing the oxygen in air to levels below that required to support life. Inhalation of nitrogen in excessive amounts can cause dizziness, nausea, vomiting, loss of consciousness, and death. Death may result from errors in judgment, confusion, or loss of consciousness that prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur in seconds and without warning. Personnel, including rescue workers, should not enter areas where the oxygen concentration is below 19.5%, unless provided with a self-contained breathing apparatus or air-line respirator.

Physical Properties

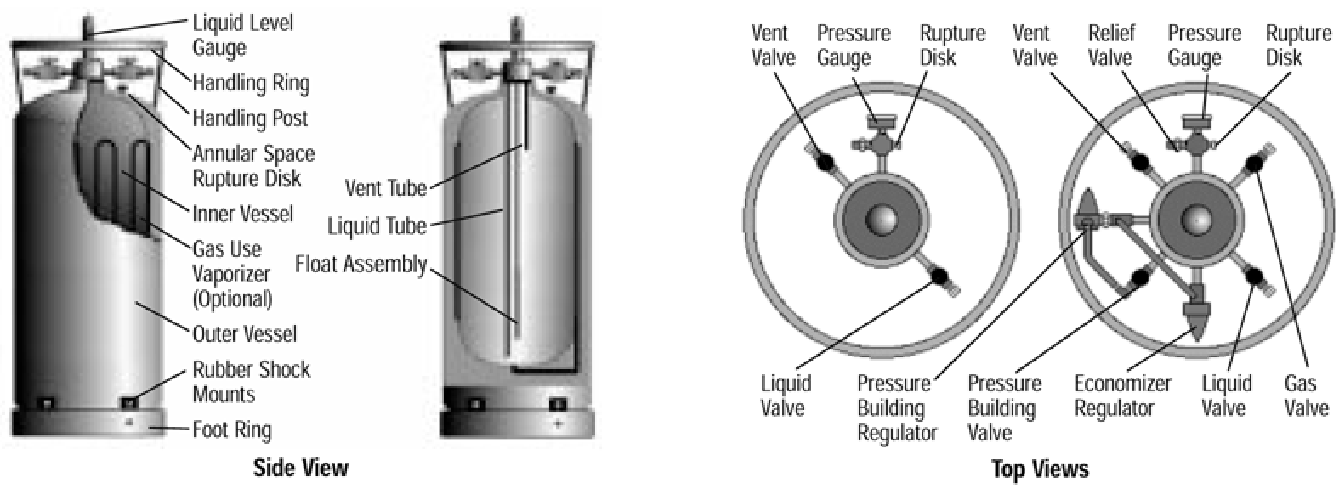
- **Molecular Weight:** 28.01
- **Boiling Point @ 1 atm:** -320.5°F (-195.8°C, 77^{o}K)
- **Freezing Point @ 1 atm:** -346.0°F (-210.0°C, 63^{o}K)
- **Critical Temperature:** -232.5°F (-146.9°C)
- **Critical Pressure:** 492.3 psia (33.5 atm)
- **Density, Liquid @ BP, 1 atm:** 50.45 lb/scf

- **Density, Gas @ 68°F (20°C), 1 atm:** 0.0725 lb/scf
- **Specific Gravity, Gas (air=1) @ 68°F (20°C), 1 atm:** 0.967
- **Specific Gravity, Liquid (water=1) @ 68°F (20°C), 1 atm:** 0.808
- **Specific Volume @ 68°F (20°C), 1 atm:** 13.80 scf/lb
- **Latent Heat of Vaporization:** 2399 BTU/lb mole
- **Expansion Ratio, Liquid to Gas, BP to 68°F (20°C):** 1 to 694

Containers

Fig. 2 shows a typical cryogenic liquid cylinder. Cryogenic liquid cylinders are insulated, vacuum-jacketed pressure vessels. They come equipped with safety relief valves and rupture discs to protect the cylinders from pressure build-up. These containers operate at pressures up to 350 psig and have capacities between 80 and 450 liters of liquid. Product may be withdrawn as a gas by passing liquid through an internal vaporizer or as a liquid under its own vapor pressure.

Figure 2



Handling and Storage

Store and use this product with adequate ventilation. Do not store in a confined space. Cryogenic containers are equipped with pressure relief devices to control internal pressure. Under normal conditions, these containers will periodically vent product. Do not plug, remove, or tamper with any pressure relief device. Never allow any unprotected part of the body to come in contact with uninsulated pipes or equipment that contains cryogenic product. The extremely cold metal will cause the flesh to stick fast and tear when one attempts to withdraw from it. Use a suitable hand truck for container movement. Containers should be handled and stored in an upright position. Do not drop, tip, or roll containers on their sides. Do not remove or interchange connections. Contact the vendor if you experience any difficulty operating the container valve or with the container connections. Discontinue use. Use the proper connection. **DO NOT USE ADAPTERS!**

Use piping and equipment designed to withstand the pressures to be encountered. On gas withdrawal systems, use a check valve or other protective apparatus in any line or piping from the container to prevent reverse flow. To prevent cryogenic liquids or cold gas from being trapped in piping between valves, the piping should be equipped with pressure relief devices. Only transfer lines designed for use with cryogenic liquids should be used. Some elastomers and metals such as carbon steel may become brittle at low temperatures and will easily fracture. These materials must be avoided in cryogenic service. It is recommended that all vents be piped to the exterior of the building or to a well ventilated indoor space.

Personal Protective Equipment (PPE)

One must be thoroughly familiar with the properties and safety considerations before handling a cryogenic liquid and its associated equipment. The eyes are the most sensitive body part to the extreme cold of the liquid and vapors of cryogenic liquids. The recommended personal protective equipment for handling cryogens includes a full face shield over safety glasses, loose-fitting thermal insulated or leather gloves, long sleeve shirts, and trousers without cuffs. In addition, safety shoes are recommended for people involved in the handling of containers. Depending on the application, special clothing suitable for that application may be advisable.

A special note on insulated gloves: Gloves should be loose-fitting so they are able to be quickly removed if cryogenic liquid is spilled on them. Insulated gloves are not made to permit the hands to be put into a cryogenic liquid. They will only provide short-term protection from accidental contact with the liquid. In emergency situations, self-contained breathing apparatus (SCBA) may be required.

Created: July 14, 2010