TEXAS A&M UNIVERSITY-TEXARKANA

CHEMICAL HYGIENE PLAN

DECEMBER 2000

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I. PURPOSE

Protecting the health and safety of every person on the Texas A&M University-Texarkana campus is of paramount importance, and it is a continuous work in progress. The TAMU-T Chemical Hygiene Plan (CHP) constitutes written standard operating procedures designed to ensure laboratory operations are carried out in a manner that protects all persons from harmful exposures associated with hazardous chemicals, as well as complying with state and federal regulations and The Texas A&M University System Laboratory Standard.

II. OBJECTIVES

The TAMU-T Chemical Hygiene Plan shall be used in all current and future laboratories. The plan will be continuously reviewed and updated as needed and/or required. The safety and well being of all persons will be accomplished by our dedication to achieving the following goals:

- Provide the necessary facilities, staff and equipment to operate in the safest manner possible
- Reduce or minimize the extent of chemical exposure
- Follow all aspects of the Chemical Hygiene Plan
- Provide adequate ventilation to all laboratories
- Observe the Threshold Limit Values (TLVs) for all chemicals
- Ensure the chemical inventory in labs is constantly maintained in a manner that ensures only the least amount of required chemicals are on hand for the specific needs of the department, as well as constant monitoring of the inventory to dispose of chemicals that have reached the end of their shelf life
- Protect the environment from hazardous chemicals and chemical waste
- By inspecting all laboratories on a periodic basis to ensure all of the above goals are being met

III. SAFETY RESPONSIBILITIES

Responsibility for chemical hygiene in the laboratory rests with the responsible Dean, the Chemical Hygiene Officer (CHO), the Principal Investigator (PI), and the laboratory worker.

The TAMU-T President has the ultimate responsibility for the chemical hygiene program within the University and must provide continuing support for institutional chemical hygiene.

A. Chemical Hygiene Officer

The head of the Biology/Science Department shall be the designated Chemical Hygiene Officer (CHO). The CHO is responsible for chemical hygiene and laboratory safety. The CHO shall provide guidance to the

Principal Investigator (PI) on developing and implementing chemical hygiene plans and for providing technical assistance in developing standard operating procedures related to chemical hygiene, laboratory safety and emergency response. The CHO is responsible for giving prior approval for any operation which presents a foreseeable hazard to any person.

B. Principal Investigator

The Chemical Hygiene Officer (CHO) shall designate a Principal Investigator (PI). The Principal Investigator shall be responsible for developing and implementing the Chemical Hygiene Plan. The PI is responsible for the health and safety of all personnel under his direction. Specific responsibilities include:

- Reviewing the CHP on an annual basis, ensuring it is continuously updated as to current chemical safety procedures
- Monitoring the purchase, use and disposal of chemicals used in laboratory procedures
- Ensuring all lab personnel and students are properly trained in the use of hazardous chemicals
- Maintaining documentation of training
- Ensuring all personnel and students know and follow the rules of laboratory safety
- Ensuring engineering controls are operative and personal protective equipment is properly selected, used and maintained
- Reviewing specific hazards for each new chemical introduced into the lab and training personnel/students in safe handling of the chemical
- Ensuring Material Safety Data Sheets are available for each hazardous chemical found in the laboratory
- Seeking ways to improve chemical hygiene and laboratory safety
- Filing written reports to the University President, the Health and Safety Committee and the Risk Management Office concerning any chemical spill, accident or injury that occurs in the laboratory
- Ensuring regular chemical hygiene and housekeeping inspections are performed
- Understanding and keeping current of all legal requirements concerning hazardous chemicals
- Ensuring laboratory equipment is properly maintained and in good working order

C. Employees/Students

All laboratory employees and students are responsible for:

- Knowing and following the proper safety procedures in the CHP
- Reporting all hazardous conditions to the lab supervisor
- Wearing the prescribed personal protective equipment

- Reporting any injury, illness or chemical spill to the lab supervisor

- Requesting information or training when unsure of how to handle a hazardous chemical

IV. STANDARD OPERATING PROCEDURES

This document represents an initial minimum set of guidelines for the handling of hazardous chemicals in TAMU-T laboratories. A hazardous chemical can be defined as any chemical that poses a physical or health hazard. As the University grows, individual administrative units, laboratories or research groups are expected to develop more detailed procedures as their individual situations warrant.

A. General Guidelines

Every laboratory worker shall observe the following guidelines:

- If an injury occurs in the lab that requires medical attention, call 9-911 immediately

- Students working in laboratories must be supervised by a lab employee at all times

- If a toxic/hazardous chemical comes in contact with the skin, immediately begin flushing the area with water and continue to do so for at least 15 minutes or until medical assistance arrives

- Know the safety rules and procedures that apply to the work being performed; review potential hazards and take the appropriate safety precautions before beginning any new operation

- Become familiar with the location and use of: fire extinguishers, eyewash stations, emergency showers, fire exits, evacuation routes and fire alarm pull stations

- Become familiar with the types of personal protective equipment (PPE) available and understand its use and limitations; always wear the required PPE when using hazardous chemicals

- Use only the chemicals for which you have the appropriate exposure controls (such as a chemical fume hood) and appropriate training

- Only TAMU-T employees, students and approved visitors are allowed in TAMU-T laboratories

- Make sure all equipment is in good working order before using hazardous chemicals

- Use hazardous chemicals and all lab equipment only as directed or for their intended purpose

B. Operations Requiring Prior Approval

The CHO must give prior approval and be ultimately responsible for any laboratory activity which presents a foreseeable hazard to employees, students or structures. This would include such operations as working alone, conducting unattended experiments and conducting particularly hazardous experiments.

1. Unattended operations – Unattended experiments must be approved by the CHO. The employee performing the experiment must design procedures to prevent the release of hazardous substances in the event of an interruption of utility services, such as cooling water and/or electricity. Lights should be left on and signs posted identifying the nature of the hazardous substance in use.

2. Working alone – Students are not allowed to work in laboratories without supervision of a TAMU-T lab employee, unless the student is an independent research student who has been approved to work alone by the PI. It is advisable for lab employees to always avoid working (conducting experiments, tests, etc.) alone in a laboratory. If an employee must work alone for some reason, prior approvable must also be given by the CHO. Experiments known to be of a particularly hazardous nature shall **never** be undertaken by anyone while working alone.

3. Hazardous materials – Very hazardous materials, such as carcinogens, reproductive toxins and chemicals with a very high degree of acute toxicity, will not be purchased or used without prior written approval from the CHO. The CHO must weigh the need for conducting operations using these type chemicals with the degree of risk of exposure to staff and students. If the risk outweighs the need, the CHO shall deny the request.

C. Emergency Eyewash/Safety Showers

Emergency eyewash stations are located in the TAMU-T Laboratory. These stations should be kept free of any obstruction which might inhibit their use. Eyewash stations should be tested on a monthly basis to verify the units are in proper working order and to flush the lines of stale water and debris. The PI is responsible for ensuring these stations are checked. Documentation of the time, date and the person's name that performed the check shall be kept by the PI. Presently, there is no safety shower in the TAMU-T Laboratory. There is a faucet with an attached hose that will be used as a safety shower for the time being. This faucet is located in a storeroom at the southwest end of the 2nd floor of the academic building.

D. Equipment

Only use the proper equipment for each task and ensure that equipment is in good working order. All glassware should be handled, used and stored with the utmost care to prevent chips, cracks and breakage. If cracked or chipped glassware is found, it should never be used for any task, but disposed of in the proper manner.

E. Fire Extinguishers and First Aid Kits

Each laboratory will be equipped with fire extinguishers and first aid kits. Everyone working in a laboratory will be shown how to properly use the extinguisher. Fire extinguishers shall be mounted on an interior lab wall in a highly visible and accessible area. Each extinguisher will be checked on an annual basis to ensure it is in good working order. First aid kits will be checked by the Risk Management Office during regular campus-wide first aid kit checks, to replenish supplies as needed.

F. Horseplay

Horseplay and practical jokes are not permitted in the laboratory. While these activities may be the source of good fun in the appropriate place, they become dangerous in laboratory settings where hazardous chemicals are used. These types of activities will not be tolerated and could result in the expulsion of the offender from the laboratory.

G. Housekeeping

There is a definite relationship between safety and orderliness in all areas of life. If housekeeping standards fall, the likeliness of having a safe environment deteriorates. All laboratory work areas must be kept clean and clear of obstructions and clutter. Floors must be kept clean and dry and all halls and aisles shall remain clear of

boxes or other items that could be trip hazards. All laboratory wastes shall be kept in appropriate containers and labeled accordingly.

H. Material Safety Data Sheets (MSDSs)

MSDSs should be the first source of information about the hazards associated with any chemical. MSDSs should contain the following information, divided into separate sections on the sheet:

- Name, address and phone number of the manufacturer
- Chemical name, synonyms, and Chemical Abstract Number (CAS)
- Physical properties
- Health hazard information (most MSDSs use NFPA or HMIS hazard ratings)
- First aid measures
- Firefighting measures
- Handling and storage precautions
- Exposure controls/personal protection
- Stability and reactivity

Most newer MSDSs willl also contain the following information:

- Toxicological information
- Ecological information
- Disposal consideration
- Transport information
- Regulatory information

Manufacturers are required to provide a MSDS for each chemical product they sell. A MSDS book will be placed in a conspicuous place in the TAMU-T laboratory. The Risk Management/Security Office maintains a file of all MSDSs for every hazardous chemical on campus. If you are using a chemical that you cannot find an MSDS for, contact the Risk Management Office and one will be provided for you.

I. Personal Protective Equipment and Personal Hygiene

Personal Protective Equipment (PPE) and personal hygiene are basic aspects of laboratory safety. The PI is responsible for the selection, procurement, care and replacement of all personal protective equipment. The following guidelines will minimize exposure to hazardous chemicals during routine use and in the event of an accident.

1. Appropriate Clothing – Skin and body protection involves wearing protective clothing over all parts of the body that could become contaminated with hazardous chemicals. It is recommended that employees/students wear long-sleeved/long-legged clothing to minimize exposed skin surfaces. A lab coat should be worn over street clothes and should be laundered regularly. Lab coats are intended to prevent contact with dirt, chemical dusts and minor chemical splashes or spills. If they become contaminated, they should immediately be removed and the affected skin surface washed thoroughly. Sandals or open-toed shoes should not be worn. Long hair and loose clothing should be confined.

2. Protective Clothing – Additional protective clothing may be required for some types of procedures or with specific substances. This may include impermeable aprons and gloves as well as plastic coated coveralls, shoe covers and arm sleeves. These garments can be either washable or disposable. The choice of garments depends on the degree of protection required and the areas of the body which may be contaminated.

3. 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 full face shields are the three main types of eye protection. The degree of protection required is dependant on the type chemicals being used. Safety glasses shall be worn when using any chemical. Safety goggles should be worn in situations where bulk quantities of chemicals are being handled and chemical splash to the face is possible. Goggles and full face shields should be worn when handling highly reactive substances or large quantities of hazardous chemicals, corrosives, poisons and hot chemicals. All eye protection should meet the requirements of the American National Standards Institute (ANSI) standard, Z87-1. Material Safety Data Sheets (MSDS) will list the recommended PPE for use with each chemical.

4. Glass Tubing – When inserting tubing into stoppers, lubricate tubing and wear leather gloves to protect hands from being cut in the event of the tubing breaking.

5. Gloves – Gloves are essential when working with hazardous substances. The proper gloves will prevent skin absorption, infection or burns. Chemical resistant gloves should be worn whenever the potential for contact with corrosive or toxic substances and substances of unknown toxicity exist. Glove selection should be based on the type chemical being handled, the particular hazard involved, and the glove's suitability for the operation being conducted. Before each use, gloves should be checked for integrity. Gloves should also be washed before removal whenever possible to prevent skin contamination. Non-disposable gloves should be replaced periodically, depending on frequency of use and their resistance to the substances being handled.

6. Personal Hygiene – Hands should be washed frequently throughout the day; after glove removal, before leaving the lab, after contact with any hazardous material, and before eating, drinking, smoking or applying cosmetics.

7. Respiratory Protection – Inhalation hazards can be controlled using ventilation or respiratory protection. Check the chemical label and MSDS for information on a substance's inhalation hazard and special ventilation requirements. When a potential inhalation hazard exists, the label or MSDS will contain special warnings. Take appropriate precautions when handling these substances. Controlling inhalation exposures through engineering controls (ventilation) is always the preferred method. As with other PPE, respiratory protection relies heavily on employee work practices and training to be effective.

8. Respirators - TAMU-T does not use any chemicals at this time requiring the use of a respirator. In the future, if it becomes necessary to use chemicals requiring respirators, a Respiratory Protection Program will need to be put in place before the chemical can be introduced into the lab or any other area of the University.

J. Hazard Assessments

Before any task involving hazardous materials or physical hazards is performed, the PI should conduct a written hazard assessment for the project. Tasks involving similar hazards may be grouped together in a single assessment. The hazard assessment should not be limited to chemical hazards, but should also include such issues as radiation hazards, biological hazards, heat and cold hazards and physical hazards.

V. LABORATORY CHEMICALS

A. Chemical Procurement

The PI for any laboratory shall establish guidelines for the procurement of all lab chemicals and shall be responsible for all hazardous chemicals purchased for TAMU-T laboratories. Requests for new chemicals must be submitted to the PI for approval before purchasing. All employees involved in the receiving of chemicals should be informed about proper handling, storage and disposal procedures. Chemicals should not be accepted without accompanying labels, Material Safety Data Sheets and proper packaging. Damaged or leaking containers shall not be accepted for any reason. All chemicals should be dated upon receipt. The PI should always inform employees about the proper handling of any new chemicals introduced into the laboratory.

B. Chemical Classifications

1. Flammable and combustible

   Flammable substances are those that readily catch fire and burn in air. The vapors from flammable liquid burn, not the liquid itself. Flammable liquids are those that have a flash point below 100 degrees F and a vapor pressure that does not exceed 40 pounds per square inch (psi) at 100 degrees F. In addition to liquids, flammable substances are also solids and gases. Examples of flammable gases are acetylene, ethylene oxide and hydrogen. Flammable solids are those that are capable of producing fires as a result of friction or heat retained from production or that, if ignited, produce a serious transportation hazard.

   A combustible liquid is one which has a flash point at or above 100 degrees F. Organic acids are combustible materials with many being liquids.

   a.) Explosives

   Explosive gases and solids are also part of the flammable and combustible group. Light, mechanical shock, heat and certain catalysts can act as initiators of explosive reactions. One example of explosive mixture is a suspension of oxidizable particles, such as magnesium powder or zinc dust, in air. Explosives include nitrates, chlorates, perchlorates, and picrates.

   b.) Pyrophorics

   Pyrophoric chemicals are those substances that react so rapidly with air and its moisture that the ensuing oxidation and/or hydrolysis lead to ignition. Ignition can be instantaneous, delayed, or occur only if the material is finely divided or spread in a diffuse layer. Some examples are: finely

divided metals, such as calcium, magnesium, and zirconium; metal or non-metal hydrides, such as germane and diborane; alkylated metal alkoxides or non-metal halides, such as diethylethoxyaluminum.

Spontaneous (instantaneous) ignition or combustion occurs when a substance reaches its ignition temperature without the application of external heat. Substances capable of spontaneous combustion include alkali metals such sodium and potassium, finely divided pyrophoric metals and phosphorus.

c.) Water-reactive substances

Water sensitive compounds react exothermically and violently with water, particularly if it is present in limited quantities, since no significant cooling effect will occur. Some examples of water-reactive chemicals would include alkali and alkaline earth metals such as potassium and calcium; anhydrous metals halides, such as aluminum bromide and germanium chloride.

d.) Peroxidizable substances

Peroxidizable substances slowly react under ambient conditions with atmospheric oxygen to initially form peroxides. Some peroxide formers are ethers, liquid paraffins and olefins. Peroxides are extremely sensitive to shocks, sparks or other forms of accidental ignition. Since these chemicals are packaged in an air atmosphere, peroxides can form even though the packages have not been opened. Unless an inhibitor was added by the manufacturer, sealed containers of ethers should be discarded within one (1) year of receiving. It is very important to date such containers upon receipt and opening.

2. Corrosives

Corrosives include strong acids, strong bases, dehydrating agents, and oxidizing agents. These chemicals erode the skin, damage the eyes and cause severe bronchial irritation.

a.) Strong acids

All concentrated acids can damage the skin and eyes. Nitric, chromic and hydrofluoric acids are particularly damaging because of the types of chemical burns they inflict. When handling these chemicals, rubber gloves, aprons and face shields must be used.

b.) Strong bases

Common bases include sodium hydroxide, potassium hydroxide and ammonia. Metal hydroxides are extremely damaging to the eyes. When handling these chemicals, the appropriate gloves, aprons and face shields must be used.

c.) Dehydrating agents

Strong dehydrating agents include concentrated sulfuric acid, sodium hydroxide, phosphorous pentoxide, and calcium oxide. These substances can cause severe burns on contact with the skin because of their affinity for water.

d.) Oxidizers

Oxidizers can be defined as any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials.

C. Chemical Transporting

Transporting chemicals should always be handled in a manner that ensures the safety of all personnel. Carts used for transport should be sturdy and have a substantial rim around the edge. Glass bottles must be protected during transportation within the building. Use bottle carriers for transporting chemicals which are in glass containers. Safety-coated glass bottles can be purchased from the manufacturer. Beakers and flasks should be grasped by the body, not by the lid. When hand carried, they should be placed in an acid bucket to protect against spillage or breakage. Jars of solids should be moved in plastic boxes. Close caps securely and avoid storing chemical containers in hard to reach areas. Pour chemicals carefully and never add water to concentrated acid. Containers holding more than five (5) gallons should be grounded when transferring flammable liquids.

D. Chemical Storage

The proper storage of chemicals is very important for the health and safety of all laboratory staff. Improper storage can result in hazardous situations that can endanger laboratory workers as well as campus property. The following is a list of important safety rules for the storage of chemicals:

- Never store chemicals solely by alphabetical order; segregate according to hazard class and then place alphabetically
- Never store liquids above eye level
- Store especially hazardous chemicals in a secondary container
- Don't store chemicals in a fume hood
- Return chemicals to their storage areas at the end of the day
- Flammable chemicals that should be refrigerated must be stored in an approved, **explosion-resistant** refrigerator that is labeled as such
- Never stack bottles on top of one another
- Never store chemicals anywhere other than an approved storage area
- Label all chemical containers with the date of receipt and the date opened

E. Inventory Control

Proper inventory control is essential in the laboratory. The security of the laboratory chemical inventory rests with the lab PI. All PI's are required to inventory their chemicals when they initially set up their labs. Chemicals that are inherited with the lab should be disposed of if they no longer are of any use. Subsequent shipments of chemicals must be dated and included on the chemical inventory list when they are received. The PI shall also conduct an annual inventory of all chemicals on hand. A copy of this inventory shall be

maintained in the laboratory and a copy shall be sent to the Risk Management Office. Additionally, the following principals should be applied in an effort to keep an accurate track of laboratory chemicals.

1. Chemicals must be purchased in limited amounts. A (6) six-month supply, or less, is generally the preferred amount.

2. An expiration date should be assigned to each chemical container. This date should be no longer than one year from the date received. At the end of the period, a chemical may be marked for disposal or assigned a new expiration date if there is no hazard. (This would not include peroxide formers.)

3. Information about every chemical received, such as date received, manufacturer and quantity, shall be recorded on a chemical inventory form to ensure a "cradle-to-grave" record of each chemical.

4. One person should be designated as the individual responsible for removal and return of chemicals to the storage area. This person should record the date and time checked out, returned and the amount used.

5. Chemicals should be examined semi-annually. During this inspection, those chemicals which have the following conditions should be disposed of using proper procedures: chemicals kept beyond their shelf life; deterioration of the chemical; questionable labels or no labels; leaking containers; and corroded caps.

F. Special Considerations

In addition to the general requirements for storing chemicals, various groups of chemicals have special considerations.

1. Flammable and combustible liquids

Maximum allowable container capacity, in NFPA 45, sets the maximum allowable size of container for the storage of flammable liquid and combustible liquids in laboratories.

Flammable Liquids	Combustible Liquids
IA fp<73F (22.7 C) bp < 100 F (37.4 C)	Class II fp>100 F (37.4 C) < 140 F (60 C)
IB fp<73F (22.7 C) bp > 100 F (37.4 C)	Class IIIA fp>140 F (59.4 C) < 200 F (93.3C)
IC fp>73F (22.7 C) bp < 100 F (37.4 C)	Class IIIB fp>200 F (93.3 C)

Container Type	Flammable Liquids			Combustible Liquid	
	IA	IB	IC	II	IIIA
Glass	500 ml (1 pt.)	1L (1 qt.)	4L (1.1 gal.)	4L (1.1 gal.)	20L (5 gal.)
Metal (non-drum)	4 L (1.1 gal.)	20 L (5 gal.)	20 L (5 gal.)	20L (5 gal.)	20L (5 gal.)
DOT approved plastic	4 L (1.1 gal.)	20 L (5 gal.)	20 L (5 gal.)	20L (5 gal.)	20L (5 gal.)
Safety cans	10 L (2.6 gal.)	20 L (5 gal.)	20 L (5 gal.)	20L (5 gal.)	20L (5 gal.)
Metal drum	Not Allowed	20 L (5 gal.)	20 L (5 gal.)	227L (60 gal.)	227L (60 gal.)
Polyethylene	4 L (1.1 gal.)	20 L (5 gal.)	227 L (60 gal.)	227L (60 gal.)	227L (60 gal.)

The presence of flammable liquids in glass containers presents substantial hazards from accidental breakage. Many suppliers furnish glass containers with shatter-resistant coatings. These shatter-resistant glass containers offer significant protection from accidental breakage and are recommended for use when hazardous chemicals must be kept in glass rather than plastic or metal containers. Flammable

and combustible materials should be kept as far away from oxidizers as possible. Organic acids, which are combustible, generally should not be stored with mineral acids, which are oxidizers.

2. Oxidizers

Oxidizers should be stored to avoid contact with incompatible materials, such as combustible or flammable liquids. Solid oxidizers should not be stored directly beneath incompatible liquids. Oxidizers should be stored on separate shelves with solid vertical and horizontal partitions isolating each shelf. Gaseous oxidizing materials are highly reactive, and can react vigorously with finely divided metals, organic liquids, and other materials that are readily oxidizable. Spilled oxidizers should be placed in a clean, separate container and disposed of in a proper manner. Oxidizer materials should not be placed in the trash. Spilled materials should never be returned to the original container.

3. Health hazards

Chemicals that are considered to be health hazards include those that are highly toxic and carcinogenic substances. Storage areas should exhibit a warning sign and have limited access.

4. Compressed gases

Cylinders of compressed gas should be securely strapped or chained to a wall or bench top. When a cylinder is not in use, it must be capped. Cylinders should always be stored in a secure, upright position.

5. Corrosives

Corrosives should never be stored with combustible or flammable materials. They should be stored in storage cabinets or in polyethylene trays or containers large enough to contain the contents of the bottle. Care must be exercised to prevent mutually reactive substances from contacting one another. For example, sulfuric acid should never be stored in the same tray or cabinet as sodium hydroxide.

6. Water-sensitive and air-sensitive chemicals

Water-sensitive chemicals should naturally be stored away from water sources. Air-sensitive chemicals should be stored under inert gas whenever possible. Containers should be waterproof and/or sealed against air exchange, and inspected frequently.

7. Unstable chemicals or chemicals with a short shelf life

Whenever possible, unstable chemicals, or those with a short shelf life, should be purchased with inhibitors present. Consumption of the chemical should occur before the inhibitor is exhausted. These chemicals should be protected from heat, high temperature, rapid temperature changes, mechanical shock and light.

8. Incompatible chemicals

Chemicals that are incompatible should not be stored together. It is impossible to list all of the chemical incompatibilities that can be potentially encountered in the storage area. When in doubt, lab workers should consult the PI or CHO for proper storage instructions. MSDS and references such as the NFPA 49, Hazardous Chemical Data and NFPA 491M, Manual of Hazardous Chemical Reactions, can provide useful information concerning potential storage problems.

G. Labels

Make sure all labels are easily readable. Label all secondary containers with the chemical name and appropriate hazards. Date all peroxidizable and other chemicals which may become unstable over time. Test and /or dispose of them within a year of receiving.

H. Containers

Make sure all containers are in good condition. If deteriorated containers are found, dispose of the container and transfer the chemical to a good container. Make sure the container is appropriate for the chemical being stored. Examples are: hydrofluoric acid must not be stored in glass containers and some oxidizers should not be stored in plastic containers.

VI. LABORATORY FUME HOODS

The chemical fume hood is one of the most important pieces of safety equipment in the TAMU-T laboratory. The fume hood is intended for use during all procedures which pose a significant inhalation hazard. A properly maintained and working fume hood provides a continuous wall of air flowing though the face of the hood.

A. Fume Hood Air Flow

Air flow patterns in labs can be affected by many factors, such as traffic patterns, room make-up air, doorways, room size, hood location, work practices, objects inside the hood, baffle adjustments and sash openings. Ideally, there should never be any turbulence at the hood face which could spill contaminated air into the room. All areas of the open hood face should have a velocity sufficient to draw room air and not spill contaminated air from the hood.

B. Fume Hood Classification Guidelines

Fume hood velocities for all labs on the TAMU-T campus will be evaluated on an annual basis. The face velocity of all hoods shall fall between 80 and 120 feet per minute (FPM) for normal chemical use. If the face velocity is between 70-79 or 121-150, the hood should be marked for restricted use, indicating it should not be used for protection from highly toxic substances. If the hood falls into any other range, it shall not be used, and it will be marked indicating it is shut down for repairs.

C. Fume Hood Work Practices

1. All work involving hazardous chemicals should be performed inside a ventilation hood.

2. Before any work involving hazardous chemicals is performed, turn the hood fan on and make sure it is working.

3. Check the inspection sticker to make sure the hood has been inspected within the last year.

4. Fume hoods should be used with the sash positioned at 18 inches or less when possible for optimal performance.

5. Keep all equipment at least 6 inches inside the face of the hood to prevent disruptive airflow patterns.

6. Maintain an air space under large equipment by placing on blocks to allow air currents to freely pass under the equipment. This minimizes "dead space" at the hood face and thereby improves overall hood performance.

7. Do not use the fume hood as a storage cabinet. Excessive storage can obstruct airflow and cause areas of low air velocity at the face opening.

8. Do not put your face or head inside the hood.

9. **Do not use perchloric acid in the TAMU-T fume hood,** as it is not designed for the use of this chemical.

10. Minimize sources of cross drafts (open windows, doors, fans, etc.) which may pull contaminated air from the hood.

11. Ensure all fume hood users are aware of safety procedures in case of an emergency.

D. Fume Hood Inspections

Fume hoods shall be inspected on an annual basis by the PI or other qualified persons and shall be certified in writing. The PI will maintain a copy of the fume hood certification and a label will be placed on the hood indicating the date inspected, the person/company performing the inspection and that the hood is in proper working order. In the event a fume hood fails an inspection, a warning sign shall be posted indicating the fume hood is out of service for repair and the hood shall not be operated for any reason until properly repaired. Any observed decline or failure of operation warrants an immediate shut-down of the hood and the PI shall be notified to initiate repairs and post warning signs that the hood is inoperable.

VII. ELECTRICALLY POWERED LABORATORY APPARATUS

The utilization of electrically powered equipment can pose hazards in the laboratory when not used properly. Problems that are encountered when using any lab equipment should be reported to the laboratory supervisor immediately.

A. Electrical Concerns

The typical laboratory requires a large quantity of electrical power. This increases the likelihood of electrically-related problems and hazards. The following recommendations are basic to a sound electrical safety program in the laboratory.

1. All electrical equipment should be properly grounded.

2. All electrical equipment shall be U.L. listed and/or F.M. approved.

3. Sufficient room for work must be present in the area of breaker boxes. All circuit breakers and fuses shall be labeled to indicate whether they are in the "on" or "off" position, and what appliance or room area is served.

4. All electrical equipment shall be routinely checked to ensure it is in good working order.

5. All power cords will be checked for cuts or fraying before each use.

6. Extension cords shall not be used as a substitute for permanent wiring.

7. Electrical cords shall not be suspended over doors or passageways. Cords should not be routed over metal objects such as emergency showers, overhead pipes or metal racks. Do not place cords under carpets, rugs or heavy objects. Do not place cords across pathways where they will become worn from repeated abuse.

8. Multi-outlet plugs shall not be used unless they have a built-in circuit breaker. This causes overloading on electrical wiring, which will cause damage and possible overheating.

B. Autoclaves

The use of an autoclave is a very effective way to decontaminate infectious waste. Autoclaves work by killing microbes with superheated steam. Although they are very effective sterilizers, accidents and injuries can result from improper use. In order to safely operate the autoclave, the following procedures must be utilized:

1. Do not put sharp or pointed contaminated objects into an autoclave bag. Place them in an appropriate rigid sharps container.

2. Never use red biohazard bags to autoclave.

3. Always use caution when handling an infectious waste autoclave bag in case sharp objects were inadvertently placed in the bag. Never lift a bag from the bottom to load it into the chamber, lift from the top of the bag.

4. Never overfill an autoclave as an over-packed autoclave chamber does not allow efficient steam distribution.

5. Conduct autoclave sterility testing on a regular basis using appropriate biological indicators to monitor efficiency. Use indicator tape with each load to verify it has been autoclaved.

6. Do not mix contaminated and clean items together during the same autoclave cycle. Clean items generally require shorter decontamination times (15-20 minutes) while a bag of infectious waste (24" X 36") typically requires 45 minutes to an hour to be effectively decontaminated throughout.

7. All lab workers shall wear personal protective equipment, including heat resistant gloves, safety glasses and a lab coat when operating an autoclave. Caution should be used when opening the autoclave door, allowing superheated steam to exit before removing the contents.

8. Always be on the alert when handling pressurized containers as superheated liquids may spurt from closed containers. Never seal a liquid container with a cork or stopper as this could cause an explosion inside the autoclave.

9. Avoid contact with Agar plated as it will melt and the agar will become liquefied when autoclaved. Use a secondary tray to catch any potential leakage from an autoclave bag rather than allowing it to leak onto the floor of the autoclave chamber.

10. If there is a spill inside the autoclave chamber, allow the unit to cool before attempting to clean up the spill. If glass breaks in the autoclave, use tongs, forceps, or other mechanical means to recover fragments. Do not use bare or gloved hands to pick up broken glassware.

11. Do not leave an autoclave operating unattended for a long period. Always be sure someone is in the vicinity while an autoclave is cycling in case there is a problem.

All autoclaves should be placed under a preventive maintenance contract to ensure they are operating properly.

C. Centrifuges

All centrifuge operators shall be instructed on proper operating procedures, which would include balancing loads, selection of proper rotor, head, cups, and tubes, and use of accessory equipment. (Consult the centrifuge operating manual.) Additionally, the following guidelines should be followed when dealing with centrifuges.

1. The centrifuge operator is responsible for the condition of the machine at the end of each procedure.

2. Operating procedures for each centrifuge must be established by the laboratory Principal Investigator in accordance with the procedural outlines in the operating manual. Guidelines for centrifugation of infectious agents, chemical hazards and/or radioactive materials must be included in the procedures.

3. Plastic centrifuge tubes should be used whenever possible to minimize breakage.

4. Nitrocellulose tubes should only be used when clear, without discoloration, and flexible. It is advisable to purchase small lots several times a year rather than one large lot. Storage at 4 C extends shelf life. Nitrocellulose tubes must not be used in angle-head centrifuges.

5. All centrifuge tubes must be inspected before each use. Broken, cracked or damaged tubes should be disposed of.

6. Refer to the centrifuge operating manual for selection of appropriate tubes, carrier cups, and rotors. Capped centrifuges should be used whenever possible.

D. Refrigerators

There should not be any potential sources of electrical sparks on the inside of a laboratory refrigerator where chemicals are to be stored. Three types of chemical storage refrigerator/freezers exist: explosion-proof, explosion-resistant, and modified domestic models. If the unit will be used to store flammable or combustible materials, the refrigerator/freezer should be explosion-resistant and labeled to indicate it is suitable for storing flammable materials.

The explosion-resistant refrigerator/freezer has a spark-proof, corrosion-resistant interior. The electrical components are encased, and the door gaskets are non-sparking. The explosion-proof refrigerator is engineered for spark-proof operation externally. This type of refrigerator is hard-wired at installation to meet local electrical codes for maximum safety in hazardous areas, such as a chemical storage room.

All refrigerators, regardless of the type, should never be used to store food and must have labels on the door indicating this.

E. Drying Ovens

Drying ovens are commonly used to remove water or other solvents from samples, and to dry laboratory glassware. Since these ovens do not have a provision for preventing the discharge of volatilized substances into the air, organic compounds should not be dried in these units. Conventional oven units should not be used to dry

any chemical that is moderately volatile and might pose a health hazard of acute or chronic toxicity. Glassware rinsed in organic solvent should not be dried in an oven.

F. Lasers

Currently, TAMU-T is not equipped for the use of lasers. Lasers shall not be used until approval is given by the TAMU-T President, CHO and PI.

VIII. SPECIAL PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES

In addition to general safety guidelines, special precautions are needed when handling select carcinogens, reproductive toxins and substances that have a high degree of acute toxicity.
The PI shall ensure that the below listed precautions are taken in order to minimize risk of exposure to these substances.

1. Quantities of these substances used and stored in the laboratory should be minimized, as should their concentrations in solutions or mixtures.

2. Work with genotoxins, reproductive toxins and acutely toxic chemicals should be performed within a functioning hood, biological safety cabinet, sealed system, or other system designed to minimize expsure to these substances. (The exhaust air from the ventilation system may require scrubbing before being released into the atmosphere.) In all cases, work with these chemicals shall be done in such a manner that the OSHA permissible exposure limits (PEL) or similar standardsare not exceeded.

3. Compressed gas cylinders which contain acutely toxic chemicals, such as arsine and nitrogen dioxide, should be kept in ventilated gas cabinets. The ventilation efficiency of the designated ventilation hood or gas cabinet and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances should be evaluated periodically by the PI. The interval of evaluating systems may vary from weekly to semi-annually depending on the frequency of usage, quantities employed and the level of the hazard.

4. TAMU-T laboratories utilizing these substances must designate an area for this purpose and must sign or mark this area with an appropriate hazard warning. The designated area may be the entire laboratory, an area of the lab or a device such as a ventilation hood or glove box. The designated area must be marked with a DANGER, specific agent, AUTHORIZED PERSONNEL ONLY or comparable warning sign.

5. All laboratory staff who work in a TAMU-T lab which has an area designated for use with select carcinogens, reproductive toxins and acutely toxic chemicals must be trained regarding the serious harmful effects of these substances as well as signs and symptoms regarding exposure to these substances, whether or not they actually work with the substances themselves.

6. TAMU-T lab workers working with these substances must have access to the appropriate personal protective equipment and clothing and must be trained on how to properly utilize the safety equipment.

7. Detection equipment may be required if chemicals (especially poisonous gases) with a high degree of acute toxicity are utilized.

8. All waste contaminated with these substances should be collected and disposed of in a timely manner as outlined in the TAMU-T Hazardous Waste Program.

9. The designated work area shall be thoroughly decontaminated and cleaned at regular intervals.

10. Special precautions to avoid release and exposure to highly toxic chemicals, reproductive toxins and genotoxins must be utilized. For instance, volatile substances should be kept cool and contained. Gases should have properly functioning valves, check valves and regulators. Containment, which can withstand pressure buildup and appropriate piping and dispersive solids, should be kept in closed containers and used in places with minimum air currents. Appropriate contact materials should be used to avoid static charging.

11. Emergency response planning for releases or spills shall be prepared by the PI and included in the training of laboratory workers and others which may be affected in the building.

IX. CHEMICAL DISPOSAL

Hazardous chemicals used in the TAMU-T laboratory will be disposed of in a safe, approved manner consistent with all applicable laws and the TAMU-T Campus Waste Management Program. Laboratory staff should use the smallest quantity of hazardous substance that is practical to generate the least amount of hazardous waste. This should include reviewing experimental protocols with the goal of substituting non-hazardous or less hazardous reagents, using micro-scale procedures, and using materials that can be easily neutralized or detoxified. TAMU-T has an approved, underground chemical neutralization/dilution system that is connected to the laboratory sinks. Small quantities of lab chemicals can be flushed down the sinks sending the chemical to the underground dilution tanks. Maintenance of the dilution tank as well as the approved disposal of any leftover chemical waste in the tank will be the responsibility of the Director of the Physical Plant.

X. EMERGENCY PROCEDURES

All laboratory personnel need to know what to do in the event of a chemical spill or other emergency that may occur in TAMU-T laboratories. While most spills can be safely cleaned up by those who caused the spill, some spills should only be cleaned up by specifically trained emergency response personnel. Most spills can be avoided if proper spill prevention guidelines are followed. The CHO, PI and the Risk Management Office shall be notified whenever there is a spill of any type. An analysis of the spill will be conducted in order to find out the cause of the spills and what methods could be taken to prevent it from happening again.

A. Spill Prevention

1. General precautions

    - Reduce clutter and unnecessary materials in work areas
    - Eliminate tripping hazards
    - Have all of the needed equipment readily available before starting work

2. Storage precautions

    - Use sturdy shelves
    - Store large containers close to the floor

- Push containers on shelves to the back of the shelf to avoid falling
- Purchase storage shelves with lips to further reduce the danger of falling
- Inspect the storage area on a regular basis for leaking or defective containers
- Use the appropriate storage container
- Don't store unprotected glass containers on floor

3. Transportation precautions

- Use carts when appropriate to transfer chemicals
- Use safety containers when possible
- Use bottle carriers for large bottles
- Use straps to secure containers when appropriate
- Think about potential hazards before transporting chemicals
- Consider purchasing plastic coated shatter resistant bottles

4. Transferring precautions

- Pay careful attention to the size container being used to avoid overfilling
- Use pumps or other mechanical devices rather than simply pouring a chemical
- Provide containment to capture leaks and spills

B. Spill Preparation

Before any hazardous chemical is used in the laboratory, the PI has the responsibility to perform a hazard assessment of the procedure to be undertaken. This would include determining what could go wrong and what to do in the event of a spill or other emergency. When performing this task, the PI should determine what PPE is needed, as well as any other safety equipment and containment/clean-up materials and to have these items on hand. Spill control kits should be available and their locations clearly marked. All staff and students should be aware of the kits, how to use them and their limitations. Suggested items for Small Spill Kit are:

- Safety goggles
- Lab coat
- Heavy gloves appropriate for the material
- 5 gallon plastic bucket
- Small bag of absorbent (kitty litter)

- Acid/Base neutralization materials
- Acid spill- sodium bicarbonate
- Base spill- monosodium phosphate
- Small broom and dustpan

C. Emergency Response

Anytime a spill occurs, whether a major spill or relatively minor one, there are certain procedures to follow to ensure the situation is controlled as much as possible. This helps to prevent or minimize further injury or damage to property and the environment. If a small spill is not handled properly, it can turn into a much more serious situation. Large spills can turn into major catastrophes if not handled properly.

1. Small spills:
    - Alert other staff and students in the area of the spill
    - Wear protective equipment, including safety goggles, gloves and long-sleeved lab coat
    - Avoid breathing vapor of spilled materials
    - Absorb or cover the spill with suitable materials, collect residue, place in container and dispose of through the Campus Hazardous Waste Program
    - Clean spill area with soap and water for final decontamination
    - Notify the CHO or PI. Dependant on the hazardous nature of the chemical spilled, the CHO or PI will decide if the situation warrants notifying the TAMU-T President, Risk Management Office or any other responders
2. Large spills:
    - Attend to injured or contaminated persons and remove them from the area
    - Alert people in and around the lab to evacuate
    - Call 9-911 for emergency responders
    - Turn off ignition and heat sources
    - Close doors to affected areas
    - Make sure the incident area is sealed off and have knowledgeable laboratory staff available to consult with emergency responders
    - Meet at a designated area away from the incident to ensure all persons are accounted for

- Notify the CHO and PI who shall in turn notify: the University President, V.P. for Academic Affairs, Risk Management Officer and the Director of Physical Plant.

3. Contamination:

- In case of skin contact, flush the area with large amounts of water for at least 15 minutes and seek medical assistance

- In case of eye contact, flush eyes for at least 15 minutes with large amounts of water and seek medical assistance

- Remember to call 9-911 for all medical emergencies and notify the CHO and PI. Dependant on the nature of the contamination, they in turn may need to notify the TAMU-T President and Risk Management Office

XI. TRAINING

All individuals who work in TAMU-T laboratories who may be exposed to hazardous chemicals must be apprised of the hazards of chemicals present in the lab. Laboratory safety training must be provided to all new employees before initial assignment and before new exposure situations. The TAMU-T Principal Investigator is responsible for ensuring all staff and students are properly trained in the use of hazardous chemicals and equipment in the laboratory. Laboratory training must include:

- Detection methods and observations that may be used to detect the presence or release hazardous chemical. Examples of detection methods include visual appearance, odor and an understanding of chemical monitoring devices.

- Physical and health hazards of the chemical

- Work practices, personal protective equipment, and emergency procedures to be used to ensure that the employee may protect him/herself from overexposure to hazardous chemicals

All laboratory workers must also be informed of the location and availability of the following:

- Location and information on how to read Material Safety Data Sheets (MSDSs)

- OSHA Lab Standard- 29CFR Part 1910.1450

- TAMU-T Chemical Hygiene Plan

- Reference material on chemical safety, including Material Safety Data Sheets (MSDSs)

- Permissible exposure limits (PELs) for OSHA regulated substances

- Signs and symptoms associated with exposure to the hazardous chemicals found in the TAMU-T lab

The training of all staff and students shall be documented as to date, time, location, instructors name and what information was covered. Staff training records shall be maintained by the Risk Management Office.

XII. MEDICAL EVALUATIONS

Medical consultation and/or examination by a licensed physician who is experienced in diagnosing and treating victims of chemical exposure shall be made available to employees of TAMU-T laboratories under the following circumstances:

- When any individual develops signs or symptoms associated with exposures to the hazardous materials being used
- When monitoring reveals exposures above the "Action Level" or PEL established for the chemical
- An accident such as a spill or equipment failure results in possible overexposure to hazardous materials

This would also include any follow-up exams deemed necessary by the licensed physician. All exams and consultations will be provided at no cost to the employee, without loss of pay, and at a reasonable time and place. TAMU-T will provide the physician with:

- Identity of the hazardous chemical the employee was exposed to, if known
- Description of the conditions under which the exposure occurred
- Description of the signs and symptoms of exposure that the individual is experiencing

LABORATORY EMERGENCY NOTIFICATION PHONE NUMBERS

Appendix A

A. In the event of a small chemical spill, notify:

1. CHO - Dr. David Allard…….. 223-3131
2. PI - Dr. Chris McAllister……..…… 223-3133

Dr. Allard or Dr. McAllister will decide whether the nature of the spill warrants notifying any emergency responders, the TAMU-T President, Risk Management Office or other responders.

B. In the event of a large spill, notify:

1. All emergency responders…… 9-911
   (Police, Fire, Life Net, Emergency Management)

2 Dr. David Allard - CHO…….. 223-3131

3. Dr. Chris McAllister - PI……..…. 223-3133

4. Dr. Stephen Hensley – President……. 223-3001

5. Dr. John Johnson - V.P. for Academic Affairs……. 223-3003

6. John Gann - Risk Management…… 223-3114, pager # 260-0497

7. Ward Martaindale - Physical Plant…… 223-3049, pager # 791-3601

8. Martha Clay or Gail Hackworth - Reception…… 223-3000

INCOMPATIBLE CHEMICALS

Appendix B

CHEMICAL	KEEP OUT OF CONTACT WITH:
Acetic acid	Nitric acid, chromic acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganate
Acetic anhydride	Hydroxyl-containing compounds, such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals, such as sodium potassium, lithium, magnesium, calcium, powdered aluminum	Carbon dioxide, carbon tetrachloride, other chlorinated hydrocarbons (Also prohibit the use of water, foam and dry chemical extinguishers on fires involving these metals. Dry sand should be employed.)
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Bromine	(same os chlorine) Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Butyl lithium	Water
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic acid	Naphthalene, camphor, glycerol, acetic acid, turpentine, alcohol, flammable liquids in general
Chlorine	(same as bromine) Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids, organic and inorganic
Cyanides (NA, K)	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, other oxidizing agents and halogens
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant
Hydrocarbon (benzene, butane, propane, gasoline, turpentine, etc.)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or there salts, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid oxidizing gases
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitroparaffins	Inorganic bases, amines
Nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, acetone, nitratable substances, flammable gases
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, sulfuric acid, organics
Peroxides, organic	Acids (organic or mineral), also avoid friction, store cold
Phosphorous (white)	Air, oxygen

CHEMICAL	KEEP OUT OF CONTACT WITH:
Phosphorous pentoxide	Alcohols, strong bases, water
Potassium perchlorate	Acids (see also, perchloric acid)
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Acids, (see also, chlorates)
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid
Silver and silver salts	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid, acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	Carbon tetrachloride, carbon dioxide, water, (see alkali metals)
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural

CHEMICAL GLOVE CHART

Appendix C

TYPE GLOVE	ADVANTAGES	DISADVANTAGES	USE AGAINST:
Natural rubber	Low cost, good physical properties, dexterity	Poor vs. oils, greases, organic; may be poor quality	Bases, alcohols, dilute aqueous solutions, fair vs. aldehydes, ketones
Natural rubber blends	Low cost, dexterity, better chemical resistance than natural rubber vs. some chemicals	Physical properties frequently inferior to natural rubber	Same as natural rubber
Polyvinyl chloride (PVC)	Low cost, very good physical properties, medium chemical resistance	Plasticzers can be stripped; frequently imported, may be poor quality	Strong acids and bases, salts, other water solutions, alcohols
Neoprene	Medium cost, medium chemical resistance, medium physical properties	NA	Oxidizing acids anilines, phenol, glycol ethers
Nitrile	Low cost, excellent physical properties, dexterity	Poor vs. benzene, methyl chloride, trichloroethylene, many ketones	Oils, greases, aliphatic chemicals, xylene perchloroethane, trichloroethane
Butyl	Specialty glove, polar organics	Expensive, poor vs. hydrocarbons, chlorinated solvents	Glycol ethers, ketones, esters
Polyvinyl Alcohol (PVA)	Specialty glove, resists a very broad range of organics, good physical properties	Very expensive, water sensitive, poor vs. light alcohols	Aliphatics, aromatics, chlorinated solvents, ketones, (except acetone) esters, ethers

TYPE GLOVE	ADVANTAGES	DISADVANTAGES	USE AGAINST:
Fluoroelastomer (Viton)	Specialty glove, organic solvents	Extremely expensive, poor physical properties, poor vs. some ketones, esters, amines	Aromatics, chlorinated solvents, also aliphatics and alcohols
Norfoil (Silver shield)	Excellent chemical resistance	Poor fit, easily punctures, poor grip, stiff	Use for Hazmat work